Design for Integrated and Connected Environments: A Society-Centered Research Coalition in Pursuit of Healthy Built-Environments

Participating Departments: Architecture, Urban Design, Cognitive Science and Computer Science, Social Sciences, Electrical and Computer Engineering

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Executive Summary

UNC Charlotte as a post-World War II campus, located in the most populous city in the Carolinas, with high growth and rapidly expanding programs and regional influence, is emerging as a national leader for research and civic engagement in *"Connected Communities."* The established goal for smart connected communities is to accelerate the creation of new levels of economic opportunity and growth, safety and security, health and wellness, accessibility and inclusivity, and overall quality of life. To that end, Smart Connected Communities is supported by many established funding sources such as the National Science Foundation, Gates Foundation, Knight Foundation and many others.

From connected objects to connected buildings, cities and landscapes, the ways in which we design, plan, and engineer connected environments influence not only the ways people interact with and through these environments but also the availability, scarcity, circulation and, ultimately, fair distribution of resources that people access or exchange. This proposed research cluster integrates areas of design, architecture, planning, engineering, and humanities to seek novel ways in which we design, operate, experience, and analyze built environments that are digitally interconnected and mutually shared.

As many of the issues that research in connected communities aims to address engage issues of long-term structural inequity, it is critical for research teams to shift from design methods where technologies are developed within the confines of the university (and only subsequently applied to community conditions) to design methods that actively engage community partners. It is essential, particularly for an urban university such as UNC Charlotte, that the research goals and questions as well as application methods be co-created with community partners. This not only expands technical efficacy but also broadens the impacts of technology creation and thus the impacts of the university. At UNC Charlotte, as an urban research university, we have assembled such a team to address societal challenges by fostering a collaborative research team among computer science and engineering; domain experts from architecture and urban design; and expertise in systems mapping and community engagement. The project direction stems from College of Arts and Architecture; Colleges of Engineering (electrical engineering, computer science) and College of Liberal arts and Sciences. Among the myriad of social challenges, our team will focus on the future of smart cities as a social ecosystem to enhance health and prosperity, energy and promote equity.

Smart connected communities have a solid technology base and integrated systems that provide the foundation which enables the functionality and scalability necessary for sustained growth that can be translated into the built environment at different scales from objects and buildings to neighborhoods, cities and regions.

This emerging cluster proposes two directions of research: 1) design and development of novel methods and technologies to connect people, objects, and places, places in close collaboration with the Urban Synergetics Lab (USL) and Integrated Design Lab (IDRL) and 2) extensive collaboration with local community members with the aim to co-design and co-create applications of enabling technologies to communities who are typically excluded from decision-making. The community will be actively involved in policy making, identifying the functional and technological requirements, as well as tailoring the methods of feedback.

important building-related issues. Example efforts include behavioral energy studies, and projects associated with building energy modeling, analytics, design optimization, Health and Productivity. She has supervised approximately 20 students funded by SIBS projects. She has experience managing large federal projects, most importantly through her management of UNCC's entry in the 2013 Solar Decathlon where he supervised approximately 60 students and numerous contractors over the duration of the project. This project involved well over $1.2 M of federal funds and in-kind support and placed 1st in the "People's Choice" category and won the "Engineering" category among US universities.

Jefferson Ellinger is the director of the Design Computation program at UNC Charlotte, a dual degree program offering Master of Science in Architecture and Master of Science in Computer Science. Recent research includes building integrated plant based air filtration systems that reduce indoor air pollution, increase microbiological diversity and increase oxygen levels from within. The system is currently being tested for efficacy against live coronavirus at Yale University. His forthcoming book From Less to More outlines the evolution of architectural design theory as influenced by philosophical concepts of difference and advanced computation. He has over $400K in external funding.

Nadia M. Anderson is the Director of the UNC Charlotte City Building Lab dedicated to urban research and co-creation with Charlotte's low-income communities of color. She has conducted community-engaged research for over fifteen years, focusing on issues related to urbanism and equity including affordable housing and inclusive decision-making. She has collaborated with teams developing smart and connected cities technology including Drs. Azarbyjani and Tabkhi's team as well as work with big data and disaster mitigation at other universities. She recently received a $25,000 grant from the National Endowment for the Arts to support inclusive neighborhood visioning. She is also a Gambrell Faculty Fellow with the UNC Charlotte Urban Institute investigating new models of affordable housing.

Dr. Ming-Chun Lee conducts research in the areas of digital visualization, geographic information systems, and their applications to the field of urban design and community planning. Dr. Lee brings over 10 years of experience working with local government and nonprofit sectors on topics of geospatial technologies, scenario planning, and community development. He has been involved in several regional scenario planning projects funded by HUD Sustainable Communities Regional Planning Grants, including *Sustainable Places Project* (Envision Central Texas) and *CONNECT Our Future Regional Growth Framework*.

Alignment with Regional and National Priorities

Addressing connectivity, social mobility and equity are emerging as one singular issue and challenge of most urban cities. There are a number of programs and funding available for *Connected Communities* research that reflects the importance of transforming the urban space to a social ecosystem to enhance health and prosperity, energy and promote equity.

Smart and Connected Communities advances UNC Charlotte's mission as North Carolina's urban research university by creating opportunities for cross-disciplinary inquiry, undergraduate and graduate research, and engagement with multiple publics in the Charlotte region and beyond. As stated in the 2018 Civic Action Plan (CAP), community-engaged research is critical for responding to Charlotte's need to improve socio-economic mobility. This proposal supports CAP recommendations to create an integrated institutional structure for engaged research, reducing barriers between the academy and the public.

This cluster addresses the *University's mission* by: leveraging our "location in the state's largest city to offer internationally competitive programs of research and creative activity" that reinforces our "commitment to addressing the cultural, economic, educational, environmental, health, and social needs of the greater Charlotte region" and beyond. It also aligns with the *College of Arts + Architecture's Strategic Plan* to develop vibrant cross-disciplinary partnerships both within the College and with other colleges and individuals across UNCC. It also aligns with *National Science Foundation'*s 10 Big Ideas, in particular, Idea 1: Future of Work at the Human-Technology Frontier: Understanding how constantly evolving technologies are actively shaping the lives of workers and how people in turn can shape those technologies, especially in the world of work. Idea 2: Growing Convergence Research: Merging ideas, approaches, tools, and technologies from widely diverse fields of science and engineering to stimulate discovery and innovation.

In addition, the **National Science Foundation** reviews all funding proposals in terms of intellectual merit and broader impacts. Broader impacts include more inclusionary research practices, particularly with respect to underrepresented groups, publicly accessible distribution of research results, and societal impact. We also align with several priorities of the **National Institutes of Health (NIH).** Our work can lead to understanding complexities involved in systemic and social influences on health behaviors and develop integrated technical/social systems for overcoming harmful behaviors and conditions that address **NIH's** focus on health disparities. Our focus on the built environment also fits **NIH's** interest in studying housing and neighborhoods that support community health and wellness. In addition, this initiative will expand UNC Charlotte's engagement with the local and regional needs described in the 2017 Opportunity Task Force Report through partnerships with underserved neighborhoods, connecting science-based research with socio-economic needs that will improve built environment conditions such as affordable housing, transportation equity, and efficient utility systems.

Supporting Documents

Name	Title	Contribution/Expertise
Dr. Mona Azarbayjani	Associate Professor of Architecture, Graduate program Director Affiliate Faculty: Epic, Infrastructure & Environmental Systems	Energy Analytics, Human Comfort and quantify user-centered design and experiences with new technologies, Advancing Occupant Centered Performance Simulation Metrics: Linking Indoor Environmental Quality to Health, Behavior and Productivity
Dr. Dimitris Papanikolaou	Assistant Professor of Architecture, jointly Software & Info. Systems. Affiliate Faculty: School of Data Science, Complex Systems Institute, Infrastructure & Environmental Systems	Ubiquitous computing, Shared mobility, decision-support systems, computer-supported cooperative work, human-computer interaction, multi-agent systems, system dynamics, information visualization, urban operations research, design research
Jefferson Ellinger	Associate Professor of Architecture Affiliate Faculty: School of Data Science, Infrastructure & Environmental Systems	Computational design, design ecology, material performance, advanced computational techniques for building construction
Dr. Ming-Chun Lee	Associate Professor of Urban Design	Geospatial analytics, scenario-based participatory planning, urban design,

		community development
Nadia M. Anderson	Associate Professor of Architecture and Urban Design	Community engagement, housing and neighborhood systems design, just decision-making, environmental justice
Dr. Hamed Tabkhi	Assistant Electrical and Computer Engineering Affiliate Faculty: School of Data Science, Infrastructure & Environmental Systems the founder and director of the Transformative Computer Systems and Architecture Research (TeCSAR) lab	real-time Artificial Intelligence (AI) and decentralized edge cognitive Intelligence, integrated into physical environments, to enable a broad range of smart and connected applications. AI for public and pedestrian safety, smart transportation, smart power systems, and health care systems
Dr. Suzanne Leeland	Professor, Department of Political Science and Public Administration Professor, Public Policy Doctoral Program	Policy Process and Administration; Economy; Urban Development; Political Institutions and Public Policy; Transportation Policy; Gender and Race
Dr. Samira Sheikh	Assistant Professor in Cognitive Science Department of Computer Science and Department of Psychology affiliate faculty member of the Data Science Initiative and Project Mosaic at UNCC.	Natural Language Processing, Data Science, Computational Sociolinguistics, Cognitive Science, and Artificial Intelligence.