THE DURHAM SCHOOL

PH.D. SYMPOSIUM 2024

Thursday, May 23rd
Omaha, Nebraska

THE DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION

UNIVERSITY OF NEBRASKA–LINCOLN

NORTHEAST ROOM

1 – 1:25 PM	**"Indoor Particle Exposure and Emotional Dilemmas Faced by Occupants in Extreme Weather"** Xingtong Guo Worcester Polytechnic Institute
1:25 – 1:50 PM	**"Real-time Indoor Sensing of Volatile Organic Compounds During Building Disinfection Events via Photoionization Detection and Proton Transfer Reaction Mass Spectrometry"** Xiaosu Ding Purdue University
1:50 – 2:15 PM	**"Indoor Atmospheric Nanocluster Aerosol Dynamics in Residential Buildings"** Satya Sundar Patra Purdue University
2:15 – 2:40 PM	**"Interactive Effects of IEQ Factors on Environmental Stress"** Mirmahdi Seyedrezaei University of Southern California
2:40 – 2:50 PM	**BREAK**
2:50 – 3:15 PM	**"Exploring Inclusive Spaces for Women in Civil Engineering"** Elizabeth Volpe University of Florida
3:15 – 3:40 PM	**"A Field Study of HVAC System Faults in 340 U.S. Houses"** Seyed Ali Rooholghodos University of Nebraska - Lincoln
3:40 – 4:05 PM	**"Causal Thinking on Thermal Comfort - Towards a Causal Inference Approach in Building Science"** Ruiji Sun University of California Berkeley
4:05 – 4:30 PM	**"Spatial-Temporal Building Energy Vulnerability Analysis: A Human-Centered Approach"** Chen Xia Pennsylvania State University

SOUTHEAST ROOM

1 – 1:25 PM	**"Data Collection for Validation of Recovery Models: Quad-State Tornado Field Study"** Blythe Johnston Colorado State University
1:25 – 1:50 PM	**"Utilizing Machine Learning for Efficient Post-Earthquake Building Assessment"** Abdallah Al Zubi University of Nebraska - Lincoln
1:50 – 2:15 PM	**"Digital Twin for Monitoring In-Service Performance of Post-Tensioned Self-Centering Cross-Laminated Timber Shear Walls"** Yiye Xu Oregon State University
2:15 – 2:40 PM	**"Design for Reuse Enrichment of BIM Models"** Guilherme Eliote University of Texas at Austin
2:40 – 2:50 PM	BREAK
2:50 – 3:15 PM	**"Leveraging Remote Sensing Technology and Advanced Computing Techniques to Support Operation and Maintenance of Infrastructure Systems"** Shiva Arabi Arizona State University
3:15 – 3:40 PM	**"Future of Building Inspection - Damage Level Quantification Using Computer Vision and Graph Theory"** Pedram Bazrafshan Drexel University
3:40 – 4:05 PM	**"Construction Safety Training and Efficiency Assessment with Mixed Reality"** Xuanchang Liu Illinois Institute of Technology
4:05 – 4:30 PM	**"Bridging Generations: Enhancing Skill Transfer in the Building Manufacturing Industry for an Aging Workforce "** Ruoxin Xiong Carnegie Mellon University

BIOS & ABSTRACTS - PH.D. SYMPOSIUM

(in alphabetical order by last name)

Abdallah Al-Zu'bi

Abdallah is pursuing his Ph.D. in Architectural Engineering under the supervision of Dr. Fadi AlSaleem and Dr. Roohi. He began his studies at UNL in Spring 2022. His current research focuses on implementing machine learning algorithms using low-power physical devices.

Education qualification includes; M.Sc., Smart Building Engineering, University of Nebraska Lincoln (2023) (Thesis: "Trainable Continuous Time Recurrent Network), M.Sc., Data Science, Princess Sumaya University for Technology (2021 (Thesis: "A Clustering Approach Based on Pathfinder Optimization)"B. Sc., Computer Engineering, Jordan University of Science and Technology (2012) Graduation project "Automated system for Arabic optical character recognition"

Professional Experience includes: Data Scientist, AI lab for John Wiley & Sons (2019-2022), and Software Engineer at SEDCO, Globital, and Atypon (2012-2019)

Utilizing Machine Learning for Efficient Post-Earthquake Building Assessment

In the aftermath of earthquakes, the rapid assessment of structural integrity in buildings is critical to ensure public safety and prioritize resource allocation. However, the traditional reliance on human experts for this assessment is fraught with challenges, including time constraints and the sheer scale of buildings needing evaluation. This research introduces an innovative approach utilizing machine learning (ML) to automate the process of building assessment post-earthquake. By leveraging advanced algorithms and vast datasets of structural health, our ML model can quickly and accurately evaluate the damage and stability of buildings. This method is particularly crucial for regions with limited resources, where many potentially compromised buildings might otherwise remain unchecked and pose a risk of collapse within weeks.

Shiva Arabi

Shiva Arabi is a Ph.D. candidate in civil, environmental, and sustainable engineering at Arizona State University, specializing in construction management. She received a bachelor's degree in architectural engineering from the Art University of Tehran and a master's degree in project management and construction from Tarbiat Modares University. Her research integrates remote sensing technology and advanced computing techniques to support the operation and maintenance of infrastructure systems. Her goal is to enhance the sustainability of built environments by improving the efficiency and longevity of these critical systems. She actively contributes to the academic community through publications in reputable journals and conference proceedings.

Leveraging Remote Sensing technology and Advanced Computing Techniques to Support Operation and Maintenance of Infrastructure Systems

Maintaining robust and sustainable infrastructure is crucial for the United States' global competitiveness and societal well-being. However, the nation's infrastructure is deteriorating, raising concerns about its long-term viability. Traditional operations and maintenance (O&M) practices rely heavily on physical inspections, which are often unreliable, time-consuming, and costly. This research explores the potential of advanced sensing and computing technologies to improve O&M processes for critical infrastructure systems, focusing on power grids and drinking water distribution networks. One objective is to integrate satellite imagery with machine learning algorithms for the automatic detection of underground water leaks. This approach aims for near real-time leak identification, allowing for targeted resource allocation and streamlined repairs, which could reduce overall costs. The second objective evaluates the effectiveness of tree growth regulators (TGRs) in controlling tree growth within powerline corridors. This study uses Light Detection and Ranging (LiDAR) data and mathematical models to assess the impact of TGRs. The findings indicate that TGRs can reduce the need for frequent tree pruning, potentially lowering the costs and volume of vegetation management activities. These findings contribute to the development of artificial intelligence and data-driven approaches for sustainable and efficient infrastructure O&M. By automating initial leak detection and optimizing vegetation management, this research aims to support a proactive and cost-effective approach to infrastructure maintenance.

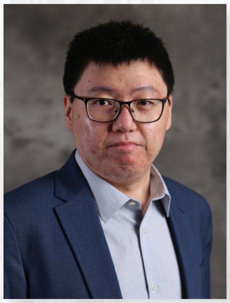
Pedram Bazrafshan

Pedram Bazrafshan is a Ph.D. Candidate in the Civil, Architectural, and Environmental Engineering (CAEE) Department at Drexel University. He started his Ph.D. studies in Jan 2023. Pedram's research endeavors are dedicated to automating the visual inspection process for structures, from data acquisition to a decision support system. His first journal paper was published in the high-impact factor (9.6) Journal of Computer-Aided Civil and Infrastructure Engineering and was featured as the cover paper of that issue. His scholarly efforts have been recognized by several awards, including the O. H. Ammann Research Fellowship in Structural Engineering by the American Society of Civil Engineers (ASCE), the 3rd place for the Best Student Paper Competition at the SPIE 2024 Smart Structures+NDE Conference, and the Provost's Award for Best In-Person Oral Research Presentation at Drexel University in 2023. Pedram is the President of the Graduate Student Association (GSA) of the CAEE department, and he is an active member of several professional societies.

Future of building inspection - Damage level quantification using computer vision and graph theory

This research focuses on automating the visual inspection process for structures. As infrastructures are aging and threats (e.g., hurricanes) are intensifying (e.g., due to climate change), the importance of enhancing the speed and reliability of monitoring and maintenance procedures is increasing. The inherently subjective and manual nature of current structural assessment procedures undermines the reliability of such practices. Therefore, developing objective and autonomous methods that facilitate robust and reliable infrastructure assessment is a necessity. In this regard, this research investigates surface mosaic crack patterns of concrete structures from a fundamental perspective. This research endeavor is to relate these crack patterns with quantifiable numbers: crack quantification.

Quantifiable features are therefore extracted from the crack patterns to translate the crack patterns into meaningful information. With this, different crack patterns of different structures can be fundamentally compared with each other, crack patterns can be linked to the damage level of the structures, etc. This research incorporates graph theory to convert crack patterns into their mathematical representative graph (combination of nodes and edges). Using artificial intelligence, graph features are then extracted. To showcase the capability of the proposed approach, this presentation delivers an example of predicting the damage index for cracked concrete shear walls. Specifically, for four different reinforced concrete shear walls (RCSWs), the results showed that the extracted graph features have more than a 70% correlation with the Park and Ang damage index, and the dissipated energy of each RCSW. These findings are a testament to the potential of the proposed method for studying crack patterns from a fundamental perspective.

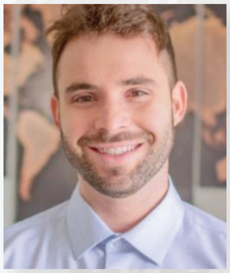


Xiaosu Ding

Xiaosu Ding is a Ph.D. candidate in the Department of Civil Engineering at Purdue University. His research topic is to develop building resilience and sustainability with the environmental sensing of built environments. Xiaosu's research work includes (1.) characterizing gas-phase indoor pollutants and human exposure during COVID-19 building disinfection activities; (2.) evaluating the real-time field performance of low-cost sensors in detecting indoor gas-phase pollutants; (3.) Indoor environment quality measurement on real-life living experiments in compact spaces. He is also a passional teacher, serving as a teaching assistant/teaching fellow for six semesters at Purdue University.

Real-time indoor sensing of volatile organic compounds during building disinfection events via photoionization detection and proton transfer reaction mass spectrometry

Photoionization detectors (PIDs) are low-cost sensors that are widely used for real-time volatile organic compound (VOC) monitoring in buildings. Performance assessments of PIDs are often based on reference VOC measurements derived from offline, time-integrated sample analysis. However, such assessment techniques lack valuable real-time information needed to evaluate how PIDs track transient emission events. This study evaluates the real-time performance of a PID in sensing indoor VOC mixtures during building disinfection events through co-location measurements with a state-of-the-art proton transfer reaction time-of-flight mass spectrometer (PTR-TOF-MS). The measurements show that, in general, the PID successfully identified VOC emission events and thus may be suitable for integration with building automation systems for ventilation control. However, the PID response was much less than PTR-TOF-MS, suggesting that the PID is not efficiently detecting many components of the emitted VOC mixtures.



Guilherme Eliote

Guilherme Eliote is a Ph.D. candidate in Construction Engineering and Project Management. He earned his master's degree in civil engineering from the University of Texas at Austin in 2021 and his bachelor's degree from the Federal University of Rio de Janeiro in 2017. Guilherme's research addresses building obsolescence and adaptation. He also focuses on advancing the circular economy through innovative strategies such as design for disassembly and reuse, utilizing Building Information Modeling (BIM).

Design for Reuse Enrichment of BIM Models

The construction industry is one of the most unproductive and wasteful sectors in the global economy. The concept of the circular economy (CE) has emerged as a promising solution to address environmental challenges. Although several CE strategies, such as Design for Reuse (DfR), have been extensively studied, their practical application remains limited. Building Information Modeling (BIM) offers a valuable tool to support the implementation of DfR concepts. However, several steps are needed to effectively integrate and evaluate DfR within a BIM platform. This presentation will demonstrate an approach to enhancing BIM models with influential DfR factors, facilitating comprehensive analysis and practical application.

Xingtong Guo

Xingtong Guo is a Ph. D student in the Department of Civil, Environmental, and Architectural Engineering at Worcester Polytechnic Institute (WPI). She holds a master's degree in Power Engineering from Tongji University. She has received the Postgraduate International Academic Conference Award Fund from Tongji University and Carl Koontz Awards from WPI. She is a current ASHRAE and ISIAQ member. Her research interests lie in occupant-centric building design, understanding occupants' thermal comfort and mental health during extreme weather, and building energy efficiency.

Indoor Particle Exposure and Emotional Dilemmas Faced by Occupants in Extreme Weather

Amidst advanced climate change, the frequency of extreme heat events and wildfires is increasing, leading to a rise in compound events. Occupants in naturally ventilated buildings may face the challenge of choosing between indoor air quality (IAQ) and thermal comfort when outdoor air has both high temperatures and poor quality. The impact of indoor heat stress on occupants' emotional (e.g., anger, sadness) and physical (e.g., rest, energy) states during extreme heat remains poorly understood, particularly in relation to different cooling methods. Additionally, the effects of window-opening behaviors on IAQ and PM2.5 exposure require further study.

In this study, we collected 10,795 subjective responses through Amazon Mechanical Turk (MTurk) from residents of six U.S. states during the summer of 2023. The results revealed a significant correlation ($r = 0.55$ to 0.68, $p < 0.001$) between self-evaluated heat stress experienced indoors and the emotional and physical states of the occupants. We also analyzed the impact of window-opening behaviors on indoor PM2.5 concentration during a wildfire in 2020. The findings suggested that window-opening behavior can lead to a 75% increase in the indoor/outdoor (I/O) ratio of PM2.5.

Blythe Johnston

Blythe Johnston is a PhD candidate at Colorado State University who works within the NIST Center for Risk-Based Community Resilience Planning. Before CSU, Blythe acquired her bachelor's degree in civil engineering at The University of Alabama. In her research, she studies community resilience and long-term recovery to natural hazards through field study data collection, interdisciplinary data integration, and agent-based modeling techniques. Her other recent work includes the integration of forward-looking climate data into local hazard mitigation plans and the exploration of social metrics that show predictive strength for adverse outcomes following a hazard event. The goal of this work is to advance interdisciplinarity in natural hazards research.

Data Collection for Validation of Recovery Models: Quad-State Tornado Field Study

With the increased modeling capabilities of recent years, it is now possible to model not only community-level damage due to a hazard event but also the recovery trajectory of the building stock in the months and years after this event. The Center of Excellence for Risk-Based Community Resilience Planning (CoE) has begun to provide analyses that simulate damage to the built environment across a user-defined region due to various hazard events, including floods, tornados, hurricanes, tsunamis, and earthquakes. This asset-level damage is chained with other models to simulate the socio-economic impact of the event as well as the anticipated repair times for various elements of the built environment. These simulations are run using the Interdependent Networked Community Resilience Modelling Environment (IN-CORE). The outputs must be validated for a range of implementation contexts and communities to ensure the analyses housed in IN-CORE possess sufficient generalizability and fidelity. To this end, the CoE is conducting a longitudinal study of a series of communities impacted to varying degrees by a tornado outbreak in December of 2021 to inform and validate building damage and repair models in IN-CORE. Due to the severity of the damage caused by this event and the number of communities that were simultaneously impacted by this event, the convened research team determined that a longitudinal field study of the area to document initial damage and recovery over time was merited. To optimize the limited time available in the field, a series of social parameters were considered to plan the most efficient trip of the most representative set of communities possible. The results of this work should lead to a more nuanced and contextualized understanding of how the same event can have varied long-term impacts on communities with different social characteristics. This longitudinal study is still underway, capturing recovery data for three years following the event.

Xuanchang Liu

Xuanchang Liu is a dedicated Ph.D. candidate in Architectural Engineering at the Illinois Institute of Technology, Chicago. With a master's in civil engineering from IIT, Xuanchang has developed a specialized Decision Support System to enhance the selection of building components based on maintainability principles. His doctoral research is pioneering the use of mixed reality in construction safety, aiming to revolutionize training methods and performance assessment in construction engineering. His work aims to refine construction engineering training methods and improve performance metrics, striving to implement more efficient educational practices and promote safer working conditions across the construction industry.

Construction Safety Training and Efficiency Assessment with Mixed Reality

Construction sites are characterized by their dynamic nature, as they are filled with a multitude of activities and potential risks. Safety in construction is a critical aspect of production activities and a major priority effort for successful implementations in construction organizations. Therefore, the provision of construction safety training plays a pivotal role in cultivating a safety-oriented environment within the construction sector. However, the efficacy and significance of the training program, as well as its adequacy, are perennially pertinent inquiries. This research investigated the effectiveness of mixed-reality (MX) devices compared to traditional lecture-based video training in construction safety education by analyzing both knowledge acquisition and practical application skills among construction engineering students. The results of this study suggest that while traditional and MX-based methods are comparably effective for theoretical knowledge transfer, MX devices offer a significant advantage in training scenarios that require the application of knowledge in practical, real-world-like settings. This indicates a potential shift in educational strategies within construction safety training, emphasizing the role of immersive technologies in enhancing critical practical skills.

Satya Sundar Patra

Satya is a Ph.D. student in the Lyles School of Civil Engineering at Purdue University, with a concentration in architectural engineering. His research focuses on understanding the fate and exposure of particles in indoor environments, with a particular interest in indoor new particle formation. Satya's dissertation is titled "Indoor Particle Dynamics in Residential Buildings: From a Few Nanometers to Tens of Micrometers." He is a Ross Fellow and Bilsland Fellow at Purdue University and has won multiple conference awards for his presentations, including at ACS Spring 2023 and Healthy Buildings 2023. He is also the recipient of the ASHRAE Grant-in-Aid Award, Dr. James Etzel Endowment, and John R. Blandford Graduate Student Award.

Indoor Atmospheric Nanocluster Aerosol Dynamics in Residential Buildings

Sub-3 nm nanocluster aerosol (NCA) can originate from primary processes, such as combustion, or secondary processes, such as the oxidation of volatile organic compounds (VOCs). NCA can effectively deposit in the human respiratory system and subsequently translocate to vital organs. Given their high surface area-to-mass ratios, NCA exhibit a higher likelihood of bioactivity and toxicity. Despite the human health relevance of NCA, their prevalence in indoor environments, where people spend most of their time, remains largely unknown. Indoor atmospheric NCA behavior and prevalence vary with building and occupant characteristics, and sources are often transient, leading to rapid concentration changes. However, a comprehensive understanding of the formation, transformation, and exposure of indoor NCA down to 1 nm in residential buildings is currently lacking. To address this, we conducted field measurements of indoor atmospheric NCA formation and growth during common household activities in a mechanically ventilated residential building. We also combined these measurements with a comprehensive material balance model to analyze the transformation of indoor atmospheric NCA. The findings reveal unique NCA dynamics and increased inhalation exposure to indoor atmospheric NCA during common household activities from both primary emissions and secondary formation. Additionally, these indoor atmospheric NCA could not be accurately modeled using conventional indoor air pollution markers like PM2.5 and NOx. Understanding these unique behaviors and transformations of indoor atmospheric NCA is crucial for assessing and mitigating potential human health risks in residential and office buildings.

Mirmahdi Seyedrazaei

Mirmahdi Seyedrazaei is pursuing a Ph.D. in Civil Engineering at the University of Southern California (USC) under Professor Becerik-Gerber's supervision. He holds BS and MS degrees in Civil Engineering from Sharif University of Technology and is also pursuing MSc degrees in Computer Science and Green Technologies at USC. He is passionate about adopting multidisciplinary approaches to improve living conditions, and his research focuses on human-building interactions and social justice in the built environment. Mirmahdi's current projects include a longitudinal study on office workers' stress and health using sensing technologies, matching learning, and statistical approaches. Additionally, he has explored how Indoor Environmental Quality (IEQ) factors interactive effects influence cognitive performance and stress, considering gender and BMI differences. Besides research, he enjoys traveling, hiking, humanitarian activism, reading, and playing sports.

Interactive effects of IEQ factors on Environmental Stress

This study examines how Indoor Environmental Quality (IEQ) factors—air temperature, lighting Correlated Color Temperature (CCT), and noise levels—affect environmental stress in office settings. Conducted through a mixed design-controlled experiment, the study involved 52 young adults in an open-plan office in a North American Mediterranean climate. Researchers assessed objective and subjective stress responses and environmental comfort under different conditions: air temperatures of 20°C and 25°C, lighting CCTs of 2700 K and 6500 K, and noise levels of 50 dB and 65 dB, considering gender and Body Mass Index (BMI). Findings indicated that higher temperatures and noise levels increased physiological stress, particularly among individuals with higher BMI. Gender differences were notable, with males showing higher stress responses under warmer conditions. The study also observed negative correlations between perceived comfort votes (acoustic, thermal, visual, and overall) and subjective stress (assessed by STAI score). By combining physiological responses and subjective perceptions, this research adds to the understanding of how complex dynamics of IEQ factors shape health in the workplace

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Seyed Ali Rooholghodos

Seyed Ali Rooholghodos is a Ph.D. candidate in Mechanical Engineering at the University of Nebraska-Lincoln, specializing in Fault Detection and Diagnosis of HVAC systems, Computational Fluid Dynamics, and data-driven analysis techniques. He holds a BSc from Bu-Ali Sina University and two MSc degrees in Mechanical Engineering from Ferdowsi University of Mashhad and The Catholic University of America. His current research focuses on enhancing the efficiency and reliability of air conditioning systems through innovative fault detection methodologies and comprehensive field studies, aimed at reducing energy consumption and improving system maintenance across various U.S. climates.

A Field Study of HVAC System Faults in 340 U.S. Houses

This research aims to analyze the prevalence of installation faults in residential air conditioning systems and heat pumps across various U.S. cities. These cities represent a range of climate zones and sizes to ensure a comprehensive understanding of the installation faults in diverse environments. The study focuses on systems installed within the last year to primarily assess installation-related faults rather than issues arising from aging or other factors.

The methodology includes identifying addresses with recently installed systems via city permit records and conducting a detailed online survey. Homeowners provided information about their AC systems and surrounding conditions. Additionally, a field study was conducted on participating homes, where comprehensive data collection involved sensor measurements, temperature and pressure readings in AC refrigerant circuits, and photographic documentation of system setups. Unique to this research is the development and proposed application of a novel methodology for measuring refrigerant charge in HVAC systems. This innovative approach, currently under patent consideration, enables the non-invasive measurement of superheat to determine refrigerant charge without the need for continuous pressure sensor installation. This advancement addresses the challenges of potential leakage and cost associated with traditional methods, offering a more reliable and efficient way to monitor refrigerant charge over time.

The goal of identifying fault prevalence is to estimate the energy losses associated with these faults, determine where additional efforts or regulatory measures are necessary, assess the value proposition of using fault detection and diagnosis tools, and understand the factors—such as geographical or socio-economic—that correlate with higher fault prevalence.

Based on the methodology described the findings from our comprehensive analysis are summarized below, highlighting key insights into fault patterns and system efficiencies:

- *The distribution of evaporator airflow fault intensity typically centers around -0.2, suggesting that many systems operate at flow rates below the optimal 400 cfm/ton. Statistically, all surveyed cities show a negative mean fault intensity, which supports the observation that most systems do not meet the ideal airflow rate.*
- *A significant number of HVAC systems exhibit a perfect refrigerant charge, indicating optimal charging in many cases. Across various cities, the mean refrigerant charge fault intensity values typically show slight variations around zero.*
- *A significant majority of HVAC systems exhibit no liquid line restriction faults, with the highest frequency count at fault intensity of zero, suggesting optimal liquid line flow.*

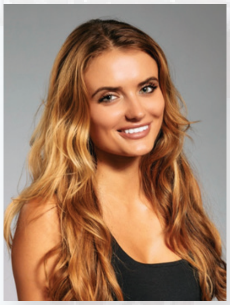
The study used two methods to assess HVAC system oversizing, revealing that the first method identified 26% of systems as oversized based on switching frequency, while the other stricter method found 13.5% oversized by observing consecutive short cycles.

Ruiji Sun

Ruiji Sun is currently a Ph.D. candidate in Building Science at UC Berkeley and a Research Assistant at the Center for the Built Environment (CBE). His dissertation focuses on causal inference in the built environment. Other areas of his research include indoor environmental quality, personalized environmental control systems, building metadata schema, and building energy modeling. He double majored in Mechanical Engineering (HVAC) and Architecture and then obtained an M.S. degree from Carnegie Mellon University. Ruiji also served as a board member of IBPSA-USA and as the president of ASHRAE at UC Berkeley.

Causal thinking on thermal comfort - towards a causal inference approach in building science

Causal thinking emphasizes the understanding of asymmetric causal relationships between variables, requiring us to specify which variable is the cause (independent variable) and which is the effect (dependent variable). Reversing the causal relationship direction can lead to profoundly different assumptions and interpretations. We demonstrate this by comparing two linear regression approaches used in thermal comfort research: Approach (a), which regresses thermal sensation votes (y-axis) on indoor temperature (x-axis); Approach (b), which does the reverse, regressing indoor temperature (y-axis) on thermal sensation votes (x-axis). From a correlational perspective, they may appear interchangeable, but causal thinking reveals substantial and practical differences between them. Approach (a) represents occupants' thermal sensations as responses to indoor temperature. In contrast, Approach (b), rooted in adaptive comfort theory, suggests that thermal sensations can trigger behavioral changes, which in turn alter indoor temperature. Using the same data, we found that two approaches lead to different neutral temperatures and comfort zones. Approach (b) leads to what we call a 'preferred zone', which is 10 C narrower than the conventionally derived comfort zone using Approach (a). We hypothesize that the 'preferred zone' might be interpreted as thermal conditions that occupants are likely to choose when they have significant control over their personal and environmental thermal settings. This finding has important implications for occupant comfort and building energy efficiency. We highlight the importance of integrating causal thinking into correlation-based statistical methods, which have been widely used in building science.



Elizabeth Volpe

Elizabeth Volpe, EIT, LEED-GA, is a Ph.D. candidate in the Simmons Research Lab located in the Department of Civil and Coastal Engineering in the Herbert Wertheim College of Engineering at the University of Florida. Her research interests include inclusive engineering, engineering leadership, professional formation, AI in Engineering, the experiences of early career women in engineering, and improving sustainability, diversity, equity, inclusion, and justice within engineering. Elizabeth received an M.S. in civil engineering and construction management and Engineering Leadership Certificate from the University of Florida and B.S. in civil engineering from Clemson University.

Exploring Inclusive Spaces for Women in Civil Engineering

To design and construct high-performance, sustainable, and healthy 'smart infrastructure' for the future, it is imperative to consider who is making design and building decisions. Workforce development and enhancing inclusion within the civil engineering industry are critical to addressing the challenges of tomorrow. This study focuses on diversifying the civil engineering workforce, particularly by improving the retention and inclusion of women in the field. By following the stories of early career women during a crucial period for career decision-making, I aim to understand how to create more inclusive spaces that support and retain women in engineering, ultimately leading to more inclusive design and construction practices.

Using qualitative research methods, specifically narrative inquiry, I followed the experiences of eight early-career women transitioning into civil engineering careers. Through interviews, diary entries, site visits, and observations, I gained insights into the challenges these women face and how they navigate them. Using the Workforce Sustainability model as a guiding framework, I was able to analyze the data for key constructs that contribute to a sustainable career in engineering. Additionally, we co-constructed generative AI images to design inclusive engineering workplaces, providing detailed descriptions and images of ideal engineering environments for women.

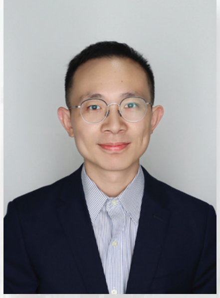
This research highlights how those in management can best support and sustain women in civil engineering, offering practical recommendations for creating and sustaining more inclusive workplaces. The implications of this work are significant for engineering leadership, policy, and women in engineering.

Chen Xia

Chen Xia is a Ph.D. Candidate in the Department of Architectural Engineering at Penn State University. Her overall research objectives lie in utilizing urban data analytics and large-scale energy modeling to advance sustainable and resilient urban systems. Her Ph.D. dissertation focuses on the spatial-temporal analysis of community energy vulnerability during extreme weather events.

Spatial-Temporal Building Energy Vulnerability Analysis: A Human-Centered Approach

With global trends in electrification, communities highly dependent on electricity face increasing challenges, especially with the increasing frequency of extreme weather events. These events surge electricity demand and cause widespread blackouts, affecting communities unevenly across different regions and times. This reality raises an urgent need to comprehensively assess residential energy vulnerabilities to ensure energy security for households. This presentation proposes a novel approach to building energy vulnerability analysis with a human-centered perspective. By integrating data on occupancy demographics, mobility patterns, and characteristics of the built environment, the work will provide a comprehensive profile of residential energy vulnerability which not only acknowledges the environmental aspects but also emphasizes the socio-economic dimensions of energy usage, thereby ensuring more targeted, equitable, and effective building decarbonization and electrification strategies.



Ruoxin Xiong

Ruoxin Xiong is a Ph.D. candidate from the Department of Civil and Environmental Engineering at Carnegie Mellon University. His research primarily focuses on understanding human-system dynamics using advanced data capture and processing technologies and developing risk-aware approaches in construction and infrastructure operations. His work spans various critical systems, including industrialized construction, airport operations, and bridge management.

Bridging Generations: Enhancing Skill Transfer in the Building Manufacturing Industry for an Aging Workforce

The building manufacturing industry faces the critical challenge of transferring knowledge and skills from an aging workforce to novice operators. Experienced workers possess a tacit understanding of the process dynamics to achieve efficient manufacturing performance. However, such tacit knowledge is difficult to share and retain within organizations. The aging manufacturing workforce issue has led to a need for decision-making support mechanisms for efficient operations. Two main challenges hinder the development of such systems. One challenge is the lack of data in modeling human-machine interaction dynamics. Another challenge is the lack of methods to interpret process patterns in changing contexts. We address these challenges by investigating the interplay between human operators and machines within dynamic manufacturing environments. Specifically, we first collected human-machine collaboration behaviors in different scenarios. A cognitive behavior decoding method interprets interactive behavior patterns between humans and machines. Simultaneously, we utilized behavior knowledge graph models to facilitate the transfer and reasoning of implicit knowledge related to efficient operations. Finally, we developed a large language model (LLM) augmented with a behavior knowledge graph to support decisions in operational tasks. An adaptive human-AI interface prototype was implemented and tested in real-world environments. The results demonstrate advancements in automated cognitive behavior capturing and decoding, leading to more efficient knowledge and skill transfer between workers. By bridging generational gaps and enhancing skill transfer, this research contributes to the sustainability of the building manufacturing industry.

Yiye Xu

Yiye Xu is a Ph.D. candidate at Oregon State University's School of Civil and Construction Engineering, expected to complete her degree in Civil Engineering with a minor in Computer Science by Summer 2024. She will join the Department of Engineering Technologies, Safety, and Construction at Central Washington University as an assistant professor in Fall 2024.

Her research interests center on smart construction and workplace safety. She leverages tools such as Building Information Modeling (BIM) and Unmanned Aerial Systems (UAS) to innovate in the planning, monitoring, and management of construction operations, thereby improving decision-making throughout the construction project life cycle. Xu has worked on various research projects funded by esteemed organizations such as the National Cooperative Highway Research Program (NCHRP), the National Science Foundation (NSF), the Pacific Northwest Transportation Center (PacTrans), and the Center for Construction Research and Training (CPWR). Her scholarly contributions have been published in top-tier academic journals and conferences, including the ASCE Journal of Computing in Civil Engineering, Engineering Construction and Architectural Management, and Safety Science.

Digital Twin for Monitoring In-Service Performance of Post-Tensioned Self-Centering Cross-Laminated Timber Shear Walls

A digital twin (DT) is described as a multiphysics, multiscale model in which a digital model, such as a building information model (BIM), is continually updated with data from a physical system, including sensor data and simulation results. This study explores the integration of sensor data into BIM as a foundational step towards employing DTs for structural health monitoring (SHM). It presents a methodological approach for embedding the as-built geometry, material properties, and sensor data of existing buildings into a digital model, thereby enhancing the ability to assess structural performance. Using a mass-timber structural system at Oregon State University's George W. Peavy Forest Science Center as a case study, the BIM was developed from light detection and ranging (LiDAR) point clouds. Embedded sensors monitored various environmental and structural parameters critical for assessing the long-term integrity of the structure, such as humidity, temperatures, and wood moisture content, alongside physical changes like displacements and deformations. This integration of sensors within the BIM framework is posited to improve data management by providing spatial context to the data, thus aiding analysis. Furthermore, the incorporation of a material- and phenomena-specific warning tool into the IFC-BIM platform enables quick identification of potential issues, supporting facility managers in proactive maintenance and inspection scheduling, potentially extending the building's lifecycle.

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