NOTTINGHAM TRENT UNIVERSITY NSF RCN-SEES SHBE

RCN-SEES: Predictive Modeling Network for Sustainable Human-Building Ecosystems

US-UK WORKSHOP ON BIOSENSING-ENABLED, WELLBEING-CENTRIC SUSTAINABLE BUILT ENVIRONMENT ECOSYSTEMS

October 27-28, 2022. Nottingham Trent University, Nottingham, UK
Hooley Room, Newton Building, City Campus

Final Program

Program At Glance

Time	Topic
October 27 (Thursday)	
8:30 AM – 10:45 AM	City Tour (US delegates. Assemble at the hotel lobby by 8.30am. Will not return to hotel but go directly to NTU)
10:30 AM – 11:00 AM	Arrival
11:00 AM – 11:10 AM	Welcome Remark by Dr. Ming Sun and Dr. Yong Tao
11:10 AM – 12:30 PM	Presentations Part 1 (4 Presentations)
12:30 AM – 1:30 PM	Lunch
1:30 PM – 3:10 PM	Presentations Part 2 (5 Presentations)
3:10 PM – 3:30 PM	Break
3:30 PM – 4:30 PM	Breakout Session 1 – Topic 1
4:30 PM – 5:00 PM	Discussions
6:00 PM – Late	Networking Dinner (Cosy Club – US delegates)
October 28 (Friday)	
9:00 AM – 9:10 AM	Welcome by Dr. Ming Sun
9:10 AM – 10:30 AM	Presentation Part 3 (4 Presentations)
10:30 AM – 10:50 AM	Break
10:50 AM – 12:10 PM	Presentations Part 4 (4 Presentations)
12:10 PM – 1:10 PM	Lunch
1:10 PM – 2:30 PM	Presentation Part 5 (4 Presentations)
2.30 PM - 2.40 PM	Break
2:40 PM – 3:40 PM	Breakout Session 2 – Topic 2
3:40 PM – 4:00 PM	Summary Session
4:00 PM	End of Day 2

Technical Program:

Time Slot	Presentation	Presenter	Affiliation
	October 27 (Thursday)		
	Presentation Part 1 (Facilitator: Juan C. Ordonez)		
11:10 to 11:30 AM	Wellbeing-Centric Sustainable Built Environment Ecosystems	Yong Tao	Cleveland State Univ.
11:30 AM - 11:50 PM	The Use of Wearables for Post-Occupancy Evaluation	Derek Clement-Croome	University of Reading
11:50 to 12:10 PM	Coastal Cities in a Warming Climate	Jorge E. González	The City College of New York
12:10 to 12:30 PM	Housing retrofits and impact on occupants' quality of life	Anton Ianakiev	Nottingham Trent University
12.30-1.30 PM	Lunch		
	Presentation Part 2 (Facilitator: Nina Sharifi)		
1:30 to 1:50 PM	Data-driven Methods to Evaluate Human-Infrastructure Interdependencies	Hiba Baroud	Vanderbilt University
1:50 to 2:10 PM	The autonomous analysis of movement in infants for early detection of neurological disorders	Alex Turner	University of Nottingham
2:10 to 2:30 PM	Understanding energy hogs: The role of magnitude and variability in electricity use	Stephen Bird	Clarkson University
2:30 to 2:50 PM	Bring biophilic art to intelligent buildings	Anthony Adole	AllSee Technologies/NTU
2:50 to 3:10 PM	SOBA: Sustainability-Oriented Building Automation	Sez Atamturktur-Russcher	Penn State University
3:10 to 3:30 PM	Break		
3:30 to 4:30 PM	**Breakout Session 1** **Research focuses on human and building interactions in the context of human well-being and future work environment**		
4:30 to 5:00 PM	**Discussions & Adjourn (Ming Sun/Yong Tao)**		

	October 28 (Friday)		
	Presentation Part 3 (Facilitator: Hiba Baroud)		
9:10 – 9:30 AM	Investigating relationships between retrofit building systems and occupant well-being	Nina Sharifi	Syracuse University
9:30 to 9:50 AM	Biophilic design of buildings	Yangang Xing	Nottingham Trent University
9:50 to 10:10 AM	Multi-Fidelity Modeling Approach Enabling Fast Characterization of Building Thermal Responses	Juan C. Ordonez	Florida State University
10:10 – 10:30 AM	Occupant Preference-Aware Load Scheduling for Resilient Communities	Wangda Zuo	Penn State University
10:30-10:50 AM	Break		

Presentation Part 4 (Facilitator: David Fannon)			
10:50 to 11:10 AM	Strategies for resolving the participation gap in buildings and cities	Richard Bull	Nottingham Trent University
11:10 to 11:30 AM	Standalone Stretchable Device Platform for Human Health Monitoring	Huanyu Larry Cheng	Penn State University
11:30 to 11:50 AM	Embedded intelligence and computer vision for robot situation understanding	Qinggang Meng/Baihua Li	University of Loughborough
11:50 to 12:10 PM	Visual Analytics Approach for Wellbeing Centric Sustainable Built Environment Ecosystems	Isaac Cho	Utah State University
12.10 to 12.30 PM	Introduction to the Smart Wireless Innovation Facility (SWIFt) Lab and Testbed	Ivan Marjanovic	Smart Wireless Innovation Facility (SWIFt)/NTU
12:30 to 1:10 PM	Lunch		
Presentation 5 (Facilitator: Wangda Zuo)			
1:10 to 1:30 PM	AI-assisted Digital Twin Thermal Comfort Analysis and Optimisations in Miami	Thomas Spiegelhalter	Florida International University
1:30 to 1:50 AM	Human-In-The-Loop Thermostat	David Fannon	Northeastern University
1:50 to 2:10 PM	Fusing Virtual Experimental Data on Human Experiences into Building Performance Analysis	Yimin Zhu	Louisiana State University
2:10 to 2:30 PM	Measuring wellbeing of building occupants	Ming Sun	Nottingham Trent University
2:30 to 2:30 PM	Break		
2:40 to 3:40 PM	**Breakout Session 2** **International multidisciplinary research collaboration infrastructure**		
3:40 to 4:00 PM	**Summary & Adjourn (Ming Sun/Yong Tao)**		

- Each presentation is 20 minutes, including questions.
- Please plan a 15-minute presentation and a 5-minutes transition or short question.

Workshop Outcome Summary on Future Collaborative Opportunities

1) Special issue, invited by Jorge Gonzalez, co-authored by US & UK researchers, based on themes of the workshop, multidiscipline, in *Sustainable buildings and cities*, ASME, sensor, and wellbeing.

2) Forwarding editorial, open access, May 2023 target, 5-6 articles, could be standalone, perspective type of article like editorial is possible.

3) Communication forum to maintain communication among the members:
    a. Web platform
    b. New steering committee with a rotating chair
    c. Maintain the website
    d. Members to host conferences.

4) UK-US program topics including:
    a. Occupant behaviors
    b. Indoor/outdoor environments
    c. Global project on occupant behavior database
    d. World human-building interaction data.

5) Data infrastructure topics:
    a. Public data in the built environment, infrastructure to integrate different types of data, built environment, and health data sets
    b. Data sharing infrastructure - data infrastructure – identify data sources and data collection capabilities
    c. Website to describe data sources and capabilities by members
    d. A simple well-being indicator to start.

6) Funding – collaborative funding sources between UK and US researchers

7) Different use cases, VPN to connect with end users IoT, data exchange use cases, data portal, technology intensive use cases, develop specific cases, affordable telecom infrastructure, telecom components to predict events, and digital twin.

8) A follow-up event to regroup the ideas in the near future to
    a. Identify five articles and get UK collaborators to log in SHBE.
    b. Establish working groups.

WORKSHOP PRESENTATIONS AND PARTICIPANT BISKETCHES

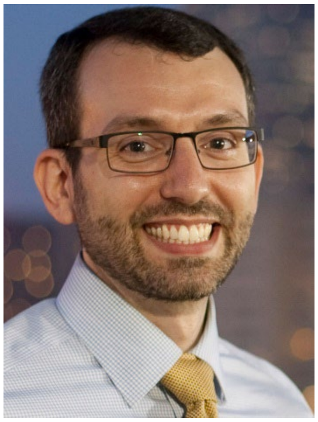
Wellbeing-Centric Sustainable Built Environment Ecosystems

Yong Tao, Cleveland State University
y.tao19@csuohio.edu

An overview of the workshop is given to highlight the evolvement of Sustainable Human-Building Ecosystems (SHBE) research concepts to Wellbeing-Centric Sustainable Built Environment Ecosystems. The objective of the workshop is to develop a research agenda centered on multidisciplinary research collaborations, addressing the understanding of human and building interactions in the context of human wellbeing and future work environment. In particular, we hope to discuss the ideas related to the following topics:

- Measurements and validate human wellbeing and productivity indicators.
- Data-driven, decision-making processes for sustainable and resilient building and community development that benefit to all people.
- Validation and verification of comparative models that utilize data from affordable, reliable biosensing technology.

Bio:
Dr. Yong X. Tao is Betty L. Gordon Endowed Chair and Distinguished Professor, and chair of the Department of Mechanical Engineering at the Cleveland State University. He is an ASME Fellow and Editor-in-Chief of Heat Transfer Research journal. His research spans from fundamentals of thermal sciences, refrigeration system performance, to renewable energy systems in buildings with extensive technical publications. He has received research funding as a single PI or Co-PI in multidisciplinary teamwork projects from the NSF, NASA, Air Force, DSL, DOE, ASHRAE, and industries. Dr. Tao is founding board director and President of American Society of Thermal and Fluids Engineers (ASTFE). He is also an active member of the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE), past chair the Heat Transfer Division of ASME, and other leadership roles as conference chair or program chair. His leadership in multiple zero-energy building projects since 2005 has received recognitions including from former U.S. Secretary of Commerce and Secretary of Energy as playing vital role in building international collaboration in the area of energy-efficient buildings.



Human-In-The-Loop Thermostat

David Fannon, Northeastern University
d.fannon@northeastern.edu

My colleagues and I are studying the interaction among humans, their homes, and heat pumps. We are collecting—and more importantly integrating—*quantitative* measures of home performance and interior environment, as well as *qualitative* data about satisfaction (immediate and general) and environmental attitudes. The immediate purpose of this US Dept. of Energy supported longitudinal study is a dataset capturing dynamics of hardware performance and human behavior to inform better heat-pump controls in grid-interactive buildings. We know human behavior drives operating energy (with the associated environmental consequences) and human comfort is critical to wellbeing. Our data also suggest the opportunity for behavioral interventions, our next topic or work. For example, can we provide grid services (like peak shaving, shifting, resilience in adverse conditions) while balancing quality of the indoor environment, economic and ecological values for individuals?

I am particularly interested in understanding personal comfort in non-steady state environments to move past historical demand-response approaches in which users *tolerate* conditions of discomfort to save energy, instead embracing positive approaches that promote wellbeing for occupants as well as buildings and infrastructure systems. Through this workshop, I am eager to explore opportunities to apply similar methods to other questions, for example passive cooling. I am also interested in expanding to broader dimensions of human well-being and methods of longitudinal studies of dynamic behavior and conditions. Finally, I am very excited by all approaches that focus on the individual human, rather than buildings, as the locus and measure for control, comfort, and wellbeing.

Bio:

David Fannon is an architect and building scientist whose work integrates research, analysis, and design to provide occupant comfort and wellbeing in long-lasting, low-resource consuming buildings. He holds a joint appointment in the School of Architecture and the Department of Civil and Environmental Engineering. He teaches courses in design, environmental systems, and sustainability, and received the 2019 CAMD excellence in teaching award. David's research has been funded by public and private sources including NSF, DOE, and AIA; and published in journals like Enquiry, Energy and Buildings, and Buildings and Environment. Along with colleagues Michelle Laboy and Peter Wiederspahn, David received the 2017-2019 Latrobe Prize for their work on long-lasting buildings, documented in their book The Architecture of Persistence: Designing for Future Use (2022). David holds a Bachelor of Architecture degree from Rensselaer Polytechnic Institute, a Masters from University of California Berkeley, and is a registered architect in the State of New York. He is a member of ASHRAE and a LEED Accredited Professional with a Building Design and Construction specialty.

AI-assisted Digital Twin Thermal Comfort Analysis and Optimisations in Miami

Thomas Spiegelhalter, Florida International University
tspiege@fiu.edu

In less than 150 years, our carbon society transformed the planet. Yet, the latest IPCC reports show that we are quickly arriving at points of no return in the warming and inhabitation of our world. So, as part of an E.U.-U.S-funded $1.9 million research project, we have been working on multiple research projects for the future of the Miami Islands since 2018:

1. We developed an AI-assisted and drone cloud-data-supported digital twin and generative GIS-IoT-BIM-based API to map and optimise existing building infrastructures toward retrofitted and new data-driven carbon-neutral building designs. These efforts include genetic design combinatorics, graphical programming, and AI-assisted experimental 2D-GAN generating 3D designs with life-cycle scenarios.

2. The digital twin has selected indoor and outdoor thermal comfort studies. We examine the effects of building and landscape use patterns, morphologies and shapes on residents' life satisfaction and well-being. The factors include (1) meteorological factors—air and surface temperature, relative humidity, wind speed and direction, solar radiation, etc. —and (2) personal factors—gender, age, length of stay, and length of residence are included. The analysis is conducted empirically using CFD-supported cross-sectional sensor infrastructures, individual survey data and point-of-interest big data in Miami at fine geographical scales.

Bio:

Founder and Principal of Studio Thomas Spiegelhalter & Associates in Freiburg/Germany, E.U. in 1990, L.A. and Miami Beach, U.S. with a focus on design/built Sustainable, Carbon-Neutral Architecture, Resilient Engineering and Urban Planning. Spiegelhalter is a licensed architect, engineer and town planner in all European Union Member States (License: E.U. 037201, N.85/384/EW G0). He is also a LEED accredited professional and provides sustainable design consulting services, urban master planning, multi-dimensional analysis and scenario modelling, and Building Information Modelling (BIM) for private, institutional and commercial clients in Europe, Asia, and the Americas. As an architect, engineer and town planner, he has been responsible for numerous environmental designs since 1989. Spiegelhalter has received 54 honors, prizes and awards for his sustainable design-built work through participation in competitions, applied research and professional, regional, national, and international levels Spiegelhalter is a professor at the Florida International University in the Department of Architecture in the College of Communication, Architecture + the Arts, and co-director of the Structural and Environmental Technologies Laboratory.

Data-driven Methods to Evaluate Human-Infrastructure Interdependencies

Hiba Baroud, Vanderbilt University
hiba.baroud@vanderbilt.edu

Interactions between humans and the built environment are often the reason behind climate change and natural hazards leading to disasters. If we understand human-infrastructure interdependencies, we can better prepare for future uncertain and disruptive events. However, many ex-post disaster studies reveal, what we know about interdependencies is still limited. Additionally, a lack of understanding of social and organizational interdependencies with infrastructures can result in unintended consequences that harm communities. Interdependencies are uncertain and they change over time in response to hazards, climate, and development, but most studies consider them to be deterministic and static. To ensure sustainable and resilient development of buildings and communities, there is a need to accurately predict the behavior of human-infrastructure interdependencies to inform decisions of planning and investment of critical infrastructure in ways that benefit all people. My research interests are at the intersection of statistical learning, network analysis, and risk analysis. My work considers a multidisciplinary approach that is founded in statistical network models which allow inference and prediction of network structures based on partial historical data and node attributes and provide a probabilistic assessment that helps measure the risk and resilience of systems across a range of uncertain scenarios (e.g., climate change, development).

Bio:

Dr. Hiba Baroud is an Environmental Engineering associate professor and the associate chair in the Department of Civil and Environmental Engineering at Vanderbilt University. Her research is at the intersection of data analytics and risk and resilience modeling. Her group develops and applies methods founded in statistical learning, network models, and decision analysis to evaluate infrastructure performance during disasters. She is particularly interested in uncertain and dynamic interdependencies across multiple systems (infrastructure, humans, environment). Applications are focused on smart cities, developing countries, and Arctic communities. She is the co-chair of the Risk and Resilience Measurements Committee of the Infrastructure Resilience Division in the American Society of Civil Engineers (ASCE). She serves on the editorial board of the ASCE Journal of Infrastructure Systems and as Associate Editor of the ASCE Natural Hazards Review. Hiba is the recipient of the 2019 Global Voices Fellowship and the 2020 National Science Foundation Early CAREER award.

Enhancing Building Thermal Model via Gaussian Process Regression

Juan C. Ordonez, Florida State University/Florida A&M University
ordonez@eng.famu.fsu.edu

The accurate mapping of temperature and humidity distributions can enable a wide range of engineering innovations in the context of a sustainable built environment. This presentation highligts a multi-fidelity modeling approach that enables fast characterization of building thermal responses. The proposed approach is based on Gaussian process regression that allows the user to select the proper mix of high and low fidelity points and thus tune the computational expense. The framework can be useful in the overall energy balance of buildings, the development of control actions that minimize energy consumption and to support strategies that rely on building temperature to enhance occupants' wellbeing. We will illustrate the approach implementation using an off-grid building.

This work has been conduted in collaboration with C. Ordonez and S. Yang.

Prof. Juan C. Ordonez (M.S., Energy Systems, Ph.D. ME Duke University) is a full professor of of Mechanical Engineering at the FAMU-FSU College of Engineering. He is also the director of Florida State University's Energy and Sustainability Center and serves as the thermal management lead PI for the Center for Advanced Power Systems. His research lies within the fields of heat transfer and applied thermodynamics and their application to the design, modeling, and optimization of advanced energy systems. Specific areas of research include renewable energy systems, solar thermal systems, modeling, and optimization of heat exchangers, fuel cells and fuel cell systems, HTS motors and cables, combined heat and power, HVAC systems, photobioreactors for microalgae growth. He is a member of ASME and Sigma Xi, and serves as Associate Technical Editor for Thermal Engineering, since 2005. He has published over 100 journal publications, more than 110 conference papers, and is the author of Fundamentals of Renewable Energy Processes, 4th Ed, Academic Press, 2021 with Professor Aldo Viera da Rosa.

Fusing Virtual Experimental Data on Human Experiences into Building Performance Analysis

Yimin Zhu, Louisiana State University
yiminzhu@lsu.edu

The impact of occupant behavior on building performance is well recognized. At the design stage, assumptions about occupant behavior significantly contribute to the results of building performance analysis. Traditional analytic models based on historical data and assumptions can be enhanced by data from virtual experiments on human experiences because virtual reality, including mixed reality, has the potential to elicit human responses to design and environmental features specific to a new design. However, virtual technologies have limitations such as specific hardware for data collection, sample size, and even validation of experimental procedures. This paper presents findings in virtual experiments on thermal comfort and thermally-driven behaviors, machine learning algorithms to enhance existing building performance analysis using data from virtual experiments, and an ontology-based approach to sharing virtual experimental data. A coordinated and collective effort of the research and industry communities is needed to build consensus on defining virtual experiments and data sharing. The effort can lead to the acceleration of research in virtual experiments on human experiences and, consequently, the adoption of the technology in practice.

Bio:

Dr. Yimin Zhu is a full professor and holder of the Pulte Homes Endowed Professorship in the Bert S. Turner Department of Construction Management at Louisiana State University. Dr. Zhu received his Ph.D. degree from the M. E. Rinker, Sr. School of Construction Management at the University of Florida in 1999. He served as Assistant Professor from 2004 to 2010, and Associate Professor with tenure and Graduate Program Director from 2010 to 2014 in the School of Construction at Florida International University. He joined the Bert S. Turner Department of Construction Management at Louisiana State University in 2014. Between 2000 and 2001, he was a visiting professor in the Department of Building Construction at Georgia Institute of Technology. In addition to his academic appointments, Dr. Zhu worked for the Hartsfield-Jackson Development Program in Atlanta, Georgia, Citadon in San Francisco, California, and the Timberline Software Corporation in Beaverton, Oregon. He also worked for a construction company in China in the early years of his career. Over his academic career, he has taught a variety of undergraduate and graduate courses, such as estimating, scheduling, value engineering, sustainable construction, building information modeling, and construction information systems. Dr. Zhu's research focus is on computing for built environment design and engineering. His research is funded by various state and federal agencies, including the National Science Foundation and the Department of Energy. He has published over 150 peer-reviewed technical articles on his research. He is a regular speaker at national and international conferences and workshops. He is a specialty editor for the Journal of Computing in Civil Engineering and serves on the editorial board for the International Journal of Construction Management and Scientific Reports. He is a full member of Sigma Xi: The Scientific Research Honor Society.

Visual Analytics Approach for Wellbeing Centric Sustainable Built Environment Ecosystems

Issac Cho, Utah State University
isaac.cho@usu.edu

I am a visualization researcher and have been working on developing visualization and visual analytics systems for various research domains including social media analysis, climate changes, political science, critical infrastructure, and distributed energy resource analysis. My research focuses on interactivity and the affordance it provides for data analysis and sense-making within interactive visualization systems as realized across a full spectrum of platforms from traditional desktop environments to immersive environments. My team designs, develops and implements a visual analytics system and its data processing pipeline in order to support the domain experts to analyze and explore the datasets and thus support their sensemaking and decision-making processes. I am interested in applying interactive visual analytics approaches to wellbeing centric sustainable built ecosystems to enable the user to discover and identify hidden insights and findings that could be challenging to find without visual exploratory features and user interactions. In addition, I am interested in using a fully immersive virtual environment that makes use of cutting-edge virtual reality and augmented reality technologies to provide various viewpoints for demonstrating, analyzing, and evaluating wellbeing data for building and human interactions.

Bio:

Dr. Isaac Cho is an assistant professor in the Computer Science Department and a director of the VizUS lab at Utah State University. He is also an adjust professor in the Computer Science Department at the University of North Carolina at Charlotte and an affiliated faculty member of the Ribarsky Center for Visual Analytics (the Charlotte Visualization Center). His main research interests are Interactive Visual Analytics, Human-Computer Interactions, 3D User Interfaces, and Virtual Environments. His research has been funded by NSF, DHS, and EPRI. He received his Ph.D. in Computing and Information Systems from UNC Charlotte in 2013.

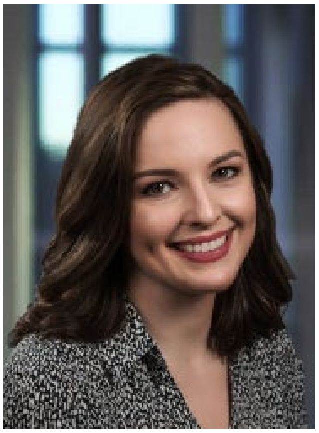
Understanding energy hogs: The role of magnitude and variability in electricity use

Stephen Bird, Clarkson University
sbird@clarkson.edu

The Smart Housing project at Clarkson University provides highly granular electricity use data in student housing that can help to improve energy conservation programs and provide the information required to design future electricity systems. Through a cluster analysis of the electricity consumption at the individual level for residents living in apartments during the Fall semesters from 2013 to 2019, we found that the top 18% of the students consume 48% of total electricity use at an average of 2.579 kWh/d/person while only 0.19 kWh/d/person is used by the lowest 22%. This finding emphasizes the magnitude of impact that a few energy "hogs" have on electricity use. A subcluster analysis of energy hogs at the individual hourly level reveals high variability in their median hour to hour usage. Some hogs use electricity at a high level constantly throughout the day, while others appear to turn off at least some of their appliances over the course of a day. This implies a significant difference in how they think about and use electricity. Our results demonstrate the importance of using both granular data and statistical analysis to better identify individual energy consumption. This analysis can serve as the foundation for the design of more effective interventions to foster energy conservation in specific groups of individuals who present similar patterns of consumption.

Bio:

Dr. Stephen Bird has a primary focus on energy and environmental policy. His current research is focused on microgrid governance, energy conflict and social acceptance, Smart Housing and split incentives, fracking, green data centers, activism and social movements, social influence, and policy learning. He is a Research Faculty Affiliate with the Positive Energy Project, and a Fall 2016 Fulbright Research Fellow at the Centre on Governance, both at the University of Ottawa. He completed his PhD on energy policy, social networks, and interest groups at Boston University in 2009. He received his Masters' from Harvard University (extension) in 2003, was a Kennedy Rappaport Fellow in 2004, and worked for Harvard's Electricity Policy Group from 2001-2010. Currently he is PI or Co-PI on a variety of research projects for New York State and the National Science Foundation with research partners that include IBM, AMD, and National Grid. Other engagements include the U.S. State Department, the European Commission, Massachusetts' Environmental Affairs, and Mass Energy (a consumer's energy non-profit). He is an avid outdoors person (climbing, hiking, ice climbing), advisor to the outing club, loves smashing a racquetball often, and plays electric bass in a variety of jazz and rock settings in the north country.



Investigating relationships between retrofit building systems and occupant well-being

Nina Sharifi, Syracuse University
nmsharif@syr.edu

An aspect of my research seeks to understand impacts of building environmental factors, including form, material strategies, and the integration of assemblies (e.g., enclosures, thermal comfort systems), on occupant behavior and comfort, and the impact of occupant response and behavior on the performance of building systems. These goals arise from the zero carbon buildings initiatives published by New York State in response to international climate change goals for reducing carbon emissions associated with buildings and infrastructure. The focus of the present research, funded by the New York State Research and Development Authority (NYSERDA) and the United States Department of Energy (US DOE), is an extension of the policy and industry plan to execute deep energy retrofits on hundreds of thousands of existing buildings in the Northeast United States and other cold climates.

The research operates at three primary scales: the device, or technology scale, concerning sensing and controls systems, the design and operation of thermal and ventilation systems; the whole-building design and operation scale, concerning impacts of enclosures and geometries of space on the performance of thermal comfort systems relative to occupant satisfaction; and, the building-to-building or community scale, concerning energy sharing and grid compatibility. In this workshop, I hope to convene with colleagues on interdisciplinary approaches to systems integration in buildings with the goal of improving human health, thermal satisfaction, and overall well-being through technical design innovation.

Bio:

Dr. Sharifi has over 15 years of experience in high-performance building technologies research and design. Her work in building-integrated active flow control systems, fuel cells, retrofit technologies, and deployable low-carbon structures has been supported by research awards exceeding $8 million from New York state and federal agencies. Dr. Sharifi is currently Principal Investigator on the Net Zero Living Lab, a retrofit research & demonstration project developing low-carbon design approaches that integrate energy, human health, and life cycle criteria for affordable housing. Dr. Sharifi advises PhD, Master of Science, Master of Architecture, and Bachelor of Architecture thesis students, and teaches sustainable building technology and design research courses at the Syracuse University School of Architecture. She operates her interdisciplinary research lab from the Syracuse Center of Excellence.

Coastal Cities in a Warming Climate

Jorge E. González, The City College of New York
jgonzalezcruz@ccny.cuny.edu

Coastal cities, where the majority of the global population resides, represent a next frontier scientific challenge in understanding and adapting to a warmer global environment as direct recipients of human impacts due to climate change. Coastal urban environments interact with and often compound the effects of mean global-warming manifested in coastal-flows, human processes, and extreme weather events. The presentation at the UK-US Workshop will highlight new understanding and methods to represent the interactions between the local coastal-urban environment and global environment as they both undergo change due to local land use for urbanization and of changing regional/global sea-surface temperatures. These include in-situ and satellite-based observations along the gradients coastal-cities-rural of natural environments and anthropogenic signals, and new modeling approaches that represent the city-natural environments scales as a unified system in space and time. It will also highlight how this understanding is leading to new environmental science, engineering applications and technologies to promote sustainable energy, improved air quality, and urban planning in the built environment. The future state of urban air quality, hydrology, human health, and energy demands, together with possible mitigation and adaptation measures to a changing climate, will be discussed in the context for several coastal cities in different climates including New York City, Los Angeles, and San Juan.

Bio:

Prof. González is the Director of *The CCNY Initiative to Promote Academic Success in STEM (CiPASS),* lead scientist of the Coastal-Urban Environmental Research Group (*CUERG*), The City College of New York Presidential Professor of Mechanical Engineering at the City College of New York (CCNY), and more recently appointed the SUNY Professor of Empire and Innovation at the University of Albany. Prof. González earned his Doctorate (1994) and Bachelor (1988) degrees in Mechanical Engineering from the Georgia Institute of Technology and from the University of Puerto Rico-Mayagüez, respectively. He teaches and conducts research in urban energy sustainability, urban weather and climate, urban remote sensing, and regional climate modeling and analysis. Professor González holds several patents in solar energy equipment, aerosol detection, and energy forecasting for buildings, and was recognized as a prominent young researcher by the National Science Foundation with a prestigious CAREER Award. He has authored or co-authored more than 100 peer-reviewed publications, has delivered 100s of conference presentations, and his research has attracted more than $50M in external funding. He is a Fellow Member of the American Society of Mechanical Engineering (ASME), and Former Vice-Chairman of the American Meteorological Society Board on the Urban Environment. He was appointed in 2015 by the Mayor of the City as Member of the Climate Change Panel for the City of New York, and more recently as Senior Visiting Scientist of the Beijing Institute of Urban Meteorology and of Brookhaven National Laboratory, and Member of the US Department of Energy Office of Science Scientific Advisory Committee. He is the co-editor of the *ASME Handbook of Integrated and Sustainable Buildings Equipment and Systems,* and was named in 2019 as the Founding Editor of the newest *ASME Journal of Engineering for Sustainable Buildings and Cities*.

Standalone Stretchable Device Platform for Human Health Monitoring

Huanyu Larry Cheng, Penn State University
huanyu.cheng@psu.edu

Conventional electronics today form on the planar surfaces of brittle wafer substrates and are not compatible with 3D deformable surfaces. As a result, stretchable electronic devices have been developed for continuous health monitoring. Practical applications of the next-generation stretchable electronics hinge on the integration of stretchable sustained power supplies with highly sensitive on-skin sensors and wireless transmission modules. This talk presents the challenges, design strategies, and novel fabrication processes behind a potential standalone stretchable device platform that (a) integrates with 3D curvilinear dynamically changing surfaces, and (b) dissolves completely after its effective operation. The resulting device platform creates application opportunities in fundamental biomedical research, disease diagnostic confirmation, healthy aging, human-machine interface, and smart internet of things.

Bio:

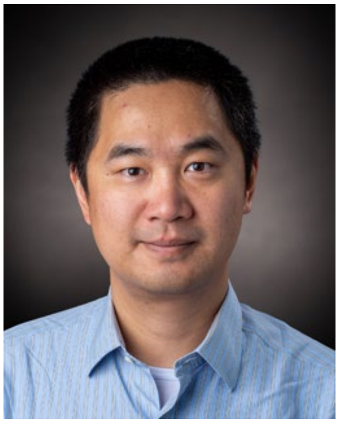
Dr. Cheng is the James L. Henderson, Jr. Memorial Associate Professor of Engineering Science and Mechanics at Penn State University. He has been affiliated with the Penn State Institutes of Energy and the Environment, the Materials Research Institute (MRI), the Institute for Computational and Data Sciences (ICDS), the Engineering, Energy, & Environmental Institute (E3I), the Sustainability Institute, and varying centers at Penn State. He has also served as an advisor or the Graduate Faculty for the Schreyer Honors College, Materials Science and Engineering, Mechanical Engineering, Biomedical Engineering, Architectural Engineering, and Additive Manufacturing and Design. His research group focuses on the design, fabrication, and application of the standalone stretchable device platform. He also serves as the associate editor for 7 journals and reviewer for > 200 journals.

SOBA: Sustainability-Oriented Building Automation

Sez Atamturktur Russcher, Penn State University
hsa109@psu.edu

The prevailing paradigm of the building industry treats the building's impact on occupant well-being and its direct or indirect impact on the environment as conflicting objectives. However, the true sustainability of built environment cannot be achieved without accounting for both building's environmental impact and occupant well-being. Once designed and built, building operation is often rarely, if ever, modified to reflect changes in conditions, performance with aging, or inter- and intra-variability of occupants. It has been predicted that the deployment of grid-interactive efficient buildings enabled by with advanced controls and novel sensing, and exploiting existing building controls to their full capabilities could result in up to 30% reduction in building energy demand and support the large scale adoption of renewable energy. With about 30% of worldwide energy use tied to building operations, the potential benefits for climate change, health (due to both reduced pollution and improved indoor environment and urban microclimates), energy and health equity, and overall global quality of life would be profound. To challenge the status quo, the proposed Sustainability-Oriented Building Automation (SOBA) project will address persistent knowledge gaps and technology barriers that prevent us from realizing self-operating buildings that can achieve unprecedented levels of sustainability in both widescale efficiency and resilience, and occupant well-being. This will, in turn, address the fallacy of the prevailing paradigm of the building industry which treats buildings' impact on occupant well-being and its direct or indirect impact on the environment as conflicting objectives and its operation parameters as static in the face of change. The fundamental breakthroughs and advanced technologies in integrated design of sustainability-oriented autonomous buildings, coupled with corresponding modeling, sensing, and control strategies, will (i) ensure the best possible operation of existing buildings in their current condition, (ii) design/retrofit schemes for different social or economic goals (e.g., minimize carbon emission, maximize return on investment) under different scenarios, (iii) inform new whole-building design strategies, and (iv) train workforce equipped with skills for predictive building operation and maintenance based on a building digital-twin training platform.

Bio:
Dr. Sez Atamturktur is the Harry and Arlene Schell Professor and Head of the Department of Architectural Engineering at Penn State University. Dr. Atamturktur's research, focused on uncertainty quantification in scientific computing, has been documented in more than 100 peer-reviewed publications in some of the finest engineering science journals and proceedings. Her research has been funded by federal agencies including the National Science Foundation, the U.S. Department of Energy, the Department of the Interior, Department of Transportation, the Department of Education, as well as industry organizations and corporations.

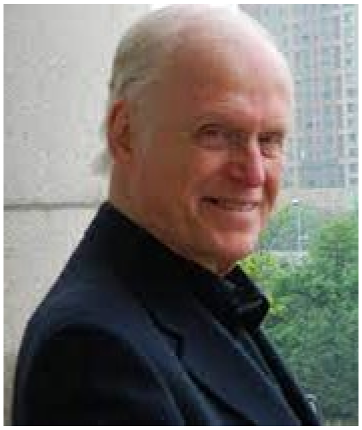


Occupant Preference-Aware Load Scheduling for Resilient Communities

Wangda Zuo, Penn State University
yfh5204@psu.edu

The load scheduling of resilient communities in the islanded mode is subject to many uncertainties such as weather forecast errors and occupant behavior stochasticity. To date, it remains unclear how occupant preferences affect the effectiveness of the load scheduling of resilient communities. This paper proposes an occupant preference-aware load scheduler for resilient communities operating in the islanded mode. The load scheduling framework is formulated as a model predictive control problem. Based on this framework, a deterministic load scheduler is adopted as the baseline. Then, a chance-constrained scheduler is proposed to address the occupant-induced uncertainty in room temperature setpoints. Key resilience indicators are selected to quantify the impacts of the uncertainties on community load scheduling. Finally, the proposed preference-aware scheduler is compared with the deterministic scheduler on a virtual testbed based on a real-world net-zero energy community in Florida, USA. Results show that the proposed scheduler performs better in terms of serving the occupants' thermal preference and reducing the required battery size, given the presence of the assumed stochastic occupant behavior. This work indicates that it is necessary to consider the stochasticity of occupant behavior when designing optimal load schedulers for resilient communities.

Bio:
Dr. Zuo is a Professor in Architectural Engineering and the Associate Director for Research of Global Building Network which is an initiative of Penn State and United Nation on high performance buildings. Dr. Zuo also holds a joint appointment at the National Renewable Energy Laboratory (NREL) and was a former Scientist at Lawrence Berkeley National Laboratory (LBNL). He is currently an Associate Editor of Journal of Solar Energy Engineering, and Fellow and Treasurer of International Building Performance Simulation Association. He is a major contributor to multiple open-source building and community energy modeling tools, including LBNL's Modelica Buildings library and NREL's URBANopt.



Evolving a New Approach to Occupants Evaluation Using Wearables

Derek Clement-Croome, University of Reading
d.j.clements-croome@reading.ac.uk

Wearables play an important role in the health and wellbeing agenda, which has become even more important in these pandemic times as offices need to be designed and managed for low infection risk in addition to all the other environmental attributes described in the 2019 BCO Guide to Specification. Measurements of peoples physical and mental wellbeing are becoming more essential. This pilot study uses Fitbit Inspire 2, GO and questionnaires with some selected interviews. Whether we are discussing climate change, virus risk or health and wellbeing in general, human behaviour features along with design and management measures. Wearables help to guide us to preferred behaviour options, whether this applies to sitting, standing and moving around, or to making us aware of the health of our bodies. There is a continuous link between bodies and minds; they affect each other. The market for wearables is expanding rapidly, as are the health conditions they can inform us about. Heartbeat patterns, sleep quality, stress via skin conductance and brain waves are all measurable, so practical data about diabetes, for example, can be captured. In the future, we will be able to do much more, and this will eventually mean virus health checks too. After a review of the wearables that are currently available, and how developments of these and others might progress in the future, an account is given of two pilot studies, which show how using wearables can give a much deeper and more enriched approach to post-occupancy evaluation (POE) in the future.

Bio:
Derek Clements-Croome is Professor Emeritus at Reading University. He worked in the building design and contracting industry before entering university life. He has founded and directed courses including a BSc in building environmental engineering at Loughborough University in 1970 and an interdisciplinary MSc in Intelligent Buildings at Reading University in 1996 covering design and management of intelligent buildings. He has also worked in architecture and building engineering at the university of Bath (1978-1988).
He now offers strategic advice to clients, designers and facilities managers on attaining and managing healthy and sustainable environments in buildings of all types. He researches, writes and lectures on these issues for companies and wider audiences nationally and internationally in China, Australia, New Zealand, South Africa, Poland and Finland particularly. Some of his books have been published in Chinese and Russian.
He edits and founded the Intelligent Buildings International Journal published by Taylor and Francis and is a Coordinator of CIB Commission W098 Intelligent and Responsive Buildings. Derek is also a Commissioner for Hammersmith and Fulham and Haringey, BEE for CABE arm of Design Council, Fellow of the BRE Academy and Fellow of Royal Society of Medicine.

Development of Well-Being Sustainable Energy Built Environment Solutions

Anton Ianakiev, Nottingham Trent University
anton.ianakiev@ntu.ac.uk

Existing homes will account for 80% of the total housing stock in 2050 and most of them have an energy performance rating of Band C or worse and the living conditions are not very good. Large scale retrofit of existing housing is needed to achieve the UK's carbon reduction goal of the 2008 Climate Change Act and to improve the residents' living conditions. Despite numerous successful pilots retrofit programs, there are still significant technical, economic, and social barriers for large scaling-up retrofits.
The NTU research team have tried to address some of the key issues of retrofit, in partnership with Nottingham City Council (NCC), Nottingham City Homes (NCH) and Nottingham Energy Partnership (NEP), in a 25M euro H2020 REMOURBAN project (2014-2020). The project retrofitted 463 social housing properties and improved the quality of life of these families through reducing fuel poverty and improving in-door environment conditions. "Homes are warmer, lighter, with better air quality and beautiful redesign that has created more internal space. Residents indicated that they felt healthier, and their wellbeing had improved because of living in more comfortable and safer homes". The average cost saving on energy use is £866 per household per year. The saving for 2050 Homes is greater, from £1850 down to £500, equivalent to a 73% saving.

Bio:
Dr Ianakiev is a Professor in Sustainable Energy Systems at School of Architecture, Design and Built Environment. He teaches Engineering Maths and Individual Project modules to undergraduate and Advanced Construction Materials and Finite Element Method modules to Postgraduate Civil Engineering students.
He led Nottingham Trent University participation in the REMOURBAN H2020 Smart Cities and Communities project (2015-2020). The project aims at the development and validation in three lighthouse cities (Nottingham, Valladolid, Eskisehir) of a sustainable urban regeneration model that leverages the convergence area of the energy, mobility and ICT sectors in order to accelerate the deployment of innovative technologies to significantly increase energy efficiency, improve sustainability of urban transport and reduce gas emissions in urban areas.
He is also the Principal Investigator in H2020 Marie Curie Actions zEPHYR project - Towards a more efficient exploitation of on-shore and urban wind energy resources. The project will look into developing more optimal means of arranging a cluster of vertical axis wind turbines (VAWT) in an urban environment (such as urban rooftops) and integrating them into the existing structures. Vertical axis wind turbines (VAWT) are seen as the optimal option for the urban environment due to their lower noise emissions and their adaptability for varying wind directions, which are typical in the built environment. VAWTs do not need to be controlled into the wind direction to be effective, which is a key advantage considering the unsteady dynamics of urban wind flow.

The Autonomous Analysis of Movement in Infants for Early Detection of Neurological Disorders

Alex Turner, University of Nottingham

This research is on the use of marker-less 2-D motion capture alongside machine learning to classify movement. This type of work can be naturally applied to the analysis of movement in general.

Bio:

Dr Alex Turner is an Assistant Professor in the School of Computer Science at the University of Nottingham. Prior to this, he was a lecturer in Computer Science at the University of Hull and a Post-Doctoral Researcher in the Department of Electronic Engineering at the University of York, where he obtained his PhD. His MSc was awarded in the Department of Computer Science at the University of York. Alex has previously taught modules in procedural programming, object-oriented programming and artificial intelligence.

Alex's main research interests are focused on the development of new technologies to improve the diagnosis and treatments of movement disorders, with a particular focus on gait and ambulation. Sufferers of movement disorders find a distinct amount of heterogeneity in their symptoms day by day, and typical treatment updates are sparse due to both the complicated nature of the diseases and the limited face to face time available with specialists. To try and solve this, novel sensors in combination with machine learning can be used to provide day to day updates of a patient's movement, which can use used to develop autonomous physiotherapy updates and well as guide changes in treatment. In addition, he also works in the development of transparent machine learning models which can provide a rationale for their decision making process. He is also interested in the application of machine learning in the biological sciences both to improve disease diagnosis and on understanding biological evolution and climate change.

Bring biophilic art to intelligent buildings

Anthony Adole, NTU and VieUnite

This project focuses on improving the health and well-being of the occupants in an environment. The project is targeted at the public to improve the mental health and well-being of people within the environment of the display device. The project aims to fill the existing gap in developing all-in-one digital therapeutic display systems. However, from our research, there appears to be no digital system that can perform all the tasks at the moment. Therefore, the project aims to launch a digital platform with real-time sensors connected to the digital display (Vieunite) to promote health and well-being compatible with the latest healthy intelligent building ambitions, ethical AI, and digital health care technology protocols. The Therapeutic digital display devices will provide content based on biophilic theory/ attributes, personal circadian cycles, dynamic mood, and indoor environmental conditions.

Bio:
Dr Anthony Adole is a Data Scientist/ Software Engineer for the Vieunite KTP project with Nottingham Trent University and AllSee Technologies Ltd. He works primarily on adapting and building machine-learning models for the automatic classification of biophilic attributes, based on the data obtained from the sensors in the environment and individuals. Anthony obtained his Ph.D. in Artificial Intelligence from Loughborough University which specialized in the application of deep neural networks and computer vision technologies for offline handwriting documents.

Biophilic design of buildings

Yangang Xing, Nottingham Trent University
yangang.xing@ntu.ac.uk

As human beings have detached themselves from natural environments by spending most of their time indoors, they have also distanced themselves from the positive experiences that nature provides. Sick building syndrome, nature deficit disorder amongst others, are examples of the impact of separating the built environment from nature. Biophilia is an innate affiliation to nature which stems from our evolutionary history, vital for sustaining health and wellbeing. Biophilic concepts have been explored from biophilic cities to biophilic hospitals. However, existing biophilic research is fragmented. In the last few decades, energy efficiency and carbon emissions have increased in importance for low environmental impact design, nonetheless, there is a need for more research in biophilic buildings which are beneficial to our health and wellbeing as well as causing less harm to the environment. This paper aims to investigate the application of biophilia in building design practices for improved health and wellbeing. The research will present a design framework centred on the emerging use of biophilic design and intelligent building technologies, which recognises the human instinct to connect with nature and the mental health benefits this can bring, such as reducing stress, anxiety and depression, and improving cognitive function.

Bio:
Dr Yangang Xing is an Associate Professor in construction technology and building services engineering. Yan's research Interest in Architectural science and Sustainability which spans the low energy buildings technologies, nature-based solutions, smart cities to biomimicry. Dr Xing has been developing innovative applications of building physics research tools and, in a broader context, systemic modelling and assessment of future post-carbon built environment. Dr Xing is devoted to identifying and developing new research activities uncapping the full potentials of multidisciplinary collaboration tackling the grand challenges facing society on the horizon. Dr Xing completed his PhD in Dynamic system simulation for sustainability planning and has participated EPSRC-funded research projects focusing on methodological and technical innovations supporting building and urban sustainability. Apart from academic research, Dr Xing also has industrial experiences working for architectural and engineering consultancy firms specialized in discovering economic viable low/zero carbon building design and urban planning solutions.

Are people the problem or the solution? Reflections on the role of people in buildings & cities

Prof Richard Bull, Nottingham Trent University
richard.bull@ntu.ac.uk

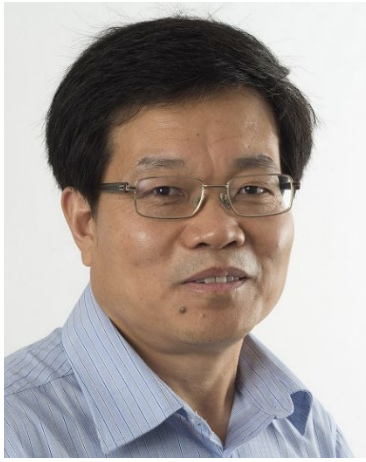
The majority of world's population now live in cities, which create huge challenges around mobility, energy, water, health and wellbeing. Are smart cities – digitally interconnected systems - the solution? We have emerging examples of the role of ICT enabled solutions –energy management systems, smart buildings, travel apps, smart lighting solutions with associated challenges around governance, privacy and security. What about the people who live in the cities – what do they want? Have we asked them? Should we ask them?

An increasingly popular model for conceptualising citizen empowerment is Shelly Arnstein's Ladder of Participation. In her model Arnstein argued that citizen involvement is a fairer way of distributing power in our society, especially within the planning context. This model has been successfully applied to a range of disciplines, most recently energy behaviours in buildings and organisations. This presentation introduces several research projects addressing energy use and occupant's behaviour in non-domestic buildings. The challenge is to tackle the participation gap and treat occupant as part of the solution instead of part of the problem. Interaction with occupants needs to move beyond feedback towards engagement. It is neither desirable nor democratic for the large ICT players to shape our cities without the clear engagement and involvement of the people who live in them, especially given legitimate concerns around data privacy and security, as these new data-sharing platforms, from smart meters to sharing platforms, harvest personal information.

Bio:

Professor Bull is Deputy Dean of the School of Architecture, Design and the Built Environment. Prior to joining NTU Professor Bull was Deputy Dean of the Faculty of Computing, Engineering and Media at De Montfort University. He was awarded his Chair of Energy and Behaviour Change in 2018.

Having completed a BA (Hons) and Masters in Theology at the London School of Theology, Richard moved to Nottingham and worked for six years at a large family owned aerospace engineering company in North Nottinghamshire. During this time he studied part-time for an MBA at NTU's Nottingham Business School, focusing on corporate social responsibility and environmental management. Richard went on to study for a ESRC Case Award PhD with Veolia at the University of Birmingham under Professor Judith Petts. His research explored the role of business in society through an examination of whether public engagement and deliberative processes can generate 'social learning' and environmental citizenship. He joined the Institute of Energy and Sustainable Development at De Montfort University (DMU) in June 2008 as a Research Fellow before being awarded an RCUK Research Fellowship in 2009. During his time at DMU he combined a range of senior leadership roles with research. These included being subject group leader for Energy and Sustainable where he oversaw the development of MSc provision (2013-2015) Head of School Engineering and Sustainable Development (2016-17) during which time he led the HEA Green Academy Team and embedded education for sustainable development in the engineering provision, Interim PVC Dean (2017 Jan-July) and finally Deputy Dean.



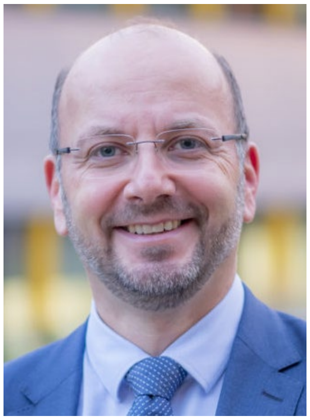
Embedded Intelligence and Computer Vision for Robot Situation Understanding

Qinggang Meng, University of Loughborough

Bio:

Dr Qinggang Meng a Professor of Robotics and Artificial Intelligence in the Department of Computer Science, Loughborough University. Before joining Loughborough University, he worked as a postdoctoral research associate for 4 years in bio-inspired robotics/developmental robotics in University of Wales, Aberystwyth (UWA), UK. He obtained my PhD from the Department of Computer Science, UWA in the area of AI and robotics. Before he came to the UK, he did one year RA in City University of Hong Kong. Before that, he was working in Intelligent Machine Institute at Tianjin University for several years in the area of intelligent robotics.

He has relatively wide research interests in robotics, unmanned aerial vehicles, driverless vehicles, networked systems, ambient assisted living, computer vision, AI and pattern recognition, machine learning and deep learning, both in theory and applications.



Introduction to the Smart Wireless Innovation Facility (SWIFt) Lab and Testbed

Ivan Marjanovic, SWIFt/NTU

SWIFt has a wealth of experience in networks such as 3G/4G/5G, IOT, and data visualisation. Our specialist team is able to consult and advise on a number of different areas from product conception to commercial delivery. The living lab we have created is the perfect test environment for organisations who want to develop and trial solutions in a secure private sandbox environment.
The SWIFt lab is located at NTU's Clifton campus in the new £23m Engineering Building. This lab is equipped with a LoRaWAN IOT network and private 5G internal and external network. There is also a electronics workshop with an extensive range of specialist equipment. It will provide a resource for you to accelerate your research and New Product Development. We also offer a demonstrator area to organisations who wish to use the SWIFt lab as a sales tool and meeting area.
SWIFt is a research, product development and test bed facility available to SME's, scale ups, larger organisations, and academic institutions. To support and accelerate the development and adoption of digital technology and wireless networks-based solutions. SWIFt is based in the Engineering Building at NTU's Clifton campus. The Clifton campus is a secure area, owned by NTU and therefore makes an ideal test bed facility.
SWIFt provides state of the art facilities for companies and academic institutions to innovate in the areas of digital technologies and wireless networks through the provision of an electronics work shop, a showcase/demonstration room and wireless networks including LoRaWAN and 5G installed internally and externally across the campus.

Bio:
Ivan Marjanovic joined SWIFt as Technical Director, following leading on four DCMS-funded 5G Projects at the University of Strathclyde as Principal Programme Manager. Prior to this he worked as a Consultant for the Scottish Government on the Demonstrating Digital Programme on affordable Wi-Fi connectivity for social housing and care homes. He also led on the implementation of a community owned shared 4G LTE mobile mast for remote rural areas, Software Defined Radio solutions with Dynamic Spectrum Sharing access, including regulatory change of 5G Shared Spectrum with Ofcom ("The Wireless Revolution"). He led on the world-first implementation of the Software Defined Radio Wi-Fi solution for passengers on Orkney Ferries and the opening of Wave 1 Rural, The 5G Scotland Centre introducing 5G at Ross Priory, Loch Lomond. Prior to this he was the Wi-Fi Delivery Lead at the London 2012 Olympics, creating the first ever dual band seamless 3G mobile data offload over Wi-Fi, and the world first High Density Wi-Fi for the Olympic Stadium with seamless Wi-Fi experience for 9 venues and spectator areas throughout the Olympic Park. His other positions have been at Motorola UK as a Product Manager for Wireless Broadband Portfolio for EMEA, Technical Project Manager at The Cloud Networks for the UK iPhone 2.5G over Wi-Fi launch for O2, and setting up the outdoor Mesh Wi-Fi Network for the Corporation of London providing 95% coverage across "The Square Mile". Following this he led on the Wi-Fi network refresh for Canary Wharf, introducing seamless indoor and outdoor coverage.

Measuring wellbeing of building occupants

Ming Sun, Nottingham Trent University
Ming.sun@ntu.ac.uk

The World Health Organisation (WHO) defined health as "a state of complete physical, mental, social well-being and not merely the absence of disease and infirmity". Wellbeing is about people feeling good and functioning well; it can be broadly classified as subjective wellbeing and objective wellbeing. Subjective wellbeing describes how people think and feel about their own wellbeing, and includes aspects such as life satisfaction, positive emotions, and whether their life is meaningful. Subjective wellbeing is usually measured through self-report. Objective wellbeing describes how basic human needs and rights are met; these may include aspects such as adequate food, physical health, education, safety etc. Objective wellbeing can be measured through self-report (e.g., asking people whether they have a specific health condition), or through more objective measures (e.g., income level, health indicators, mortality rates and life expectancy).
There is a wide range of existing wellbeing measurement instruments. Some measure as few as a single item; others measure as many as 135 items. All these measurement methods rely on self-reporting questionnaires as data collection methods with inherent limitations. From a built environment perspective, there is a disconnect between measuring wellbeing of occupants and measuring buildings using tools, such as BREEAM and LEED. There is a need for a new building occupant wellbeing measurement system(s), including defining measurement indicators, data collection protocol and analysis methods.

Bio:
Professor Sun is the Associate Dean for Research at the School of Architecture, Design and the Built Environment, Nottingham Trent University. He graduated from Tsinghua University, Beijing, China with a bachelor's degree in Architecture in 1985; and completed his PhD on integrated building design systems at Newcastle University in 1993. He then worked as a Research Associate at Newcastle and was appointed as Lecturer of Architecture (Computing) in 1994. He moved to University of Salford in 1996 as a Lecturer of Construction IT and was subsequently promoted to Senior Lecturer. In 2002, He was appointed as Professor of Construction Informatics at the University of the West of England and became the Director of Construction and Property Research Centre in 2005. Between 2012 and 2018, He worked at the School of Energy, Geosciences, Infrastructure and Society, Heriot-Watt University as Professor of Construction Management and Innovation. He was the Director of Institute of Building and Urban Design during 2012-2014, and Senior Director of Studies of Construction Project Management and Quantity Surveying during 2016-2018.