

Connect Grant AY 2018 Proposal

Project Title: Green informatics: Development of a scholarly collaboration for robust & resilient building management systems

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Co-PI Name(s): Yewande Abraham
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Please answer the following questions.

- 1. Provide a high-level, one paragraph executive summary of your project (suitable for press release):** This Connect grant seeks to develop a collaborative network for new tenure track researchers focused on smart *lifecycle management of building systems* through state-of-the-art management system design, informed through data collection, assessment, and decision frameworks. The scholars will 1. Learn the process of inter-disciplinary scholarship development; 2. Integrate knowledge from a variety of related domains to develop new methodologies and approaches; 3. Begin a long term interdisciplinary collaboration that spans several departments, cultures, and scholarly bodies of knowledge. Thus, the scholars will develop both generalizable skills and a specific interdisciplinary domain for future work.
- 2. Provide a detailed description of your project:** Many owners and operators of building systems have signed the UN Global Compact in support of the UN Sustainable Development Goals (SDGs). RIT is a signatory to the American College and University Presidents' Climate Commitment (ACUPCC) and maintains a climate action plan to achieve carbon neutrality by 2030, in support of SDG 13, Climate Action. Executive Order No. 24 (2009) established a goal to reduce greenhouse gas emissions by 80% in New York State by the year 2050. Although ambitious, these goals can be achieved through a collective effort from different sectors of the economy, including the building sector. In response to this, many owners and operators of building systems have been forced to refine or change building and management practices as they attempt to reach for the goal of carbon neutrality, and even modify comfort systems to reach carbon standards. With Dr. Jennifer Schneider, this connect grant seeks to develop a collaborative network for new to scholarship researchers (Yewande Abraham, Lisa Greenwood, Nana-Yaw Andoh, and Minh Pham) focused on smart *lifecycle management of building systems* with faculty mentors including Prof. Maureen Valentine of Civil Engineering Technology, Environmental Management & Safety (CETEMS), Dr. Katie McConky of Industrial Engineering, Prof. Dennis Andrejko of Architecture, Dr. Robert Parody of the School of Mathematical Sciences, and Ms. Enid Cardinal, Sustainability advisor to President Munson. This is unique work is to inform the built environment life cycle towards sustainability and responds to the interdisciplinary scholarly challenges in this emerging field through: 1. Development of a methodology/framework to unify and leverage the existing standards for 'green' infrastructure (building) management systems and metrics of performance to respond to our changing environmental sustainability expectations. 2. Creation of a test bed application to explore the efficacy of informatics in the building operational and lifecycle system, a data to decision to performance pipeline for green and resilient infrastructure. The researchers will also: 1. Learn the process of interdisciplinary scholarship development including: developing an integrative idea and promoting student development; 2. Integrate the domains of construction management, environmental health and safety management, architecture, and statistics to develop new methodologies and approaches; 3. Seed a long term interdisciplinary collaboration that spans several departments, cultures and scholarly bodies of knowledge. Intended outcomes include literature reviews, disseminated works, and potential external funding.
- 3. Provide a detailed, clear implementation plan for all grant proposals, identify here who will serve as the project mentor, and describe their role:** The team will work toward the

successful creation of a new, collaborative scholarly agenda. Project success will be driven through the following norms and expectations for the team 1. Weekly planning and project review meetings with students, 2. Biweekly or monthly (TBD) whole group meetings (with *mentor Jen Schneider*), 3. Monthly peer to peer feedback, 4. Bi-monthly engagement of Connect mentors and other support, 5. Adherence to the timeline.

4. Provide a timeline for your proposed activities:

Activity	Summer 19	Fall 19	Spring 20
Build shared scholarly compendium, shared literature review, examine project opportunities	XX	XX	
Draft research statements & agendas with internal peer review		XX	XX
Craft & implement demonstration scale project(s)	XX	XX	XX
Submit minimum 2 publications & possible external proposal(s)			XX

5. Describe an evaluation plan for your project including the intended or desired goals and outcomes and how they will be measured: Performance will be evaluated through the achievement of the objectives, the adherence to the implementation plan and project timeline, and the scholarly accomplishments including the creation of: 1. A merged compendium and literature review, 2. Design of at least one shared demonstration level research project, with at least two review papers for external submission, as well as, 3. The identification of possible funding sources and possible external proposal. Enhanced relationships with internal support structures and personnel provide the team members with additional mentors and champions who can support the creation of scholarly output over time. Peer to peer feedback will also help mentees stay accountable to one another. Publication of high-quality manuscripts strengthens external proposals written by the team, and builds their joint publication record.

6. Describe the roles of each of the project participants, including the project mentor: PI **Schneider** will initially lead the team but will gradually hand over leadership roles to team members (either by role or through rotating means). The team members will supervise their particular students. Schneider will also share her expertise and connections to the domain of systemic resilience systems and mentor the integration of the new collaborative body of knowledge. The Co PIs will provide guidance and direction on relevant literature in their fields of expertise, and unify these pieces. **Abraham** will contribute to the work on buildings and infrastructure by providing an insight into the sustainable buildings assessment systems such as LEED and Green Globes. Abraham is a LEED Accredited Professional in building operations and maintenance. She will also be bringing her expertise and experience from her research on operational building tracking and monitoring for improved comfort and energy performance. She will also reach out to FMS at RIT for access to data and facilities managers at Penn State and the University of Florida to understand the practices at other institutions. **Greenwood** will contribute to the work in environmental and sustainability management systems through her research and expertise on ISO standards, risk-based management systems, and sustainable system design. Dr. Greenwood holds certification as a sustainability associate under the International Society for Sustainability Professionals, has over 20 years of experience with management system design and implementation in enterprise, and is Vice Chair of the ISO U.S. Technical Advisory Group (TAG 207) on environmental management. She can leverage her connections for access to data related to management systems, standards implementation, and performance. **Andoh** will identify various active and passive sustainability applications used in current building design practice. Professor Andoh has an extensive background in Integrated Building Systems as it relates to how the cause and effect of design decisions impacts building performance and access to an Environmental Chamber that can be used to track building material performance, and with the use of Building Information Modeling, determine overall building performance based on individual parts and their interdependence. He will reach out to design professionals in the local

area for building performance data on LEED projects to simulate/create multiple scenarios. **Pham** will contribute to the work in exploring the power of informatics in the building operational life cycle and developing methodologies to analyze data related to management systems and material performance. He will also contribute by working closely with students on the applications of quantitative methods in sustainability management systems.

7. **Explain how the proposed work is relevant to the faculty members’ plan of work, faculty group scope of work, or the academic unit’s mission and goals?** This effort supports the individual, departments and college goals by expanding a scholarly agenda and supporting faculty scholarly growth. In particular, this effort supports the university and college agenda to grow scholarship capacity. **Schneider** is the Fram Chair, a professor in CETEMS Department, and principal of the Collaboratory for Resiliency & Recovery (CRR), a cross-disciplinary laboratory for resilience and response scholarship. Dr. Schneider is a million dollar PI and 2014 RIT BOT Scholar award winner. Her POW continues CRR growth. Highly collaborative, she is known for building successful cross-disciplinary teams. Her previous Connect efforts have resulted in published scholarship and external funded awards for participants. **Abraham** is an assistant professor in CETEMS. Her POW focuses on building energy efficiency, occupant comfort, and indoor environmental quality. She is interested in sustainable design and construction in buildings and is extending her research in understanding end user satisfaction in buildings. She is developing a new online Master’s program in Construction Management. **Greenwood** is an assistant professor in CETEMS. Her POW centers on environmental, health, safety, and sustainability management standards; management systems integration and implementation; social responsibility; and thinking in systems. Dr. Greenwood’s service commitments include a leadership role in international environmental standards development. She is seeking opportunities to integrate ISO and green building standards to develop better frameworks. **Andoh** is an assistant professor in Architecture. His POW places an emphasis on sustainability as a system to be addressed at multiple scales, from urbanism to architecture, and how this knowledge can be used to improve the quality of life for underserved populations. He explores local, regional, national, and international efforts to address social equity through a sustainable built environment. **Pham** is an assistant professor in Statistics. His research focuses are on developing theories and methodologies to analyze large scale and complex data. He has special interests in the integration of data analytics and sustainability.

8. **Budget**

NSF Connect Grant Budget		
Dollar Amount	Budget Item	Notes/Description
\$xxxx	Student Salaries	Split evenly by Co - PIs for student support (matched by mentored scholar home departments to bring functional budget to \$xxxx total).

The team seeks \$xxxx to support student effort in hourly wages split among the CoPI’s selected students. This connect grant funding will be matched by each department to bring the total budget to \$xxxx, or \$xxxx per mentored scholar. These students will be responsible for assisting the team in the compilation of the scholarly compendium and literature review, through the collection and creation of a *citation index* to support the expanded domain within related disciplines. In addition, student work will support the *drafting of scholarly review white papers* and development of methodologies to be tested. As the project moves into research and scholarly output, funded student effort will adjust accordingly. We intend to *integrate the research into curricula through independent study or student project courses, increasing the impact of the effort.*

9. **Describe how this project is relevant to the AdvanceRIT project goals, objectives, and ongoing activity/initiative areas** The RIT Advance goals focus on the development of faculty

capacity to thrive within a university environment. This proposal supports those goals and other expanded RIT goals, through development of a mentored, collaborative, and peer to peer network AND a scholarly focus area and agenda that not only engages early career tenure track women and men faculty, but also enhances leadership skills by developing those faculty's abilities as mentors to student scholars. This effort aims to create and integrate a new area of scholarly opportunity in an expanding area of recognized research need. The potential impact of this work on sustainable systems and technology integration as well as university goals in sustainability extends RIT's reputation as an applied, yet innovative university.

- 10. Describe the broader impact of the proposed work based on NSF Advance Merit Review Criteria** The proposed project will enhance infrastructure for collaborative research through providing an opportunity to create a common research base across different disciplines, advance discovery and understanding while promoting teaching, training and learning through mentoring of junior faculty and also create research experiences for undergraduate and/or graduate students, and create community engagement and benefit by way of the potential to work with university stakeholders. This work can also provide some visibility and awareness through our research publications and findings. The proposed work can provide value-adding benefits to RIT's climate commitment. Opportunities for collaboration beyond RIT may also be forged.
- 11. Discuss the intellectual merit of the proposed work based on NSF Advance Merit Review Criteria on intellectual merit** Again, the proposed project will lead to future collaborative research in integrative building informatics. Specifically, the team will work towards leveraging their strengths of the different domains of construction management, environmental health and safety management, architecture, and statistics to uncover novel approaches toward resiliency and advancing sustainable building management systems.

12. References:

- Abraham, Y. S., Anumba, C. J. and Asadi, S. (2017). "Data Sensing Approaches to Monitoring Building Energy Use and Occupant Behavior." *American Society of Civil Engineers (ASCE)*, Seattle, Washington
- Anumba, C. J., Abraham, Y., and Kaneda, D. (2015). "Net-Zero Carbon Buildings: A US Perspective." (C. Wing, Ed.) *Zero Carbon Journal*, Volume 4, 22-29
- Agarwal, Y, Balaji, B, Gupta, R, Lyles, J, Wei, M and Weng, T. (2010). "Occupancy-driven Energy Management for Smart Building Automation." In: *Proc. of the 2nd ACM Workshop on Embedded Sensing Systems for Energy-Efficiency in Building*, 1–6. DOI: 10.1145/1878431.1878433
- Dammann, S., & Elle, M. (2006). Environmental Indicators: Establishing a Common Language for Green Building. *Building Research & Information*, 34(4), 387-404.
- Dunn, T., Schneider, J. & R. Zigenfus "Comparison of Thirty Green Building Projects Across the US: Common Elements" *International Journal of Facility Management* 3:1 (2012).
- Jennings, BJ, Vugrin, ED and Belasich, DK 2013 Resilience Certification for Commercial Buildings: A Study of Stakeholder Perspectives. *Environment Systems and Decisions* 33(2): 184–194. DOI: 10.1007/s10669-013-9440-y
- Johansen, C, Horney, J and Tien, I 2017 Metrics for Evaluating and Improving Community Resilience. *J. Inf. Sys* 23(2). DOI: 10.1061/(ASCE)IS.1943-555X.0000329
- Kibert, C. J. (2016). *Sustainable Construction: Green Building Design and Delivery*. Hoboken, N.J: John Wiley.
- Lam, P. T., Chan, E. H., Chau, C. K., Poon, C. S., & Chun, K. P. (2011). Environmental Management System vs Green Specifications: How do they Complement Each Other in the Construction Industry? *Journal of Environmental Management*, 92(3), 788-795.
- National Institute of Building Sciences (NIBS) 2016a "Integrated Resilient Design Program." <https://www.nibs.org/?page=irdp> (Nov. 21, 2016).
- Vierra, S. (2016) "Green Building Standards and Certification Systems." Whole Building Design Guide- National Institute of Building Sciences (NIBS) <https://www.wbdg.org/resources/green-building-standards-and-certification-systems>