USC Viterbi
School of Engineering
Sonny Astani Department of Civil and Environmental Engineering

SPRING 2021

NEWSLETTER

Advancing Communities by Engineering Infrastructures That Serve the People

For USC Viterbi School of Engineering junior **Jessica Brown**, the importance of who and what surrounds her has always been integral to her mission. The building science major in the Sonny Astani Department of Civil and Environmental Engineering grew up 15 minutes outside of Washington, D.C., in Clinton, Maryland. Her mother, a community activist and attorney, was always urging Brown and her brother to make their voices heard and to do their part in preserving, protecting and contributing to the prosperity of their local community.

"I want to use my technical knowledge to make communities better and give people access to the services they need."

USC Viterbi junior Jessica Brown

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Big Impacts

A 10-Day Forecast for COVID-19

Amidst one of the worst global pandemics in history, USC researchers worked to develop a model that reliably predicts trends in COVID-19 case numbers with the goal of helping prevent further growth.

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Spotlight On...

New Faculty: Chukwuebuka C. Nweke, Assistant Professor in the Astani Department of CEE

Chukwuebuka Nweke's goal at USC Viterbi is to address the problems that lie at the intersection of civil and environmental engineering, geotechnical engineering, geomorphology and engineering seismology in order to improve the resiliency of civil infrastructure systems in the face of natural hazards.

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Remarkable Research

New Faculty: Audrey Olivier, Assistant Professor in the Astani Department of CEE

Audrey Olivier's research interests lie at the intersection of data analytics, uncertainty quantification and physics-based modeling, and the potential they hold to help build the resilient and smart urban environments of tomorrow.

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Advancing Communities by Engineering Infrastructures That Serve the People

USC Viterbi junior **Jessica Brown** is pictured with her building science studio project in 2019.

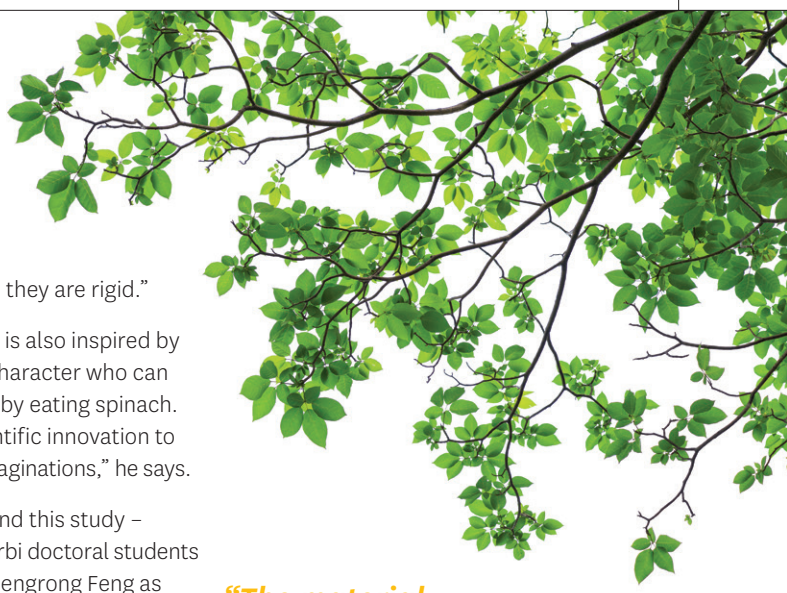
In 10th grade, Brown wrote her first research paper, documenting actions that contributed to the creation of the "American ghetto," neighborhoods characterized by low-income minority residents in places like Washington, Philadelphia, New York and other major cities. "It solidified my desire to combine my interest in engineering with the built environment and use engineering to affect the built environment for the betterment of people."

Brown's emphasis on community has also been important for her own growth and success. Among key support groups Brown mentions as pivotal to her undergraduate experience is USC Viterbi's Center for Engineering Diversity (CED) – specifically the Viterbi Summer Institute, which she attended in the months before her freshman year at USC.

"Having a community of people [such as CED and the National Society of Black Engineers] underrepresented in engineering who were available to mentor me was really important," Brown says. "Being able to advocate for myself and find the people I needed was big for me."

Most recently, Brown was the recipient of a scholarship from WTS-Los Angeles and Environmental Science Associates, which provides support to women studying transportation. In terms of her career, she says, "I want to use my technical knowledge to make communities better and give people access to the services they need. Transportation gives you physical mobility, but it's also a form of social mobility. It gets you to your place of education, to your job and to healthcare services."

Even Machines Need Their Greens



What if the same nutrients that strengthened trees could be used to strengthen engineering materials? Researchers, including **Qiming Wang**, Stephen Schrank Early Career Chair in Civil and Environmental Engineering and assistant professor of civil and environmental engineering in the Sonny Astani Department of Civil and Environmental Engineering, are among the first to infuse 3D printer ink with living material to make it stronger, more flexible and self-healing. This work was published in *The Proceedings of the National Academy of Sciences*.

The idea for this bio-inspired ink came from trees that harness the power of photosynthesis to produce glucose that transforms into cellulose, which strengthens the plant's cell structure. "When trees are young, they are flexible," Wang says. "When they are mature, they are rigid."

Wang says the research is also inspired by Popeye, the animated character who can strengthen his muscles by eating spinach. "Now we are using scientific innovation to realize our childhood imaginations," he says.

The research team behind this study – which includes USC Viterbi doctoral students Kunhao Yu and Zhangzhengrong Feng as lead authors, along with Professor Nicholas X. Fang from Massachusetts Institute of Technology and Professor Chiara Daraio from the California Institute of Technology – used a centrifuge to extract chloroplasts from spinach. They blended the spinach chloroplasts with a newly invented 3D-printable polymer ink, which they then used to 3D-print structures. Applying light makes the material even stronger.

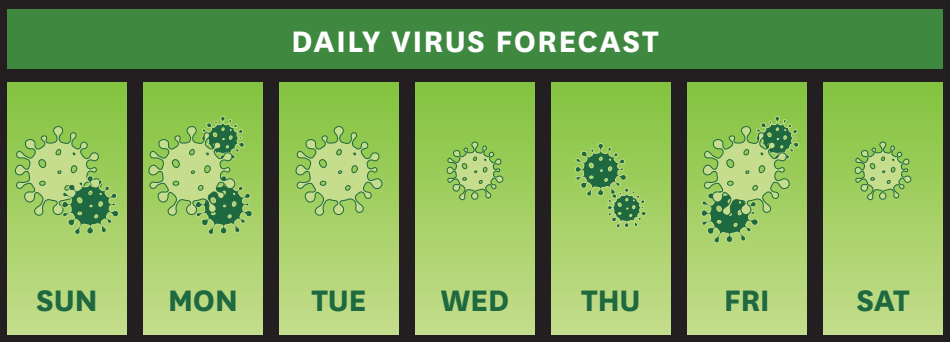
"The material behaves like a snake that hibernates through the winter. Such a temporary 'suspending behavior' has never been demonstrated in existing engineering materials," says Wang.

Big Impacts

A 10-Day Forecast for COVID-19

Data gathered can influence policymakers' actions to prevent the spread of the virus – such as lockdowns, quarantines, mask mandates or stricter physical distancing protocols.

Amidst one of the worst global pandemics in history, USC researchers worked to develop a model that reliably predicts trends in COVID-19 case numbers with the goal of helping reduce future growth.



Researchers in the Sonny Astani Department of Civil and Environmental Engineering – including **Roger Ghanem**, Gordon S. Marshall Professor of Engineering Technology and professor of civil and environmental engineering and aerospace and mechanical engineering, and doctoral student **Xiaoshu Zeng** – studied COVID-19 surge data to develop a model that reliably forecasts the number of new COVID-19 cases daily. Their work was published in *Computational Mechanics*.

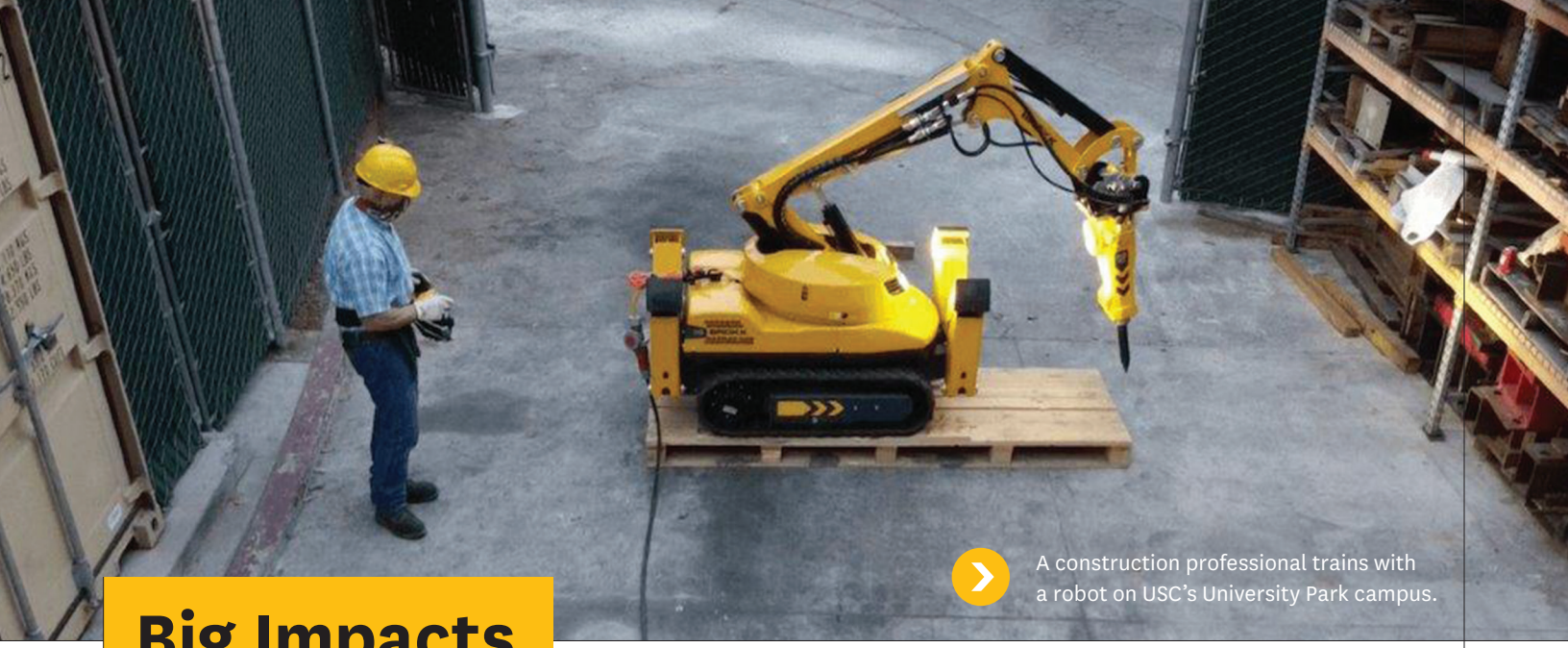
"We cannot predict the future, but using science and statistics is the best you can get at making an informed guess," Ghanem says.

The researchers take data representing daily new COVID-19 cases from the previous seven to 10 days and input them into their computational model, which uses mathematics and algorithms to process the data. The model then predicts the number of COVID-19 cases expected in a given area for the next seven to 10 days.

Ghanem and Zeng used one significant algorithm, the switching Kalman Filter (sKF) – which implements smaller models embedded in the algorithm – to show a linear (steady) or quadratic (rapid) growth rate. The algorithm will have a weighted combination of linear and quadratic behaviors that will reflect which growth rate is dominant during the observation and prediction periods. From this, the researchers can estimate the number of cases on a certain day. The whole process takes just a few minutes.

Data gathered can influence policymakers' actions to prevent the spread of the virus – such as lockdowns, quarantines, mask mandates or stricter physical distancing protocols. It can also help illuminate if those actions are effective, providing key information for state and national government agencies.

Ghanem hopes this model can provide the country with a new tool to help reduce its number of COVID-19 cases.



A construction professional trains with a robot on USC's University Park campus.

Big Impacts

Building Trust Between Construction Workers and Construction Robots

The construction industry is one of the largest in the world economy, and artificial intelligence and automation offer opportunities for industrial advancement. However, these technological opportunities are accompanied by tremendous challenges, including a lack of understanding of how construction teams and robots can successfully work together.

Researchers at the USC Sonny Astani Department of Civil and Environmental Engineering are tackling these challenges with virtual reality trainings that teach construction professionals to team up with robots to do their jobs more safely and efficiently.

The research team includes **Lucio Soibelman**, Fred Champion Estate Chair in Engineering and professor of civil and environmental engineering and spatial sciences; **Burçin Becerik-Gerber**, Dean's Professor of Civil and Environmental Engineering; and doctoral candidates **Pooya Adami** and **Patrick Rodrigues** from the Astani Department of CEE, along with **Gale Lucas**, research assistant professor at the USC Institute for Creative Technologies; **Yasemin Copur-Gencturk**, assistant professor of teacher education at USC Rossier School of Education; and postdoctoral research associate **Peter Wood**.

The VR trainings they have developed aim to provide an efficient, low-cost and scalable way to smooth transitions and ease fear of integrating technology into a traditional industry.

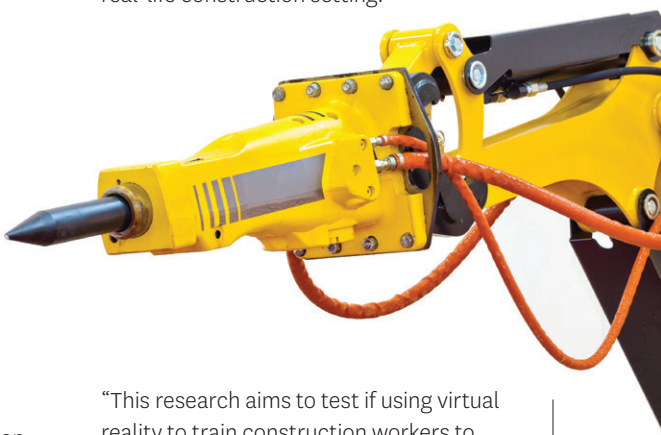
"It's not just about working together well. It's also about learning to work with robots safely," says Becerik-Gerber.

The Importance of Trust

Becerik-Gerber says trust in automation is a key factor in its adoption.

"If you don't trust your smart thermostat, for instance, you're not going to use it," she says. So, if construction personnel do not trust robots deployed to make their jobs easier, they are going to make mistakes or avoid working with them, which might have safety and productivity implications.

When designing the virtual learning environments, the team focused on creating dynamic spaces that allow for multiple forms of interaction, similar to a real construction site. They also integrated elements such as uneven surfaces, dust and shadows that would regularly impact safety and operating procedures in a real-life construction setting.



"This research aims to test if using virtual reality to train construction workers to operate and collaborate with robots can safely replace traditional hands-on training," Soibelman says. "My hypothesis is that virtual trainings can surpass traditional methods by allowing construction workers to try difficult and dangerous maneuvers and learn their consequences in the virtual world without risking the equipment, other workers or themselves."

SPOTLIGHT ON...

A Geotechnical Engineer Improving Civil Infrastructure Systems' Resilience to Natural Hazards

Chukwuebuka C. Nweke is an incoming assistant professor for the Astani Department of CEE.

There has been an exponential growth of the global urban population over the past 60 years despite a linear increase in the overall population, meaning that more people are moving to urban centers of society. With that move come increasing risks from natural and seismic events.

"These urban environments have an increasing vulnerability to disastrous natural hazards, which pose a significant threat to the lifestyle and safety of the global population," says Chukwuebuka C. Nweke, who will join the Sonny Astani Department of Civil and Environmental Engineering as an assistant professor in August 2021. "Unfortunate examples include the 2010–2011 Canterbury Earthquake Sequence, 2011 Tohoku Earthquake, 2015 Nepal Earthquake, 2018 California Wildfires and others."

Born and raised in Lagos, Nigeria, through his early teenage years, Nweke's journey to this point has brought him across the Atlantic Ocean, across the North American continent, and across three University of California institutions.

After earning his bachelor's degree in civil and environmental engineering from UC Davis and his master's degree and Ph.D. in civil (geotechnical) engineering from UC Berkeley, Nweke served as a postdoctoral researcher at UCLA investigating seismic site effects at the local (site) and regional scales and developing innovative tools for the evaluation and assessment of earthquake hazards on civil infrastructure.

Prior to joining USC Viterbi School of Engineering, Nweke worked as a practicing consulting engineer providing solutions for projects involving non-ergodic seismic hazard analysis and geotechnical infrastructure design.

Nweke's goal at USC Viterbi is to address problems that lie at the intersection of civil and environmental engineering, geotechnical engineering, geomorphology and engineering seismology in order to improve the resiliency of civil infrastructure systems in the face of natural hazards.

This includes characterizing sedimentary basin amplifications in earthquake ground motions, expanding and revolutionizing the current hazard analysis framework by incorporating physics-based earthquake simulations, understanding the mechanical behavior (static and dynamic) of bio-cemented soils and exploring analysis frameworks for other natural hazards.

The intent of his work is to improve our ability to characterize hazard demands, enhance the framework used to gauge the demand effects on infrastructure system capacity, and develop tools and methodologies to ensure technically excellent and sustainable performance over the infrastructure lifecycle.

STUDENT SPOTLIGHT

Reducing the Health Risks of Emerging Contaminants

Lily Shi is a doctoral candidate studying contaminants in drinking water.

Lily Shi, a doctoral candidate in the USC Sonny Astani Department of Civil and Environmental Engineering, is using the tools of environmental organic chemistry to conduct research devoted to mitigating human health risks caused by emerging contaminants in drinking water.

"My early Ph.D. research focused on understanding the formation pathway of halonitromethanes, a class of extremely potent carcinogen, which are often detected in reuse water and drinking water," Shi says. "Subsequently, I studied the nitromethane removal mechanism during the wastewater recycling process. My future research will be devoted to uncovering the toxic drivers in wastewater reuse and developing new ways to treat water safely."

Shi is a recipient of the Teh Fu "Dave" Yen Fellowship in Environmental Engineering and a USC TA/RA fellowship. Prior to coming to USC, she earned a master's degree in environmental engineering from the University of California, Berkeley and a bachelor's degree in environmental engineering and science from Tongji University in Shanghai, China.

REMARKABLE RESEARCH

Better Infrastructure Management Through Health Monitoring and Damage Detection

Rapidly evolving trends such as increased urbanization or intensification of climate-related hazards generate considerable loads on our aging infrastructure, motivating the need for reliable health monitoring and damage detection techniques for better infrastructure management.

Audrey Olivier, who will join the USC Sonny Astani Department of Civil and Environmental Engineering as an assistant professor in August 2021, conducted doctoral research focused on the development of probabilistic data analytics tools that can be used to monitor a structure's behavior from sensing data and detect potential damage, allowing for improved maintenance scheduling.

More broadly, Olivier's research interests lie at the intersection of data analytics, uncertainty quantification and physics-based modeling, and the potential they hold to help build the resilient and smart urban environments of tomorrow.

Her postdoctoral experience at Johns Hopkins University and Columbia University has led her to design probabilistic machine learning algorithms for data-driven materials modeling applications, or, in a smart-cities context, optimization of emergency medical services deployment in the greater New York City area.

She is now looking forward to developing her research program at the USC Viterbi School of Engineering and helping to train the next generation of civil engineering researchers and practitioners.

Olivier holds a Diplôme d'Ingénieur from École Centrale de Nantes, France, and a master's degree and Ph.D. in civil engineering and engineering mechanics from Columbia University.

Audrey Olivier's research seeks to help build the resilient and smart urban environments of tomorrow.

Olivier's research interests lie at the intersection of data analytics, uncertainty quantification and physics-based modeling, and the potential they hold to help build the resilient and smart urban environments of tomorrow.

HIGHLY ACCOMPLISHED

Members of the USC student chapter of the American Society of Civil Engineers.

USC ASCE Student Chapter Stays Busy This Spring

Our ASCE chapter is continuing to hold information sessions and events throughout the spring semester. Design teams are preparing for when the ASCE Pacific Southwest Conference resumes as an in-person event and are forming strong relationships within the teams.

The chapter has been partnering with other Astani Department of CEE organizations, such as the Chi Epsilon Honor Society student chapter and the American Academy of Environmental Engineers and Scientists® student chapter to foster a stronger sense of community during this time. Late in the spring semester, ASCE will hold a joint Fundamentals of Engineering examination preparation event with AAEES and raffle off exam prep books for two students.

USC CMAA Student Chapter Maintains Its Momentum

Through a year full of the unexpected, the USC student chapter of the Construction Management Association of America has tried to maintain interaction between its members and industry partners. The chapter has continued to hold information sessions and dinner and learn events. Members also participated virtually in the Associated Schools of Construction (ASC) Regions 6 & 7 2021 Student Competition and Construction Management Conference, bringing home third place in the Mixed-Use category. This was the third straight year USC CMAA placed in that category. Members are excited to get back to normal soon, as they continue to focus on leadership, networking and making a difference in the community.

Members of the USC CMAA student chapter meet virtually.

USC Viterbi
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STAY CONNECTED

Visit our website, **cee.usc.edu**, for in-depth CEE Trojan family highlights.

We're eager to hear about the great things our alumni are doing. Please share your successes with the Trojan community by emailing your updates to **salinapa@usc.edu**.

CHAIR'S MESSAGE

As we made our way into 2021, our department has continued to navigate the trials and tribulations of virtual education during COVID-19 and rise to each challenge. I commend every one of you for your excellence, resilience and the support you've shown your USC community.

After three semesters off campus, I'm excited to announce that our students may now look forward to an in-person commencement this summer, made possible by decreasing COVID-19 hospitalization rates in Los Angeles. We hope to see this trend continue and look forward to a complete return to normalcy in the near future.

This August, we will welcome two new assistant professors: Chukwuebuka C. Nweke and Audrey Olivier. Nweke's work explores the intersection of civil/environmental engineering, geomorphology and engineering seismology, with a focus on improving the resilience of civil infrastructure systems in the face of natural hazards. Olivier's research focuses on the intersection of data analytics, uncertainty quantification, and physics-based modeling to develop tomorrow's smart urban environments. Under their tutelage, the next generation of civil engineers will surely flourish.

I also take great pride in our various research teams designing infrastructures that better the world. They're serving fraught communities, discovering ecological possibilities, improving industrial practices, and even responding to epidemiological concerns like COVID-19. These pioneers lead our department and the world toward a brighter future.

None of these accomplishments would be possible were it not for the outstanding merit of our staff, faculty and students. I wish everyone happiness and great success this semester.

Lucio Soibelman, PhD
Fred Champion Estate Chair Professor in Engineering and Department Chair