

A man in an orange long-sleeved shirt and white shorts is wading in a stream. He is wearing black gloves and is leaning forward, looking down at the water. The background is a dense forest of green trees.

SyracuseCoE
Syracuse University

Headwaters for Innovation

PROGRESS REPORT 2018

SyracuseCoE Is New York State's Center of Excellence in Environmental and Energy Systems.

SyracuseCoE catalyzes research, development, and demonstrations to accelerate innovations for cleaner energy, healthier buildings, and more resilient communities. Led by Syracuse University, SyracuseCoE engages faculty, students, and industry partners to enable a thriving culture of collaboration for innovative research and product development. SyracuseCoE conducts projects that take ideas from the lab to the market and bring market needs to the lab for solutions. The result: advanced technologies that conserve natural resources and promote healthy buildings and cleaner, greener communities. SyracuseCoE is one of 11 Centers of Excellence funded by New York State to foster collaboration between the academic research community and the business sector to develop and commercialize new products and technologies. Each center focuses on an emerging high-technology field that is important to the economy of New York State. SyracuseCoE initiatives accelerate entrepreneurship and create jobs in the Central New York region and advance New York State's reputation for excellence in environmental and energy systems around the world.



ON THE COVER

Charles Driscoll, University Professor of Environmental Systems and Distinguished Professor of Civil and Environmental Engineering at Syracuse University, takes water samples to test for chemical deposits from the atmosphere.

Partners for a Healthy Future

Innovation seldom happens in a vacuum. Since 2001, SyracuseCoE has been a hub for elevating research, entrepreneurship, and innovation in Central New York related to clean energy and green building technologies. By fostering collaborations between the region's long-standing industry clusters and students and faculty at area academic institutions, SyracuseCoE is the catalyst behind groundbreaking research and the development and commercialization of exciting new products and technologies.

In addition, SyracuseCoE's state-of-the-art LEED Platinum headquarters facility functions as a living lab, hosting dozens of demonstration projects as well as important research on the impact of the built environment on the health and productivity of inhabitants and our natural world.

A perfect example, pictured on our cover, is an ongoing project of Charles Driscoll, University Professor of Environmental Systems and Distinguished Professor of Civil and Environmental Engineering at Syracuse University and a member of the National Academy of Engineering. Driscoll is internationally known for his research on the effects of acid and mercury deposition and climate change on forest, aquatic, and coastal ecosystems. In 2011, support provided by SyracuseCoE's Faculty Fellows Program enabled Driscoll to extend his studies of atmospheric deposition to green spaces at the SyracuseCoE headquarters, including analyzing the ability of the SyracuseCoE green roof to retain water, nutrients, and trace metals. His study is one of few studies of atmospheric deposition in urban areas and will provide important information on the impact of pollution on urban landscapes.

SyracuseCoE supports exploratory faculty research such as Driscoll's through annual competitive awards for projects in clean and renewable energy, indoor environmental quality, and water resources. SyracuseCoE's Partner Program provides similar support to local industry partners, helping these firms develop and commercialize new products, adding jobs and building the economy of the Central New York region.

SyracuseCoE support of faculty and industry partners extends beyond annual project awards. Whether it's partnering in applications for funding from state or federal sponsors or facilitating introductions to potential early adopters and other collaborators, SyracuseCoE often provides the X-factor to push a product or technology to the next level.

Consider partnering with us for a healthy future.

Expert Collaborator

Professor Jensen Zhang's collaborative research on building energy and environmental systems has elevated Syracuse University as a leader in the field.

"I'm very fortunate to be able to work with so many faculty with very different expertise—from computation, to chemistry and physics, to architecture and engineering and computer science—all interested in green building technologies."

JENSEN ZHANG

In September 2018, the world's leading experts in building science converged on Syracuse for a series of meetings and workshops. First, the seventh triennial International Building Physics Conference brought more than 300 experts and practitioners from 33 countries to focus on "Healthy, Intelligent, and Resilient Buildings and Urban Environments."

After the conference, the 15th International Forum and Workshop on Combined Heat, Air Moisture, and Pollutant Simulations (CHAMPS) convened to discuss major challenges for the design and operation of sustainable buildings. That was followed by a meeting of experts working on Annex 68, a study for the International Energy Agency focused on indoor air quality design and control in low-energy residential buildings.

The proximity of these meetings to each other and their location in Syracuse was no accident, but the result of nearly 20 years of research and international collaboration by Jianshun "Jensen" Zhang, Syracuse University professor of mechanical and aerospace engineering. Since joining the faculty in 1999, Zhang has played a major role in positioning Syracuse University as a leader in building energy and environmental system research, establishing a cutting-edge laboratory used by academic and industry researchers from around the world and developing his reputation for groundbreaking research in the fields of building science and indoor environmental quality.

Zhang's interdisciplinary research encompasses multi-scale building energy systems—from nano/micro-scale in porous media to buildings and urban environment—and involves engineering, architectural design, and human health and performance. Zhang has authored or co-authored more than 100 peer-reviewed journal papers and more than 100 refereed conference papers, as well as a book. He leads an international group in developing methods and tools for CHAMPS for building systems, is a Fellow of ASHRAE and the International Society of Indoor Air Quality and Climate, and served on the ASHRAE Environmental Health Committee, as well as several technical committees. In September, at the IBPC

meeting in Syracuse, Zhang was elected to serve a three-year term as chairman of the International Association of Building Physics.

And he's a mentor, teaching undergraduate and graduate classes in building energy and environmental systems and fundamental heat and mass transfer, and advising master's and doctoral students and postgraduate researchers attracted to Syracuse for the opportunity to work with him.

But most of all, Zhang is a collaborator—conducting interdisciplinary research with other SU faculty members, such as a current SyracuseCoE project to develop a new modular design system for engineers and architects with Bess Krietemeyer, SU assistant professor of architecture; working with industry partners such as Japanese construction company Takenaka Corporation, which has sponsored a research project on how indoor air quality impacts people's creativity; or a project for the Business and Institutional Furniture Manufacturers Association (BIFMA) to develop a method for testing and evaluating chemical emissions. This project has led to the establishment of an ANSI/BIFMA Standard for testing emissions from furniture materials, components, and systems used by the USGBC Green Building Certification Program (LEED) for selecting and specifying low-emitting materials.

And then there are his institutional collaborations, such as an international exchange program with Nanjing University in China, organizing joint workshops, programs, and exchange visits; Annex 68, an international collaboration that involves researchers from seven universities; and CHAMPS, which grew out of a software program developed by Zhang and John Grunewald of Dresden University of Technology, in Germany.

"People can use the software. They can also help develop the software. Every year through these workshops we will discuss what's new, what people have done, and the next steps," Zhang explains.

It was the opportunity for that kind of intellectual exchange that attracted Zhang to Syracuse University. At the time, he was conducting indoor air quality research at the National Resource ►



Meng Kong G'17

Postdoctoral researcher
M.S. in mechanical and aerospace engineering
Ph.D. in mechanical and aerospace engineering
Syracuse University

Homegrown Talent Kong came to Syracuse University for a master's degree. In 2012, he began working with Jensen Zhang, SU professor of mechanical and aerospace engineering, attracted by Zhang's expertise in indoor environment systems. Zhang became Kong's doctoral advisor; Kong earned a Ph.D. in mechanical and aerospace engineering in 2017 and is now a postdoctoral researcher in Zhang's lab.

SyracuseCoE Connection Kong has worked with Zhang and SU engineering Professor (now emeritus) H. Ezzat Khalifa, both SyracuseCoE Faculty Fellows, on projects related to personal comfort and ventilation. Most recently, he conducted human subject testing on the Micro-Environmental Control System—a personalized cooling system for office workers designed to fit under a desk. As a doctoral student, Kong worked on a personal ventilation (PV) project, using a thermal manikin in the TIEQ lab to study the effect of the PV under different conditions.

Highlight Kong took first place in the 2016 SyracuseCoE Student Poster Competition for *Modeling and Experimental Study of Using Micro-environment Control for Thermal Comfort*. "SyracuseCoE provides a friendly environment that facilitates research. Working here has enriched my research experience and broadened my community," he says.

Council of Canada, and SU's College of Engineering and Computer Science was searching for a faculty member to lead research and teaching relating to indoor environmental quality.

Zhang was the first faculty member SU hired in support of a regional initiative to strengthen collaborations between Central New York's universities and companies related to energy and environmental systems for the built environment.

"When I came to interview, someone asked me why I wanted to leave Canada, where I had an established indoor air quality lab," Zhang recalls. "My answer was, 'Well, it's warm here.'"

In truth, Zhang was interested in greater opportunities for collaboration between academic research institutions and industry. In Canada, he'd been part of an industry-sponsored consortium project on zero emissions and indoor air quality and wanted to do more of that kind of work.

With funding from Syracuse University, the U.S. Environmental Protection Agency, New York State, and National Grid, Zhang designed and built the Building Energy and Environmental Systems (BEES) Laboratory, a state-of-the-art research facility with capabilities for both experimental and computer simulation from material-level properties to full-scale system level behavior and performance studies. "It's a unique facility with capabilities not found elsewhere," says Zhang, who most recently hosted three chemists from Canada working on a project related to the chemical reaction of ozone under sunlight, using the lab's Indoor Environmental Quality chamber.

The growth in Zhang's research profile is integral to the parallel growth and development of SyracuseCoE, which was established as a New York State Center of Excellence in 2002. Zhang, one of SyracuseCoE's first faculty collaborators, says he has benefited greatly from the organization and its facilities.

"SyracuseCoE plays an essential role helping faculty members get connected with industry and in coordinating major funding proposals," says Zhang, whose SU research has attracted more than \$7.9 million in funding as a principal investigator (PI) and more than \$21.7 million as a co-PI, from agencies including the National Science Foundation, EPA, Department of Energy, U.S. Forest Research Laboratory, FAA, NYSERDA, NYSTAR, ASHRAE, BIFMA, American Air Barrier Association, S.C. Johnson, Xerox, and Honeywell.

In turn, SyracuseCoE Executive Director Ed Bogucz credits Zhang's research and teaching leadership to successes in winning funding to establish the STAR Center for Environmental Quality Systems in 2001 and SyracuseCoE in 2002. "Having these affiliated centers enabled us to attract additional faculty members, such as H. Ezzat Khalifa and Cliff Davidson, each of whom has done pioneering research and teaching that added to our reputation," he says.

Zhang believes he's in the perfect spot. "I'm very fortunate to be able to work with so many faculty with very different expertise—from computation, to chemistry and physics, to architecture and engineering and computer science—all interested in green building technologies," he says. "And to have the support and ability to work with people nationally and internationally enhances our ability to move the field forward." ●



IBPC2021 will be held in Copenhagen, Denmark.

The International Building Physics Conference (IBPC) is the world's premier building science meeting, held every three years in locations around the globe. In September, the seventh IBPC was held in Syracuse, the first time the conference was held in the United States.

"Given the amount of research and activity in our area related to indoor air quality, energy efficiency, and green building technologies, as well as our unique facilities, I thought Syracuse would be the perfect location for this conference," says Jensen Zhang, Syracuse University professor of mechanical and aerospace engineering, a board member of the International Association of Building Physics, and chair of the meeting.

After two days of pre-conference workshops, IBPC2018 brought more than 300 researchers and professionals from

33 countries to spend three days hearing presentations on cutting-edge research and findings, viewing demonstrations and exhibits of innovative green building technologies, and discussing future challenges and opportunities in the area of "Healthy, Intelligent, and Resilient Buildings and Urban Environments." The conference was jointly organized by SyracuseCoE, and Syracuse University's College of Engineering and Computer Science and School of Architecture. Co-chairs included Ed Bogucz, SyracuseCoE executive director; Cliff Davidson, professor of civil and environmental engineering; and Bess Krietemeyer, assistant professor of architecture.

Zhang says hosting the conference in Syracuse allowed students to attend and participate in a premier international conference. "We had many students attend,

many students assist with the conference as volunteers, and others presented research and hosted sessions," he says. "It was a unique opportunity to meet world experts and learn about trends in the field."

In addition, 20 doctoral students from the United States, Canada, and Europe (including five from SU) took part in a pre-conference short course sponsored by the International Association of Building Physics to learn about modeling and simulation.

A post-conference technical tour allowed participants to see Syracuse University facilities—including the BEES Laboratory, BEST Laboratory, and SyracuseCoE headquarters, lab facilities, and green roof. "Most of the participants were visiting Syracuse for the first time," says Zhang. "They were very impressed with the capability and research facilities we have here." ●

"Given the amount of research and activity in our area related to indoor air quality, energy efficiency, and green building technologies, as well as our unique facilities, I thought Syracuse would be the perfect location for this conference." JENSEN ZHANG

IBPC FAST FACTS



320+ attendees



250+ presentations



65+ programming hours



33 countries represented

Supporting Scholarship

SyracuseCoE catalyzes projects that focus knowledge and discovery in academia on targeted applications in the world beyond. Through its Faculty Fellows Program, SyracuseCoE awards early-stage funding and provides networking resources that enable faculty members to explore new opportunities and conduct collaborative research in emerging fields.

Each year, SyracuseCoE competitively awards funding for faculty projects in the areas of clean and renewable energy, indoor environmental quality, and water resources. Faculty Fellows projects are supported with grant funding of up to \$25,000; expertise and support of SyracuseCoE staff; and, in some cases, use of the facilities. Faculty researchers from Academic Partner universities are eligible to submit proposals.

The output of these projects advances SyracuseCoE research areas and impacts our built and natural environments in meaningful and substantial ways. ➤

Since 2015

45

Faculty supported

55

Projects

\$684K

Funding



Christa Kelleher (left) works with graduate student Crystal Burgess (right) and high school researcher Zoe Curewitz at SyracuseCoE assessing performance of green infrastructure.

The Impact of Green Infrastructure

Christa Kelleher

Assistant Professor, Department of Earth Sciences, College of Arts and Sciences; Assistant Professor, Department of Civil and Environmental Engineering, College of Engineering and Computer Science, Syracuse University

Project Assessing the impact of passive green space on water infiltration, ground temperature, and air temperature.

Backstory Like many older cities, Syracuse has a combined sewer system that includes both sanitary waste and surface runoff. Rain and snowmelt can exceed the capacity of the system and cause combined sewer overflow (CSO), rising urban stream temperatures and harming aquatic ecosystems. Green infrastructure throughout the city attempts to improve water infiltration and reduce overflows. In addition to green infrastructure, the city's many vacant lots can be considered a form of passive green infrastructure.

Nuts and Bolts Kelleher and her students are assessing the performance of green infrastructure installations and vacant lots in Syracuse. They are monitoring soil temperature, air temperature, and water infiltration on five vacant lots slated to be repurposed with green infrastructure into urban rain gardens. "These conversions are designed to impact a single CSO outlet," Kelleher explains. "The idea is that if they co-locate these sites, maybe it will impact the amount of storm water running off." Baseline information gathered before installation will be used to evaluate the progress and effectiveness of the rain gardens. In addition, as a source of comparison, they are also collecting data from rural parks and from established green spaces within the Syracuse urban core.

And Another Thing One of the sites being studied is SyracuseCoE headquarters. Graduate student Crystal Burgess installed sensors on the SyracuseCoE green roof, on a large planting bed adjacent to the parking lot, and in a mostly shaded area near the building entrance. "This allows us to gather a range of temperature profiles that we would see in an urban area and also to factor in how much factors such as buildings and vegetation play in decreasing soil temperature," Burgess says. Summer intern Zoe Curewitz, a student at Nottingham High School in Syracuse, also contributed to the project by helping to install sensors across the Syracuse University campus.

SyracuseCoE Impact Kelleher previously received a \$10,000 competitive award from the Faculty Fellow Program to study longitudinal patterns of stream temperature and levels of storm flow along Onondaga Creek using unmanned aerial vehicles. "All of this work concerns the movement of heat in urban systems," she says. In addition to funding, "SyracuseCoE has been instrumental in helping me connect with other folks at the University and beyond that to the broader community," she says. "Through SyracuseCoE, my students gain the ability to interact with others who are doing interdisciplinary water research at both the faculty and student level." ●

"Through SyracuseCoE, my students gain the ability to interact with others who are doing interdisciplinary water research at both the faculty and student level."

CHRISTA KELLEHER

Assessing Chemical Impact

Charles Driscoll

University Professor of Environmental Systems and Distinguished Professor, Department of Civil and Environmental Engineering, College of Engineering and Computer Science, Syracuse University

“If we’re interested in thinking about urban areas as landscapes, it’s nice to know what’s coming into the system and helpful to know how the landscape functions.”

CHARLES DRISCOLL



Charles Driscoll, University Professor of Environmental Systems, takes water samples as part of research measuring atmospheric deposition in different ecosystem environments.

Project Driscoll is measuring atmospheric deposition—the chemicals reaching the Earth through rain and air—in Central New York, comparing sites in urban Syracuse, including the SyracuseCoE green roof, with rural Skaneateles.

Backstory The Syracuse project is an offshoot of Driscoll’s long-standing research on the effects of acid and mercury deposition and climate change on forest, aquatic, and coastal ecosystems in the Northeast and elsewhere. Driscoll also recently began collaborating with researchers at Boston University who are taking similar measurements in Boston, to develop models to evaluate how urban landscapes are different from rural landscapes in responding to climate change and urban air pollution. He’s also sharing information with the National Atmospheric Deposition Program, which is increasing its research focus on urban areas.

Nuts and Bolts Driscoll began measuring atmospheric deposition at the SyracuseCoE headquarters in 2011. Last year, he added additional sites in Syracuse to compare levels and patterns of contaminants over the course of the year. He’s also assessing the function of the SyracuseCoE green roof in terms of its ability to retain water, nutrients, and trace metals. “We measure many more chemicals than is routine,” Driscoll says. Because there have been few measurements taken in urban areas and some of these chemicals are not typically measured, Driscoll believes some of the patterns found in Syracuse have never before been reported. As an additional comparison, he established a testing station in Skaneateles identical to the one at SyracuseCoE.

What He’s Found Not surprisingly, overall air pollution levels in Syracuse are higher than those in Skaneateles, significantly impacted by highway auto emissions, construction activities, and road salt. But there were chemicals with higher levels in the rural setting, including phosphorus. “There are harmful algal blooms in Skaneateles Lake that people think are driven by inputs of phosphorus. We think the phosphorus we’re measuring is going to be a large input to the lake,” he says. “We learn things from these measurements that stimulate interest in new areas that we didn’t really intend.”

SyracuseCoE Impact Driscoll’s project has been funded over four rounds of the Faculty Fellows Program. In addition to research funding, the SyracuseCoE green roof provides a world-class research environment. “There’s a lot of interest in green infrastructure, and the SyracuseCoE green roof is a Cadillac roof,” he says. “I don’t think there’s a green roof in the world that outperforms it.”

Practical Application Few studies have been done of atmospheric deposition in urban areas. “If we’re interested in thinking about urban areas as landscapes, it’s nice to know what’s coming into the system and helpful to know how the landscape functions,” he says. ●

Developing a Sustainable Battery

Ian Hosein

Assistant Professor, Department of Biomedical and Chemical Engineering, College of Engineering and Computer Science, Syracuse University



Ian Hosein, assistant professor of biomedical and chemical engineering, used funding from the SyracuseCoE to produce and test a prototype calcium-ion battery, which he says is a cheaper and safer alternative to lithium-ion batteries.

Project Developing a solid-state calcium-ion battery that is a cheaper, more powerful, and environmentally safer alternative to lithium-ion batteries.

Backstory Lithium-ion batteries are a popular energy technology due to lithium’s ability to store energy. Unfortunately, since lithium is mined in far-off places, it’s also expensive. And most lithium-ion batteries contain a liquid electrolyte that is flammable. “There’s a drive to find another ion that has the same energy density but is cheaper and more earth abundant,” says Hosein.

Nuts and Bolts Hosein has developed a battery using calcium—one of the most abundant elements in the world, which has double the charge of lithium—and replaced liquid electrolyte with a flame-resistant solid. “It’s essentially a plastic that contains the calcium ions and facilitates transport from one electrode to the other,” he explains. However, because every ion is unique, so is the solid electrolyte required to conduct energy. “It takes a lot of development to get the right combination of calcium source and the right plastic composition to actually get something that’s conductive,” says Hosein.

SyracuseCoE Impact A Faculty Fellows award from SyracuseCoE funded supplies and equipment to produce and test a prototype electrolyte and demonstrate that it is extremely conductive. “We have integrated the solid electrolyte into a prototype calcium-ion battery, demonstrated that it works, and are currently focusing on improving it,” Hosein says. “We never could have done this without the financial support from SyracuseCoE.”

Practical Application Having a safer and more powerful battery is important for industries ranging from personal devices to transportation. “Everyone’s heard about cell phone batteries that explode,” says Hosein. “A big concern with electric cars is the battery. You’re driving around with about a gallon of flammable liquid in there. If we can replace that with a nonflammable solid and we replace lithium with calcium, then we’re going to have a safer, better battery overall.” ●

“A big concern with electric cars is the battery. You’re driving around with about a gallon of flammable liquid in there. If we can replace that with a nonflammable solid and we replace lithium with calcium, then we’re going to have a safer, better battery overall.”

IAN HOSEIN

Using Virtual Reality for Data Simulation

Amber Bartosh

Assistant Professor, School of Architecture, Syracuse University

Melissa Green

Assistant Professor, Department of Mechanical and Aerospace Engineering, College of Engineering and Computer Science, Syracuse University

“We see alignments between what we’re trying to do in terms of data visualization. It’s not that crazy a pairing when you think about it from that standpoint.”

AMBER BARTOSH



Melissa Green and Amber Bartosh are collaborating on a project that attempts to use virtual reality software to create immersive data visualizations for architecture and engineering purposes.

Project Developing a platform to communicate quantified data using a virtual reality (VR)-enabled immersive and interactive environment.

Intellectual Collision Bartosh is an architect who uses virtual reality to visualize things like energy flows around people in a building. Green, a mechanical and aerospace engineer, seeks to use the same technology to visualize fluid flows, such as around fins in water. “We see alignments between what we’re trying to do in terms of data visualization,” says Bartosh. “It’s not that crazy a pairing when you think about it from that standpoint.”

Nuts and Bolts Advancements in digital modeling tools have dramatically increased the amount of spatial data relating to fluid dynamics flow visualization, and building energy systems. However, the two-dimensional systems typically used to represent this data usually oversimplify complex three-dimensional conditions. With initial funding from SyracuseCoE followed by a CUSE Innovation Grant from Syracuse University, Bartosh and Green are working to make links among traditional architecture, engineering software, and virtual reality software to create immersive data visualizations.

Challenges It’s a difficult process. While it’s easy to represent a building visually, it’s more challenging to show how a building is going to perform in terms of thermal control or daylighting. “Those things are more difficult to convey because we’re not used to seeing that data in 3-D,” says Bartosh. “We can measure it and record it in charts or spreadsheets, but what we’re trying to do is bring that into this virtual environment, feeling like you’re walking through the real space with the temporal qualities specifically related to energy and flow that we are trying to visualize.”

Real-World Collaboration Bartosh is using projects from SyracuseCoE partner firm Ashley McGraw Architects as test cases for data visualization methods to see if they help with communication. In turn, Ashley McGraw has integrated VR into its practice after seeing how the technology was being used by architecture faculty working at the SyracuseCoE Interactive Design and Visualization Lab (IDVL).

SyracuseCoE Impact Bartosh and Green are both SyracuseCoE Faculty Fellows working out of labs at SyracuseCoE headquarters. Green directs the Flow Visualization Lab, while Bartosh works out of the IDVL. SyracuseCoE funding allowed for the purchase of VR equipment used for their current project. “The space and resources we have here are fundamental to what we do,” Bartosh says.

Bottom Line The collaboration is an attempt to make data visualization a more streamlined process for each of their own labs and, ultimately, a feasible product transferable to other STEM and design disciplines. ●

Industry Partners

Partners in Innovation

Since its beginnings in 2001, SyracuseCoE has worked to improve sustainable systems and technologies by helping its Industry Partners develop, demonstrate, and commercialize new products and technologies.

SyracuseCoE provides assistance in multiple ways, including partnering in applications for funding from federal and state sponsors; performing testing of proof-of-concept prototypes in laboratory settings and field locations; facilitating introductions to potential early adopters and other industry collaborators; and by annual competitive awards made to support industry projects.

Those efforts continue to make a big impact across the region and throughout New York State, increasing research and development, enhancing innovation, creating new jobs, and seeding product development and manufacturing. ➤

Fast Facts

71

Companies assisted

228

Projects

1,130

Jobs created and retained

Central New York's Innovation Crossroads

Central New York has been a hotbed for innovators and entrepreneurs for more than 140 years. Today, the five-county region boasts a vibrant ecosystem for industry-university collaborations in research and development for products in many areas. From technologies that conserve natural resources and promote healthy buildings to precision medicine and next-generation medical devices, Central New York's Innovation Crossroads district is increasingly on the cutting edge for innovations that require advanced sensors and data analytics.

At the foot of University Hill in Syracuse, Central New York's Innovation Crossroads is anchored by SyracuseCoE and the Central New York Biotech Accelerator (CNYBAC), operated by Upstate Medical University. Together, SyracuseCoE and CNYBAC create a powerful hub for synergistic, collaborative research and development by academic and corporate partners.

National Grid sponsored development of the branding for Central New York's Innovation Crossroads through its Urban Center/Commercial District Revitalization Program. This program is designed to assist communities in promoting smart growth and private-sector investment in central business districts and commercial corridors that help their competitive viability, attract investment, and capitalize on their distinct development potential.

"There is significant economic potential in this Innovation Crossroads," says David Mankiewicz, senior vice president of CenterState CEO and president of University Hill Corporation. "Within close proximity, Central New York has the three major R&D centers: SyracuseCoE, the CNY Biotechnology Accelerator, and the Tech Garden. All of these centers are generating new businesses and technology-focused employment opportunities for the region. Whether it is environmental, energy, medical, biotechnology, or unmanned aerial systems, there is a significant support network for those industries in this space.

"And since these centers are located within newly designated federal Opportunity Zones, we can also look to bring significant capital investment to finance new entrepreneurial ventures," he says.

"There are many promising opportunities for synergies between our CNY Biotechnology Accelerator and SyracuseCoE," adds Robert Corona, chief executive officer of SUNY Upstate University Hospital. "Our faculty members have collaborated with SyracuseCoE to conduct pioneering research on the impact of indoor environmental quality on the cognitive function of office workers. We look forward to future collaborations concerning the impacts of environmental quality on health, development of novel medical devices, and more." ●

"Whether it is environmental, energy, medical, biotechnology, or unmanned aerial systems, there is a significant support network for those industries in this space."

DAVID MANKIEWICZ



Solving Energy Loss

Ron Wexler enjoyed the abundance of natural light and windows in his home office in Rochester, that is, until winter rolled around, and the energy loss from the older windows required him to use a space heater to remain comfortable.

Wexler, an applied scientist and former technology director of patent sales at Kodak with 30 patented inventions, set his attention to the energy-loss problem. He knew there had to be a better solution than installing plastic window film over windows each year with a hair dryer.

Wexler's answer is WindowSkin™, a custom-fit, transparent insulation panel that reduces energy loss during both cold and hot weather when installed on the interior of an existing window. The product—which lasts for 15-plus years and costs a fraction of the price of a replacement window—began manufacture in December 2018 and is expected to be available in the multi-family residential and commercial markets in early 2019. Wexler credits SyracuseCoE for assistance in testing the product and getting it to market.

In 2015, Wexler took an early prototype to Jensen Zhang, professor of mechanical and aerospace engineering at the Syracuse University College of Engineering and Computer Science. Zhang pointed Wexler to SyracuseCoE, and Wexler committed his startup firm to become an Industry Partner. SyracuseCoE invited WexEnergy to showcase its first prototype in SyracuseCoE's booth at the 2016 ARPA-E Energy Innovation Summit in Washington, D.C. "That early-stage feedback was instrumental in getting the product to where it is today," says Wexler.

In 2016, WexEnergy won a \$10,000 competitive award from SyracuseCoE's



Wex Energy WindowSkin™ is a custom-fit, transparent insulation panel that reduces energy loss when installed on the interior of an existing window for a fraction of the cost of a replacement window.

"I can't say enough about how helpful our association with SyracuseCoE has been....As a very early-stage startup, having those independent validation studies got us to entirely different conversations with potential investors and potential customers."

RON WEXLER

Innovation Fund that enabled the startup to engage Taitem Engineering of Ithaca, New York, to perform independent validation studies on WindowSkin performance. The testing found that WindowSkins mounted on an air-filled double-pane window (commonly installed from the 1950s through 1970s) deliver 55 percent of the energy-saving performance improvement of a new Energy Star window rated for cold climates. Those results led to a demonstration project on a building in Ithaca last winter, which documented 13 percent lower natural gas usage with the WindowSkins on the building.

In March, SyracuseCoE invited WexEnergy to attend the Advanced Energy Conference

in New York City, providing additional exposure that Wexler says continues to bear fruit. In June, the company was a finalist in the 76West Clean Energy Competition, which led to meeting prospective customers and partners, moving forward on the path to manufacturing and sales.

"I can't say enough about how helpful our association with SyracuseCoE has been, as well as the impact of the Innovation Fund grant on our product development," says Wexler. "As a very early-stage startup, having those independent validation studies got us to entirely different conversations with potential investors and potential customers." ●

Personal Climate Control

If you surveyed employees in any office environment on any given day, it's likely that a significant percentage would report that the temperature made them feel uncomfortable. That's because office heating and cooling systems typically use a single thermostat to control temperature in a zone that contains many people, and thermal comfort varies from person to person.

The possibility for allowing each employee to control the temperature in their own microenvironment is moving closer to reality, thanks to an ongoing project led by Syracuse University researchers, in collaboration with Air Innovations, United Technologies Research Center, Bush Technical LLC, and Cornell University.

In 2015, Syracuse University began a \$4.2 million project to develop a microenvironmental control system, called μ X, to provide localized thermal management for office workers, which would dramatically reduce building energy use. That project, led by H. Ezzat Khalifa, now professor emeritus of mechanical and aerospace engineering, produced several prototype units. Now, Air Innovations is working with SyracuseCoE to redesign the unit for cost-effective commercial manufacture.

"The real core technology that was developed is commercializable, but there are individual components that are not ready for manufacture, so we need to substitute with off-the-shelf technology," says Michael Wetzel, president and CEO of Air Innovations in Syracuse.

Wetzel says it's important to understand how the unit will be used in practice: Will employees run it all day long, or only for parts of the day when they want to adjust the temperature? Will people want it integrated into their desk or are they comfortable with it being an object sitting on the floor? "Right now we're focusing on making sure that the product is acceptable to the market, in terms

of the actual capacity for how it will be used and in terms of form and function," he says.

The hope is to secure funding for a field trial to be conducted in real-world office environments. "We'd like to have about 50 units in place by June 2019 and collect data over six months," says Wetzel. The data collected will inform capacity and aesthetic decisions about the product, which he hopes to see go commercial by mid-2020.

"What's really going to drive this product to market is people's interest in having absolute control over their environment and their productivity," says Wetzel. "There is a huge opportunity to save money and energy so this product can pay for itself over time." ●



μ X team from Syracuse University, Air Innovations, UTRC, Bush Technical, and ARPA-E

compressor design and working to design and develop a cooling unit for mass production." Bush has utilized space and equipment at SyracuseCoE to aid in student project work.

Bush was recruited for the microenvironmental control system project after a 35-year career in machine design and development by lead researcher H. Ezzat Khalifa, Ph.D. "At the end of the project, I had this compressor design and a viable product with potential demand, but I'm a retired guy with no company behind me," he says. "For me, the SyracuseCoE gives me the chance to leverage resources, expertise, and capability without having to have a full-blown staff or facility. I couldn't do this without them."

Innovative technologies in the prototype microenvironmental control system included a high-efficiency micro vapor compression system that used a small scroll compressor, specially developed for the system by Bush Technical LLC.

The performance of the compressor was so good that company founder Bill Bush was approached by potential customers interested in battery-powered applications of the unit. He's working with students and faculty in Syracuse University's College of Engineering and Computer Science to develop a wearable pack that would power a water-cooled vest. "It's the students' senior capstone project," Bush says. "They're taking the existing

The Electric Revolution

In June, SyracuseCoE hosted a NYSERDA-sponsored Electric Car Ride and Drive event, showcasing the latest in electric cars and technologies available to consumers. Front and center was SparkCharge, a homegrown startup that is developing a portable, ultrafast charging unit that allows electric vehicle owners to charge any time, anywhere.

Company founder and CEO Josh Aviv '14, G'17 is on a mission to make electric vehicles the norm. He believes the only thing standing in the way is a lack of infrastructure to support rapid charging, resulting in "range anxiety" for potential users. SparkCharge aims to eliminate that obstacle.

The company took a giant step forward in October, winning the \$1 million top prize in 43North, the annual competition sponsored by New York State for Buffalo-based start-ups. In addition to the cash prize, the company will receive a year of free incubator space and freedom from New York State taxes for 10 years. To meet award requirements, Aviv will move SparkCharge from its office at SyracuseCoE headquarters to Buffalo in early 2019; the \$1 million investment will go toward hiring and manufacturing.

The idea for SparkCharge came to Aviv as an undergraduate economics major, when he was driving around Syracuse in a friend's borrowed Jeep and was astonished by how quickly he used up \$20 in gas. At the time, he was enrolled in an environmental economics class taught by SyracuseCoE Faculty Fellow Peter Wilcoxon and began researching cars that used alternative fuel sources. That's where he learned about range anxiety.

"Automotive technology is ahead of infrastructure," says Aviv. "People are hesitant to purchase vehicles they know are more sustainable for fear of the inability to readily charge them."

Forbes.com described charging an electric vehicle with SparkCharge "as easy as ordering a pizza."

Aviv credits his success to the significant mentoring he received from Syracuse University, including the Blackstone Launchpad and SyracuseCoE. As a communications intern at SyracuseCoE in 2015, Aviv took advantage of the readily available brain trust to develop the engineering specifications for his first prototype, which was built with funding from a SyracuseCoE Innovation Fund award.

Together with many others, SyracuseCoE has continued to provide advice and mentorship on commercialization strategy, as well as assistance with writing grant proposals and pitches for funding. In 2017, SparkCharge won \$192,000 in entrepreneurial competitions, taking first place in the New York State Business Plan Competition, FuzeHub Commercialization Competition, and the Blackstone Launchpad Techstars Demo Day.

Aviv says one of the highlights for him is in bringing jobs to Upstate New York. "We are reducing the brain drain that typically happens when it comes to high-level engineering jobs," he says. "We're doing our part to keep some of that top talent here and help the region grow." ●



SparkCharge founder Josh Aviv (center) with lead systems engineer Richard Whitney (left) and chief technology officer Christopher Ellis (right)

Student Engagement

Learning by Doing

As a living lab, everything about SyracuseCoE headquarters provides a learning experience, a resource perhaps most impactful on the dozens of undergraduate and graduate students who work with us each year.

Through research, internships, mentoring, technical collaboration, and sponsorship of entrepreneurial competitions, SyracuseCoE provides financial support and exceptional learning opportunities for students, who gain invaluable experiential learning while collaborating with leaders in their fields on real-world problems.

These experiences, and the connections students make in the process, provide a springboard to careers making a global impact on the built and natural environment. ➤



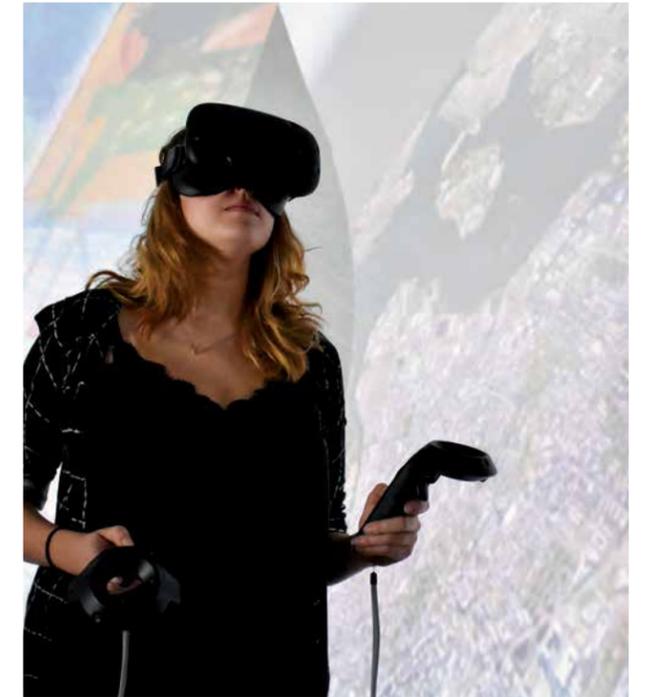
Crystal Burgess

Master's student in Earth sciences
Syracuse University

SyracuseCoE Connection Burgess is a graduate student in the lab of SyracuseCoE Faculty Fellow Christa Kelleher, SU assistant professor of Earth sciences and civil engineering. Previously, she spent a summer as an intern working on a SyracuseCoE-funded project with Laura Lutz, SU professor of Earth sciences, testing methane concentrations in homeowner well water in New York's Southern Tier.

Nuts and Bolts As part of her thesis research examining the potential impact of green spaces on urban heat islands, Burgess is monitoring soil temperature, air temperature, and water infiltration on five vacant lots in the City of Syracuse as well as established green spaces in the Syracuse urban core, including at the SyracuseCoE headquarters.

Real-World Prep Burgess hopes to pursue environmental consulting after completing her degree. **"I want to help businesses and organizations solve issues related to stormwater management and remediation," she says. "This project fits in really well with my goals."**



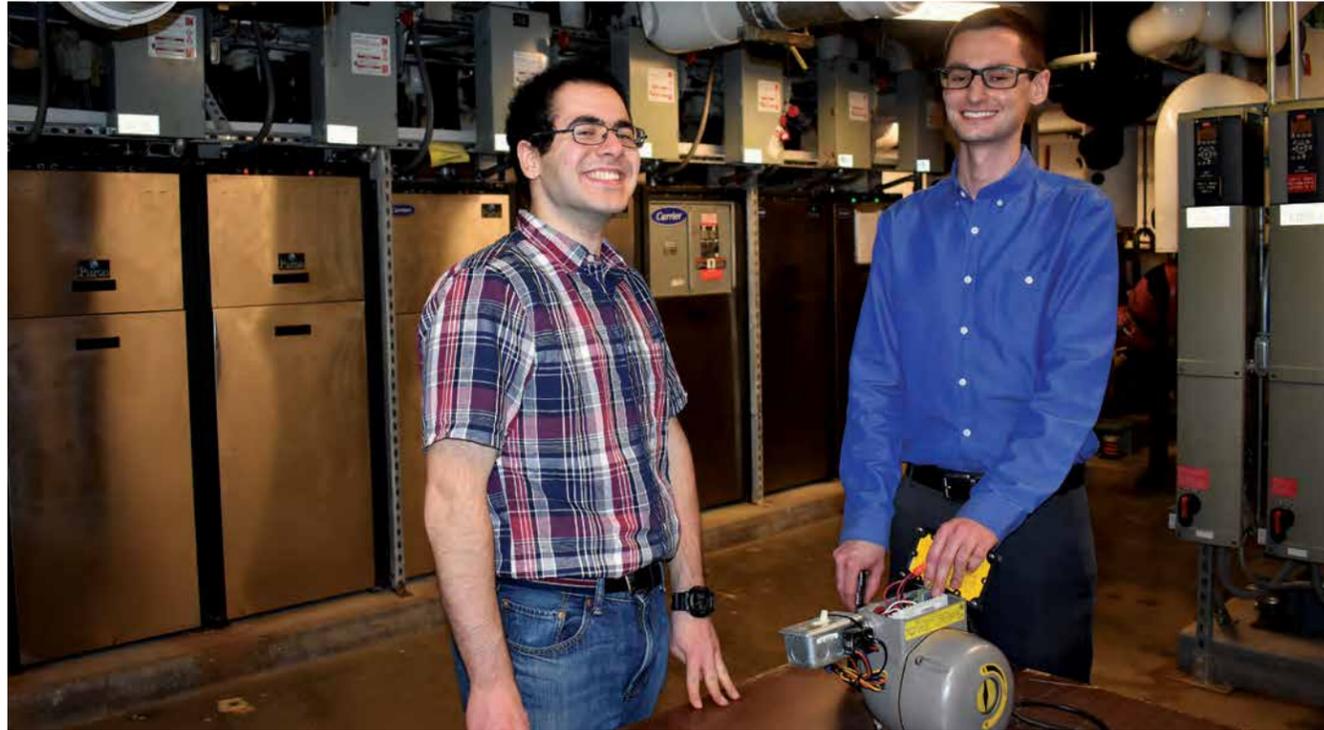
Laura Clark

Master's student in architecture
Syracuse University

SyracuseCoE Connection Clark was a summer research assistant to SyracuseCoE Faculty Fellow Amber Bartosh, SU assistant professor of architecture, helping create three-dimensional data to be visualized in a virtual, urban context from two-dimensional information. "This means taking static datasets and maps, translating them into three dimensions, and importing that into virtual cities we have created," she says.

A Living Lab "Since there are no guidelines for the type of research we are conducting, it has been a lot of trial and error," she says. **"The summer internship has given me a space where I'm able to experiment and test out new things without the fear of failing,** since it happens frequently and I'm able to try something else and move on. Jumping in feet first has allowed me to learn this technology quickly and think about this research in a different way."

Highlight "When something finally works and I can walk around in the virtual world and see what I've created. I also love getting to put someone in virtual reality who has never experienced it before. It's great to see people having that experience for the first time."



Sohrab Gousheh

Master's student in electrical engineering
Syracuse University

SyracuseCoE Connection Gousheh (left) is a building management systems intern. During his first year, he focused on the automated window blinds in the SyracuseCoE building, which tilt based on variables such as sunlight intensity and time of day. Currently, he's involved on a project for a new pressure system design for the building. "The current sensors read the difference in the indoor and outdoor pressure, but it's difficult to collect the data," he says. "My task is to design a new sensor that would measure the pressure and store them in an online database for easier access."

Real-World Prep "Working at SyracuseCoE has improved my work efficiency in a multidisciplinary group and allowed me to learn new ways of communicating with others about my part of the project," he says. **"Learning new techniques and coding languages will help me with future projects as well as to get a job after I graduate."**

Michael Garrett '16, G'18

B.S. in mechanical engineering
M.S. in mechanical engineering
Syracuse University

SyracuseCoE Connection Garrett (right) worked at SyracuseCoE in a succession of four roles over multiple years, beginning as an undergraduate student working in the COMER Lab, run by SyracuseCoE Faculty Fellow Jeongmin Ahn, associate professor of mechanical and aerospace engineering, as part of a Research Experiences for Undergraduates program. Later, he was a research assistant in Prof. Ahn's lab, a part-time building systems intern for SyracuseCoE while he earn his M.S. degree, and finally a full-time building systems engineer at SyracuseCoE. Recently, he accepted a position at Siemens.

Real-World Prep "Working here has given me a lot of practical knowledge, especially in building construction and design, and bolstered my understanding of the fundamental engineering concepts I acquired as an undergrad," he says. **"Making connections between the building's HVAC system and engineering principles, and utilizing that knowledge to improve how the building operates, has been a rewarding experience."**

Takeaway "As an undergrad, I was always curious about the people and infrastructure that keep SU running. I have enjoyed having the rare opportunity to experience SU from both the student and employee perspective."



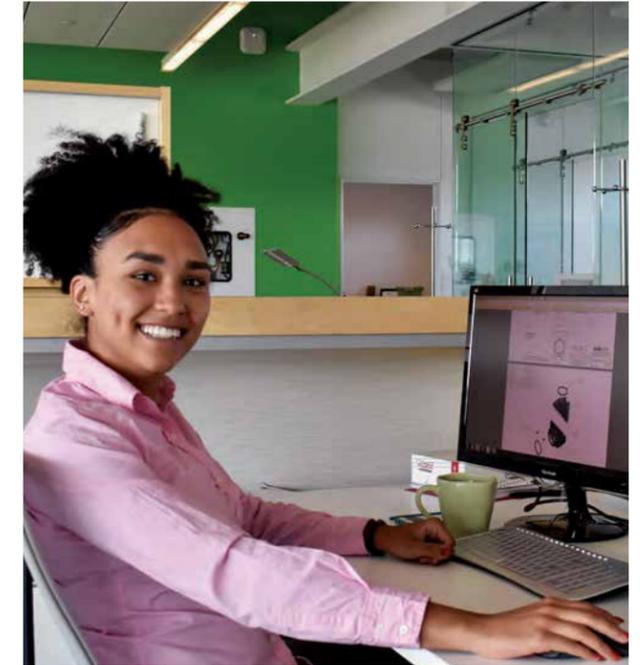
Justin King G'16

Doctoral student in mechanical and aerospace engineering
Syracuse University

SyracuseCoE Connection King is a researcher in the Flow Visualization Lab, led by SyracuseCoE Faculty Fellow Melissa Green, SU assistant professor of mechanical and aerospace engineering. King's research focuses on the fluid mechanics of the wake produced by a bio-inspired pitching panel. **"This research is an integral component of my thesis work. It would be impossible for me to advance my academic studies without my lab at SyracuseCoE,"** he says.

Favorite Fluid Flow Eddies in a river

Practical Experience "The most important thing that I have learned through my research at SyracuseCoE is to start any important project or assignment as early as you can. It is much easier to deal with unexpected difficulties and problems when you are ahead of schedule."



Ashlee Mejia

Undergraduate student in mechanical engineering
Syracuse University

SyracuseCoE Connection As an Innovation Program intern, Mejia helps Central New York companies develop innovations that involve thermal and environmental control.

Real-World Prep One of Mejia's projects focused on development of a device for Acumen Detection that will improve early detection of mastitis in cow's milk, a costly problem for dairy farmers. "I'm helping design and prototype the machine along with an electrical engineer to account for the photo-optics and circuitry."

Bonus Experience The Electric Vehicle Ride and Drive event. "I love how the SyracuseCoE helps promote sustainability in any way possible," she says. "I learned so much about electric vehicles and how affordable they actually can be. It made me consider buying a hybrid vehicle in the future."

Takeaway **"This experience has truly opened my eyes into the realm of green buildings and technology and inspired me to pursue a career in the field of energy design.** I hope to take my LEED GA exam this summer, which will make me a certified professional associate in green technology and design."



Mitchell Jones '18

B.A. in math and advertising
Syracuse University

SyracuseCoE Connection Jones was a communications intern, assisting with email marketing, the website, and social media.

Real-World Prep “My work at SyracuseCoE helped illuminate how I can use my advertising and math degrees in the real world,” he says. “For a long time, I was uncertain what I wanted to do upon graduation, but my internship exposure to the communications world expanded upon concepts I learned in the classroom and gave them context. I loved it.”

Highlight The office camaraderie. “Everyone comes to work with a positive attitude and is willing to go out of their way to help each other. It’s a great atmosphere to be a part of.”

Payoff “The experience I gained has helped me in my role as a summer PR intern for the PGA of America,” says Jones, who was hired full time by PGA America in December 2018.

Hands-on Jones worked on a project related to development of a micro-environmental control system. “I really learned a lot from the human subject study, including how people feel about our product. This study also inspired some new ideas for future work,” he says.



Paria Peyravi

Master’s student in illustration
Syracuse University

SyracuseCoE Connection Peyravi is a communications intern, assisting with graphic design and photography.

Real-World Prep “Working here gives me the opportunity to relate my knowledge of art and design to job market needs, particularly to the communications field. It provides the chance to know how to use illustration practically and strategically, gaining experience in marketing, brand design, and identity.”

Highlight In addition to the design process, Peyravi has been involved in event planning and client communication. “The International Building Physics Conference was the best example of this type of collaboration, helping me understand how to adapt what I’m learning in the classroom to a future career as a graphic designer and illustrator.”



Wayne Wang G'18

M.S. in sustainable energy
SUNY College of Environmental Science and Forestry

SyracuseCoE Connection Wang is a SyracuseCoE Innovations Program intern, where he helps prepare a weekly guide for SyracuseCoE partners on grant and funding opportunities, as well as assists on other projects, such as coordination of the SyracuseCoE-sponsored International Building Physics Conference.

Real-World Prep Wang’s graduate study focuses on sustainable energy. “A big part of being sustainable means finding better ways to consume energy, and efficiency is where this comes into play,” he says. “Working at SyracuseCoE, I am learning how we can reduce a whole lot of energy consumption just by modifying buildings. Being able to put this into practice as part of a job is amazing.”

Payoff “I want to work in some capacity with building efficiencies. SyracuseCoE is definitely giving me ideas and connections to leverage my experience and realize this. **Being exposed to all the research areas here may even help me find some new unexpected markets that I may want to contribute to.**”



Siya (Aviva) Wu G'18

M.S. in public relations
Syracuse University

SyracuseCoE Connection Wu spent summer 2018 as a communications intern, helping promote SyracuseCoE and its events through press releases, news stories, the website, and social media.

Highlight Being exposed to cutting-edge environmental and energy systems. “Learning about new technologies, projects, and events really intrigued me,” she says. “I come from China, where environmental pollution has become more serious over the years. Fortunately, China realized this situation and started to work hard to change it. Nowadays, China is cracking down with many green plans and policies. Working here has made me think a lot about building a clean and healthy world.”

Takeaway “Clean energy, healthy buildings, and resilient communities are major trends in the world. I hope to continue to work in this area as a communicator or PR professional. Whether in China or the United States, making more people aware of these trends is my mission.” ●

Faculty Fellows

(as of September 2018)

Through the Faculty Fellows Program, SyracuseCoE offers support to faculty researchers at Syracuse University, SUNY-ESF, Upstate Medical University, and other universities in SyracuseCoE's core focus areas: clean and renewable energy, indoor environmental quality, and water resources.

SCHOOL OF ARCHITECTURE, SYRACUSE UNIVERSITY



Amber Bartosh
Resilient architecture, integrated facade systems, responsive environment simulation



Bess Krietemeyer
Urban energy visualization and design decision-making tools, building envelope technologies and simulations for human interaction and design, virtual and augmented reality energy simulations



Tarek Rakha
Sustainable urban mobility, daylighting and energy in buildings, unmanned aerial vehicles for building performance inspection



Daekwon Park
Impact of design, material technology, and environmental science on the built environment

COLLEGE OF ARTS AND SCIENCES, SYRACUSE UNIVERSITY



Gregory Hoke
Tectonic geomorphology, interactions among landscapes, climate and tectonics, isotopic records of terrestrial surface conditions



Christa Kelleher
Hydrology, water quality, environmental modelling, landscape analysis



Laura Lautz
Hydrology, water quality, movement through watersheds, exchange of water between surface and subsurface environments



Zunli Lu
Freshwater quality, hydrological tracers, climate change, geochemistry



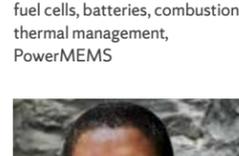
Eric Schiff
Solar cell device physics, charge carrier transport and recombination in disordered materials, deposition processes for thin-film semiconductors



James T. Spencer
Inorganic chemistry, organometallic chemistry, materials chemistry and solid state science, new sensor development, forensic science



Jeongmin Ahn
Advanced energy conversions, fuel cells, batteries, combustion, thermal management, PowerMEMS



Ben Akih-Kumgeh
Combustion physics and chemistry, fuel technology, energy systems



Tomislav Bujanovic
Sustainable microgrid infrastructure with renewable energy sources, microgrid secure communication and cybersecurity



David Chandler
Hydrology, climate change, green infrastructure, sustainable development



Thong Dang
Fluid mechanics, aerodynamics, propulsion, turbomachine, energy and indoor environmental quality



Cliff Davidson
Green infrastructure, storm water management, atmospheric particle deposition



Charles Driscoll
Aquatic chemistry, biogeochemistry, climate change science and engineering, ecosystem restoration



Sara Eftekharijad
Integration of renewable energy into power systems, power system stability and control, power system reliability and security



Melissa Green
Biological fluid mechanics, fluid structure interactions, vortex dynamics, turbulence



Ian Hosein
Materials synthesis and processing, sustainable energy production and storage, environmental remediation and water resource protection



Chris Johnson
Soil chemistry, biogeochemical processes in terrestrial ecosystems, chemistry of natural organic matter



H. Ezzat Khalifa
Personalized environmental control systems, distributed energy-efficient control of indoor environments, cooling and energy supply systems for high-efficiency data centers



Shalabh Maroo
Energy and thermal management, water desalination and filtration, biomechanical systems



Suresh Santanam
Built environment energy and indoor air quality (IAQ) improvement studies, health effects due to indoor air contaminants, indoor-outdoor contributions to IAQ



Fred Schlereth
Instrumentation, FPGA applications, software defied radio



Senem Velipasalar
Computer vision, wireless smart camera networks, multi-camera multi-object tracking, heat mapping drones



Teng Zeng
Fate and transformation of emerging organic contaminants, formation and control of disinfection byproducts



Jianshun Zhang
Material emissions, air purification, indoor air quality, hygrothermal performance of building materials and enclosure systems



Jason Dedrick
Smart grid adoption by electric utilities, economic impacts and job creation in wind energy



Tristan Brown
Sustainable energy law and policy, bioenergy systems analysis, techno-economic analysis, climate policy

MAXWELL SCHOOL OF CITIZENSHIP AND PUBLIC AFFAIRS, SYRACUSE UNIVERSITY



Pete Wilcoxon
Environmental economics, computable general equilibrium



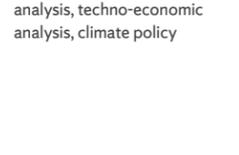
Todd Moss
Entrepreneurship, innovation, and social responsibility; crowdfunding and value creation as pursued by microenterprises



Don Carr
Biomimicry, biophilia



Marie-Odile Fortier
Life cycle assessment, methodology development, modeling energy systems, geographic resource demand analysis



Robert Malmshheimer
Land-use policies, energy policy



Biljana Bujanovic
Lignocellulosics in pulp, paper, and biorefinery industry; lignin isolation, characterization, and valorization



Paul Crovella
Sustainable construction, environmental performance measure for buildings, sustainable energy systems for buildings, historic preservation



Theodore S. Dibble
Kinetics and mechanism in the atmosphere, combustion, and radiolysis; computational chemistry; mercury



Usha Satish
IAQ, human factors, productivity, evaluation of cognition, complexity theory, simulation technology



Arthur Stipanovic
Complex fluids, soft condensed matter, conversion of renewable woody biomass for the production of fuels, chemicals, and biodegradable materials



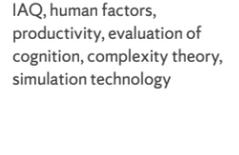
Tim Volk
Management and sustainability of short-rotation forestry, agroforestry, phytoremediation, international forestry



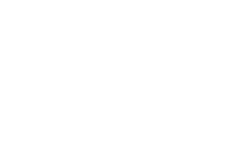
Sara Eftekharijad
Integration of renewable energy into power systems, power system stability and control, power system reliability and security



Melissa Green
Biological fluid mechanics, fluid structure interactions, vortex dynamics, turbulence



Ian Hosein
Materials synthesis and processing, sustainable energy production and storage, environmental remediation and water resource protection



Fred Schlereth
Instrumentation, FPGA applications, software defied radio

The Labs at SyracuseCoE

The SyracuseCoE headquarters building is a research testbed for environmental and energy technologies and building innovations. This LEED Platinum building has both laboratory and office space for research and business collaborations on innovative products and services in SyracuseCoE's core focus areas of clean and renewable energy, indoor environmental quality, and water resources.



Building Envelope System Technology (BEST) Testbed

The BEST Testbed is a 16-foot high and eight-foot wide opening in the south face of SyracuseCoE's headquarters used to evaluate new building envelope systems in a real building. The current installation demonstrates a mechanism that tracks the sun through the course of a day, producing electricity, hot water, and daylight for occupants.



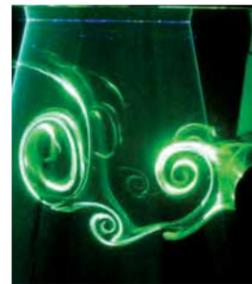
Building Energy and Environmental Systems (BEES) Testbed

Complementing the first-of-a-kind BEES Lab at Syracuse University's College of Engineering and Computer Science, the BEES Testbed at SyracuseCoE provides plug-and-play capabilities for prototypes of new heating, ventilation, and air conditioning (HVAC) systems and domestic hot water heating technologies.



Combustion and Energy Research (COMER)

The COMER Lab's vision is to develop alternative energy technologies that improve current thermal systems while reducing harmful emissions. Solid oxide fuel cell system design, oxy-fuel combustion membranes, and thermal transpiration-based propulsion devices are some of the major focuses in this laboratory.



Flow Visualization Lab

The Flow Lab studies the dynamics in vortex-dominated hydrodynamic flow fields. This work examines the interaction of static structures with a freestream flow for applications in civil engineering and aircraft structures. The lab also investigates complex flow fields such as the oscillation of wings, fins, and flukes for swimming and flying.



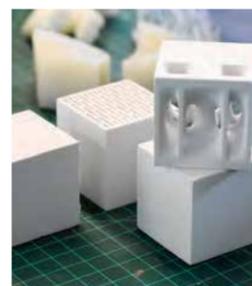
Green Infrastructure Testbed

SyracuseCoE partners conduct research on several green infrastructure typologies, including the Smart Transportation Testbed and the green roof. The aim is to understand the hydrologic performance, ecosystem interactions, and functional limitations, as well as demonstrate storm water quality and quantity management.



Interactive Design and Visualization Lab

The Interactive Design and Visualization Lab is an immersive design environment for simulating a dynamically responsive building envelope system. The lab supports visualization techniques ranging from digital projections to immersive virtual reality technologies to investigate high-performance building materials, systems, and spaces.



Material Archi-Tectonic Research (MATR) Lab

An interdisciplinary research group focusing on the intersection among design, material science, and environmental engineering. Ongoing research includes dynamic insulation, 3D-printed nonconventional building materials, and 3D-structured soil-based materials for building performance augmentation.

“The collaborative opportunities provided by the SyracuseCoE have allowed me to grow in ways I never thought possible. My experience there has instilled a versatile skill set and level of exposure that laid the foundation of my career.”

RYAN FALKENSTEIN-SMITH '13, G'16, G'17

Postdoctoral Research Associate at the National Institute of Standards and Technology



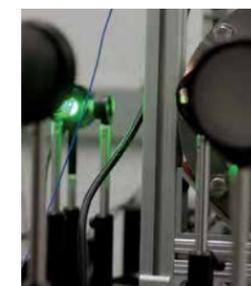
Smart Transportation Testbed

The Smart Transportation Testbed offers researchers opportunities to explore projects involving photovoltaic arrays, electric grid systems, vehicle charging stations, alternative transportation, including human-powered mobility and the sharing economy, as well as green infrastructure systems and storm water containment.



SUNY ESF Biofuels Pilot Plant

The SUNY ESF Biofuels Pilot Plant is a key facility in the production of next-generation bio-based fuels derived from renewable resources such as locally grown woody feedstocks, including plantation-grown willow, switchgrass, and forest-based biomass.



Thermodynamics and Combustion Lab (TCL)

The TCL investigates combustion properties of alternative and conventional fuels with the aim of improving energy conversion efficiencies and reducing emissions of harmful byproducts.



Total Indoor Environmental Quality Office Testbed

Complementing the TIEQ Lab, the existing SyracuseCoE office space also serves as a testbed for new energy-efficient technologies, including HVAC, lighting, and acoustics. An electrochromic window project demonstrates the interactions among daylighting, occupant comfort, and energy used for lighting, heating, and cooling.



Unmanned Aerial Vehicle Lab

A complete testing facility for autonomous guidance, navigation, and control of UAVs in an indoor environment. The lab is equipped with a sophisticated optical tracking system and decentralized wireless ad hoc network (WANET) for real-time telemetry, to develop autonomous navigation and control using onboard sensors and actuators without external navigation aids like GPS or known beacons.



Urban Ecosystem Observatory

A 150-foot tower at SyracuseCoE is extensively instrumented to measure temperature, humidity, air quality, wind speed, wind direction, and traffic on Interstates 81 and 690 (including vehicle speed, type, and number of vehicles). The tower provides detailed information about the impacts of urban activities on air quality and other factors.



Willis H. Carrier Total Indoor Environmental Quality (TIEQ) Lab

SyracuseCoE is known around the world for the capabilities of this lab to study the impact of total indoor environmental quality (TIEQ). Factors such as the air temperature, humidity, air quality, lighting, and sound are tested

to measure their influence on human performance in offices, schools, and other settings.

SyracuseCoE Invites CNY Companies to Join the TEC Innovates Cluster

More than 50 companies have benefited from the first year of a regional initiative to strengthen innovation and entrepreneurship in Central New York's Thermal and Environmental Controls (TEC) industry cluster. The three-year TEC Innovates initiative is led by SyracuseCoE in partnership with CenterState CEO and supported by funding awarded by the U.S. Economic Development Administration. TEC Innovates offers product development assistance and networking opportunities to cluster companies to bring new products to market.

"TEC Innovates provides an outstanding opportunity for companies to work with us to lead the charge toward increased regional innovation and technology development," says Ed Bogucz, executive director of SyracuseCoE and associate professor of mechanical and aerospace engineering at Syracuse University.

HOW TEC INNOVATES CAN HELP

Awards up to \$7,500

Through its Product Innovations Awards program, TEC Innovates offers CNY firms assistance with product development ranging from \$1,000 to \$7,500 for short-term projects that develop and/or test new product proof-of-concepts.

Product Development Support

These funds may be used to support company testing and validation efforts, engage faculty and/or students in projects such as the Analysis & Design Center (ADC), senior capstone projects, or for other product research and development needs.

Commercialization Expertise

SyracuseCoE staff is available to assist companies with projects to achieve their goals and objectives.

Networking

TEC Innovates cluster firms also benefit from an extensive regional network. Networking events with industry leaders promote collaboration across the industry, while monthly factory tours provide insight into the cutting-edge capabilities and potential of ongoing innovations that will shape the business in the future. Previous tours have been held at the Carrier Corporation's Innovation Center, Inficon, Fulton Cos., Unimar, Bitzer Scroll, Air Innovations, G.A. Braun, and many more.

Who is Eligible

Any company in the region's thermal and environmental controls sector within the 12 counties of CenterState New York is eligible to apply for a Product Innovation Award. ●

syracusecoe.syr.edu/tec-innovates

"TEC Innovates provides an outstanding opportunity for companies to work with us to lead the charge toward increased regional innovation and technology development."

ED BOGUCZ



Ed Bogucz (second from left) and Calvin Ahn (third from left) accept USGBC Upstate Leadership Awards on behalf of SyracuseCoE and SyracuseCoE Partner Ashley McGraw Architects.

SyracuseCoE Honored with USGBC Upstate Leadership Award

The New York Upstate Community of the U.S. Green Building Council (USGBC) presented SyracuseCoE with one of the organization's inaugural Leadership Awards, created to recognize outstanding work by individuals, project teams, and organizations at the forefront of the green building movement.

"We are honored to celebrate the leaders in New York who are the driving force behind green building and sustainability in our community," says Tracie Hall, director of USGBC New York Upstate.

The awards were presented by Rick Fedrizzi, past USGBC chairman and CEO, at the Friends of USGBC New York Upstate Gala on November 27 in Albany. SyracuseCoE and Ashley McGraw Architects were jointly presented with the Green Building Legacy Award for SyracuseCoE's LEED Platinum headquarters. The award was established to recognize buildings constructed, renovated, or operated within the past 10 years that were innovative in sustainable practices and push the envelope of sustainability in design and development. SyracuseCoE Executive Director Ed Bogucz accepted the award, together with Calvin Ahn, project manager with Ashley McGraw Architects. ●



COGfx Study Expands to Global Buildings

The team that conducted the groundbreaking COGfx study at SyracuseCoE continues to provide new insights into how the built environment influences human productivity and health.

The COGfx Study, led by researchers from Harvard University in collaboration with Upstate Medical University and Syracuse University, conducted its first phase in fall 2014 at SyracuseCoE headquarters with funding from United Technologies Corp. That study demonstrated that cognitive function test scores doubled when participants were in simulated green building environments with enhanced ventilation compared to conventional building environments.

The second study moved out of the lab and into office buildings. Conducted in 2015-16 in collaboration with researchers from Upstate Medical University, the second phase examined cognitive function of 109 office workers in 10 high-performing office buildings in five cities across the United States. Findings showed that occupants of green-certified, high-performing buildings demonstrated 26 percent higher cognitive function scores, slept better, and reported fewer health symptoms compared to those in similarly high-performing buildings that were not green-certified.

“We know that the indoor environment matters for health and cognitive function. What this study is telling us is that there’s more to it. It’s the building as a whole that has an impact on our health and well-being,” says Joseph Allen, assistant professor of exposure assessment at the Harvard T.H. Chan School of Public Health, director of the Healthy Buildings Program at the Center for Health and the Global Environment at Harvard, and principal investigator for the study.

The third phase of the study, launched in 2018 and currently underway, extends this research to office buildings around the world, creating the first ever longitudinal cohort study of buildings. The study currently has more than 40 buildings in China, India, Thailand, the United Kingdom and the United States, where 10 workers at each building are being monitored for one year via a wearable device and environmental sensor. The participants complete regular surveys and cognitive tests using the For Health App. By following a large, diverse sample of buildings and people over time, the team will investigate both individual-level and building-level effects. Changes in building performance will be tracked and compared to occupants’ health and productivity.

“This is a powerful study design that will allow us to quickly expand our knowledge of how buildings influence health,” says Allen. “Much of what we know about things like exercise and nutrition comes from the great human epidemiological cohort studies, like the famous Nurses’ Health Study. We haven’t had a similar study done for buildings, until now.” ●

“We know that the indoor environment matters for health and cognitive function. What this study is telling us is that there’s more to it. It’s the building as a whole that has an impact on our health and well-being.”

JOSEPH ALLEN



CREDITS: Alex Dunbar, Kerrie Marshall, Toshiko Mori Architect, David Owens, Paria Peyravi, James Scherzi, Steve Sartori and Syracuse University Photo and Imaging, Charles Wainwright

The SyracuseCoE Partner Program

The Partners of SyracuseCoE join a vibrant network of businesses and academic institutions working together to accelerate the commercialization of environmental and energy innovations for a sustainable future.

Learn more at syracusecoe.syr.edu.

Academic Partners

- Syracuse University
- SUNY College of Environmental Science and Forestry
- SUNY Oswego
- SUNY Upstate Medical University

Industry Partners

- Carrier
- Corning
- Engie
- King+King
- National Grid
- OBG
- SBB
- SRC

Affiliate Partners

- Air Innovations
- Aquarii
- Ashley McGraw
- Blue Rock Energy
- C&S Companies
- Cortland Research
- Frontier Energy
- Harris Beach
- J.W. Danforth
- LC Drives
- NGBC
- Taitem
- Upstate Climate Solutions
- Visual Technologies

Startup Partners

- Avatar Sustainable Technologies
- Brash Power
- Bush Technical
- Farm to Flame Energy
- Good People Energy Technologies
- Heliohex
- Hestia Technologies
- High Strain Dynamics
- M3 Innovation
- MolecuSense
- RabiEnergy
- SparkCharge
- Standard Hydrogen Corp.
- Tucc Industries
- WexEnergy

Industry Partners Council

- OBG
- Neil Webb, Chair
- Carrier Corp
- Chad Osburn
- Corning
- Patrick Jackson
- Engie
- Tim Hughes
- Ephesus Lighting
- Lee Davis
- King + King
- Pete King
- National Grid
- Brian Anderson
- SBB
- Vince Bongio
- SRC
- Bob DelZoppo



PARTNER WITH US

syracusecoe.syr.edu



SyracuseCoE
Syracuse University

727 East Washington Street
Syracuse University
Syracuse, NY 13244 USA

315.443.4445

  SyracuseCoE