Learning by Doing
Hands-On Design Courses
Equip Students for Success
The increasingly complex infrastructure-environment management and development goals of communities and businesses coupled with rapidly changing technology pose new kinds of challenges and opportunities for civil and environmental engineers in the 21st century. Developing higher-performing and more-sustainable buildings, transportation systems, and water systems, and adapting infrastructure and operations to changing climate are just some examples of multi-dimensional endeavors of modern engineering. Undergraduate education in civil and environmental engineering needs to prepare our students to be leaders in developing innovative approaches to provide for economic advancement and community well-being. Over the past several years, we have been evolving our CEE undergraduate curriculum to do just this.

In Fall 2018 we introduced a new sophomore-level project course, led by Professor Sarah Christian, entitled CEE Challenges: Design in a Changing World, so that we now have project courses in all four years of our undergraduate curriculum. This sequence of four hands-on project courses, described in the cover story, is threaded with key design-related themes. The repeated opportunities to solve ill-defined, open-ended problems help students become more comfortable with teamwork, self-guided learning, communication, and the ambiguity that permeates real projects. By building and testing their designs in each of these courses, students learn the importance of effective design communication and strategies for addressing uncertainty, planning, and constructability. The project courses focus on the same design skills and processes, but the level of complexity of the learning objectives increases as students advance through the sequence.

This issue also includes stories about several CEE research projects, spanning both graduate and undergraduate projects related to climate change adaptation, sustainable materials, and next-generation cargo transportation infrastructure. Professors Matteo Pozzi and Mario Berges along with postdoctoral researcher Carl Malings and several other collaborators have developed a tool to model and guide responses to urban heat island conditions. Sophomore Ryan Rusali is studying the strength and performance of bamboo, a sustainable building resource used in many parts of the world. Professors Sean Qian and Costa Samaras have just begun a new project sponsored by the U.S. Department of Energy on analysis of delivery networks possible with the use of emerging technologies such as aerial drones and autonomous vehicles.

Various outstanding student and faculty achievements are highlighted within. Among these is the big news that our CEE colleague and former Dean of Engineering Jim Garrett has been appointed Provost of Carnegie Mellon, and his duties as Chief Academic Officer of the university commenced on January 1.

Renovation of our 6,000-square-foot environmental engineering laboratory was initiated in December and we plan to move into the new spaces in August. Please consider supporting this critical project at giving.cmu.edu/waterlab.

We will be holding our annual CEE Alumni Awards event on Friday, April 12, beginning at 5:00 pm in the Singleton Room, Roberts Hall. All alumni are welcome. Please plan to join us if you will be on campus for Carnival Weekend.

The faculty, students, and staff of CEE thank all of our loyal and generous alumni who support the Department in so many and much appreciated ways. We send our best wishes to all of you.

Hamerschlag University Professor
CEE Department Head
Escape From the Heat Island
New models of the urban heat island effect could inform the next generation of urban planners and help prevent hundreds of heat-related deaths every year.

Determining Strength, Safety, and Sustainability with Bamboo
Sophomore Ryan Rusali studies bamboo, a fast-growing, cost-effective, and non-traditional building material whose properties aren't well understood.

Department of Education Funds Prestigious Fellowship Program
The Department of Education awarded CEE with funding for the highly prestigious and competitive Graduate Assistance in Areas of National Need (GAANN) fellowship program.

The Future—Delivered
Costa Samaras and Sean Qian will head a Department of Energy-funded analysis of next-generation delivery networks.

Leading the Way on Corporate Environmental Sustainability
When IBM’s environmental executive Wayne Balta was growing up, it was the built environment more than the natural one that caught his attention.

Connecting Native Alaskan Villages to Critical Sanitation Infrastructure
When Agnes Marszalik (BS ‘13) decided to focus her job search on areas near mountains, she had no idea that she’d end up in an area reeling from the impacts of climate change.

CEE FAST FACTS

2019 Program Rankings *

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<th>Civil</th>
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* Source: U.S. News and World Report

Enrollment AY 2018-2019

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<th>44% of CEE Students Are Women</th>
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<td>Masters</td>
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Our Faculty & Research

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$6.46M
Annual Externally Funded Sponsored Research in FY18
Whether you’re designing infrastructure for transportation, buildings, water systems, or something entirely different, taking on your first project as a recently graduated civil or environmental engineer can be daunting. For starters, there is the multitude of objectives, the risk and uncertainty, the complex planning and scheduling constraints, and of course the challenge of learning to work and communicate within a team.

To build student skill and confidence in dealing with the complex milieu involved with real projects, the CEE undergraduate curriculum includes a project course in each of a student’s four years at Carnegie Mellon.

Together, these courses create the CEE “design thread” that provides students with opportunities across all four years to gain hands-on engineering experience and to apply what they’re learning in the core courses to actual projects.

“We want students to have exposure to open-ended problems and to get them more comfortable with the ambiguity that permeates real projects,” explains Department Head Dave Dzombak. “The design courses also give students exposure to the breadth of civil and environmental engineering. Each of the projects touches different areas of the field, so that the students see the far-reaching problems that civil engineers work on and their importance to communities and individuals.”

Learning the Design Process

The design thread starts for first-year students with Exploring CEE: Infrastructure and Environment in a Changing World. This course introduces
students to areas such as structural engineering, construction project management, and environmental engineering. Additionally, they begin to learn about challenges related to working in teams, scheduling, evaluating risk, and ethical decision-making. They explore these topics through a variety of problem-solving exercises and group projects—from building a wooden truss that holds Professor Costa Samaras’ weight to using drones to collect information and inform construction decisions.

In their sophomore year, students delve more deeply, through textbook study, discussion, hands-on activities, and self-reflection, into learning the skills of design, teamwork, and graphic, oral, and written communication that they’ll need to succeed when working on bigger projects.

Professor Sarah Christian, who teaches the newly introduced sophomore course CEE Challenges: Design in a Changing World, says one of her main goals is teaching students how to define and approach open-ended and vague problems.

“You can’t always expect people to tell you what you need to do or have a book give you the answer. That’s not how engineers work in the real world,” she says. “You have to come up with and evaluate the ideas and answers on your own. You have to use your own judgment to decide when and how to apply various concepts and tools to solve a problem. Our goal is to give students a structure they can use for working through this self-guided design process.”

Communication and teamwork are also emphasized throughout her curriculum, and the students work with an entirely new group for each project. “Learning how to work effectively with teams is something that everyone struggles with throughout their careers,” says Christian, who shares tools with the students that they can use to make teams run more smoothly and effectively.

The close-knit CEE community is often among students’ favorite aspects of the department, and this opportunity to work closely with others in their cohort in their sophomore year helps students cement bonds to the department and their classmates early in their studies.

Christian says she’s already seen an effect. “I’ve noticed so many
sophomores this year who didn't know each other at the beginning of the Fall semester, who are now hanging around, walking the halls together, and doing their work together.”

**Building on New Skills**

The co-instructor of the junior-level CEE Projects: Designing the Built, Natural, and Information Environments, Professor Susan Finger, agrees that the earlier students can build teamwork skills, the better.

“When you have something big to accomplish, you can't do it by yourself,” says Finger, who teaches the course with adjunct Professor Donald Coffelt. “Everyone brings different backgrounds, interests, and strengths to a project. Those differences allow you to do more together than you could alone. By pooling everything you know, you become more successful as a team than you could be as an individual.”

Many aspects of the skills that students are now learning as sophomores had previously been taught in the junior CEE Projects course. For Finger, this means that the next class of junior students will have a head start and more opportunity to explore the technical aspects of the projects they're assigned. They'll also have many chances to practice and advance their design, communication, and teamwork skills.

The CEE Projects course focuses on teaching students what goes into completing large projects, from reviewing codes, standards, and engineering documents, to meeting with city planning commissions, to project safety management.

“We go through the whole process and show students all of the elements that must fall into place when you’re doing a big project, which comprises the vast majority of civil engineering projects,” she says.

To do this, students tackle three projects: a design-build project, a computing and sensing project, and an environmental project involving data analysis. They also explore engineering failures and what you learn when projects go wrong.

“My goal is that by the time they get to their senior year, they are skilled at working in teams and understand how a project comes together, so that they are ready for the challenge of their senior design course,” says Finger.

**Tying Everything Together**

The senior-level Civil and Environmental Engineering Design course is where everything students have learned about projects and design comes together to be applied to a larger-scale project. For example, in Fall 2018, CEE seniors were tasked to work in groups of 10 to design and build steel bridges with
measurements of around 20 feet long, 5 feet across, and 5 feet tall. Each group’s bridge had to be capable of holding 2,500 pounds of load and be created within a defined set of constraints analogous to real-world scenarios. Students also had to evaluate the environmental lifecycle performance of their designs.

After studying the rules, the students began the process of design, planning, and cutting, welding, and bolting materials together. At the end of the semester, the bridges were inspected and tested by Professor Jim Thompson.

“When you see the size and scale of these things, it’s impressive,” Thompson says. “I had some students this year stand back and look at what they did. All they could say was, ‘Wow, we did that.’”

The entire course is a chance for students to demonstrate mastery of not just their technical skills but their professional skills as well. As in the other design courses, Thompson says the open-ended nature of the project is something students must accept and manage.

“In this course and in any design course, there’s no single answer to the design challenge. Some answers are better than others, but there is a large set of valid answers. We saw three very different bridges from the three groups we had this year.”

It’s an experience Thompson believes is excellent preparation for entry into the field. “The purpose of the design thread is that, when they graduate, all CEE students have a really good understanding of what it means to design a project with consideration for associated constraints and limitations.”

As department head, Dzombak is confident that the four-course design thread is one of the many ways in which the CEE Department at Carnegie Mellon continues to offer a world-class education that equips students to excel in their professional lives.

“The CEE curriculum prepares students to be leaders in an ever-changing business and project environment,” he states. “We are equipping our students to be flexible, adaptable, and creative in addressing modern challenges in civil and environmental engineering.”
Escape From the Heat Island

New models of the urban heat island effect could inform the next generation of urban planners and help prevent hundreds of heat-related deaths every year.

Dangerously high temperatures, especially in cities, often cause conditions such as heat stroke and heat exhaustion or exacerbate preexisting medical conditions such as cardiovascular disease. Between 1999 and 2010, at least 8,081 people died in the United States due to heat-related illnesses.

One of the main factors behind this startling number is the urban heat island effect. This causes high disparities in temperature between cities and surrounding areas due to heat trapped by concentrations of populations and man-made infrastructure. Eighty-one percent of deaths reported—more than 6,500 total—occurred in urban areas.

Armed with a grant from the National Science Foundation’s (NSF) Prediction of and Resilience against Extreme Events (PREEVENTS) program, a team of researchers from Carnegie Mellon set out to provide cities with a tool to better understand this dangerous phenomenon.

The team was led by CEE professors Matteo Pozzi and Mario Berges, and their co-PI, research scientist Kelly Klima of the Department of Engineering and Public Policy and now at RAND.

The fruit of their labor is SHADE, which stands for Surface Heat Assessment for Developed Environments. Through SHADE, the team, including postdoctoral researcher Carl Malings and Elie Bou-Zeid, a professor at Princeton, and former CEE visiting scholar Carl Malings and Elie Bou-Zeid, a professor at Princeton, and former CEE visiting scholar, have developed small-scale spatio-temporal models of Pittsburgh’s urban temperatures.

While researchers at Princeton focused on simulating weather conditions and other factors that contribute to temperatures at a given location, the CMU team took a more data-driven approach. Pozzi and Malings, a PhD student of Pozzi’s at the time, worked to develop statistical models to better model, understand, and realize how temperature changes across time and space within the urban environment.
They found that high temperatures caused by regional heat-wave events can add yet another potent ingredient to the pot of dangerous temperature factors at play in the urban environment.

“One, the temperature is higher in urban areas,” says Malings. “Two, it’s even higher during heat waves. And three, the temperatures can vary a lot throughout the city, because the building composition is very different. This makes the effect very different.”

While the team at Princeton was able to model these factors at a given point, doing so over the entire city would be extremely computationally intensive, making this method impractical for real-time temperature modeling and prediction.

“The idea that we’re working on is to build what we call ‘surrogate models’ that are basically simpler models that capture the same kind of information but can be run much more quickly to get close to real-time forecasts,” says Malings.

Using this system of surrogate models, the team was able to begin observing larger trends in temperatures between different locations across time. Despite being in the early stages of the project, their findings have already led to several publications, including a recent paper on a methodology for optimal sensing to support decision-making in scenarios of extreme temperatures. This could allow for a much better early warning system for populations at high risk for heat-related illness.

In the long-term perspective, the model could inform infrastructure decisions of sensor data that is available in urban environments.”

For Malings, now a postdoctoral researcher in the Department of Mechanical Engineering, the information from SHADE will also help inform future decisions about where to place sensors for optimal results. The inferences he hopes to draw from these sensors are not limited to the urban heat island effect.

“You can do a similar thing with air pollution, where you take your prior prediction of pollution concentrations and then update those with the sensor measurements and optimize decisions based on that,” says Malings.

Having thus far restricted its modeling to Pittsburgh and New York, the team plans to spread its scope to a larger range of cities in the future.

“Cities have similar properties, but just starting in Pittsburgh and New York as our case studies, there are definitely different behaviors between the two,” says Pozzi. “Our idea for the future is to develop urban scale models for different cities, but some specific calibration needs to be done for each individual city.”
Seniors in the capstone design course 12-401 were tasked in Fall 2018 with helping Kennywood design and build a bridge to connect the park with a new Monopoly-themed ride. The teams designed, fabricated, constructed, and erected steel bridges that met specific criteria, such as load requirements, height of attachment points, and construction method, with extra points for sustainability.

You can find out more and see how one team approached their project: bit.ly/12-401-2018.
As sophomore Ryan Rusali studied Assistant Teaching Professor Sarah Christian’s work on non-typical construction materials, one material kept popping up—bamboo. Rusali knew that people across the globe use fast-growing bamboo as a cost-effective building material. But he also realized that its properties aren’t well understood.

Rusali approached Christian with the idea to learn more about bamboo, which he believes could replace wood more than at present as a sustainable building resource. He proposed research to determine the relationship between a bamboo pole’s flexural strength and its overall moisture content. Rusali also applied for—and received—project funding from the on-campus Undergraduate Research Office.

He chose to study bamboo because it’s a strong material that, unlike most wood, doesn’t require months of preparation and treatment before it may be used.

“Many of the communities that use bamboo in construction do not know exactly how strong the material is. By helping to characterize the material, I can move bamboo toward becoming a more mainstream wood alternative and help to create safer structures,” he says.

Rusali’s research involved soaking bamboo samples in water to measure the amount of liquid the material can absorb. He then soaked entire bamboo poles and tested their strength in relation to moisture content.

Rusali is excited that the real-world applications of his research could lead to more sustainable, safe building practices. “I’ve learned a lot about what research actually is and just how much effort it takes to get everything done.”

Rusali recommends that fellow students take the opportunity to build real-world experience while still in school. He adds that his professors were helpful and approachable as he worked through the project.

“I’ve benefited from this experience because it’s given me the opportunity to get to know Dr. Christian better. She’s become another academic advisor for me,” he mentions.

The research also provided Rusali with insight into potential career paths. During the study, Rusali quickly learned what he most enjoys doing.
Across cities and small towns, much of our nation’s infrastructure has fallen into disrepair. Many transportation and water infrastructure systems are outdated and dysfunctional, requiring new approaches and technological advancements to increase safety and efficiency.

This failing infrastructure has become a critical priority for the White House, as detailed in the 2018 plan for Rebuilding Infrastructure in America, and was named by the Department of Education among the top four areas of current national need. It’s also an area in which Carnegie Mellon’s CEE Department has a long track record of using computing and information technologies to solve complex civil engineering problems.

In Fall 2018, the Department of Education recognized this expertise by awarding CEE with funding for the highly prestigious and competitive Graduate Assistance in Areas of National Need (GAANN) fellowship program. The GAANN fellowship will provide a cohort of six students in the Advanced Infrastructure System (AIS) PhD program with full tuition and a yearly stipend while they research innovative ways to modernize US transportation and water infrastructure.

“Our unique graduate program in Advanced Infrastructure Systems aligns very well with the critical national need for infrastructure advancement identified by the White House and incorporated by the Department of Education into the GAANN program,” says CEE Department Head and Professor Dave Dzombak.

For more than 15 years, AIS students and faculty have studied, developed, and refined data-driven solutions and technology for infrastructure design, operation, management, and control. GAANN fellowship students will continue this work as they collaborate with AIS faculty experts to conduct research on improving roads, bridges, tunnels, buildings, pipelines, urban water systems, and traffic and water quality management. They’ll also explore applications in this area for sensing systems, data mining and analytics, and artificial intelligence techniques. For their projects, the fellows may collaborate with local and national government agencies, startup companies, large businesses, and everything in between.

“These students will have the opportunity to contribute directly to meeting an important engineering need of the nation, to be at the forefront of infrastructure technology development, and to be well positioned for impact in the next stage of their career,” says Dzombak, who leads the GAANN Fellowship Steering Committee along with professors Burcu Akinci and Scott Matthews.

Akinci adds, “This grant brings our students and faculty the opportunity to explore what they’re passionate about within the framework of critical infrastructure systems and computing. It will be impactful for the students and hopefully impactful for the entire civil and environmental engineering community.”
Carnegie Mellon Names Garrett Provost

CMU has named CEE professor and former dean Jim Garrett as the university’s provost and chief academic officer after a rigorous, comprehensive and international search. His appointment began on January 1, 2019.

Garrett recently served as dean of the College of Engineering and is the Thomas Lord Professor of Civil and Environmental Engineering. Garrett is a key member of the university leadership team with the primary responsibility of ensuring academic excellence across the university. As the university’s chief academic officer, Garrett oversees academic activities across CMU’s campuses and programs around the world and is instrumental in long-range institutional and academic planning and implementation.

As dean, Garrett leveraged partnerships both regionally and globally to advance research and educational opportunities with a deep commitment to the integration of research and teaching across engineering, science, arts, and business. He broadened the impact of campuses in Rwanda and California, and through his fundraising efforts has transformed the environment for the College of Engineering and increased the college’s connectivity with the rest of the university.

“I am deeply honored to be appointed to serve Carnegie Mellon as its next provost,” Garrett says. “As I begin this new journey, I am committed to working across the entire university and to partner with students, faculty, and staff to better understand the challenges and opportunities that lie ahead. Together, I know we can continue to make an extraordinary difference in the world.”

Wang Joins CEE Faculty

Joining the faculty in Fall 2019 not only gives Gerald “Jerry” Wang the opportunity to inspire students and further his research into the movement of atoms: it also will allow him to be part of a school he says reflects his values.

“I think it is one of the best places to do science and engineering,” Wang says, adding that while many universities speak to fostering a collaborative environment, CMU delivers. “It’s not just part of the culture. It is the culture.”

Wang earned a joint bachelor’s degree from Yale - in Mechanical Engineering, and in Mathematics and Physics. He earned his master’s of science in Mechanical Engineering and his PhD in Mechanical Engineering and Computation at Massachusetts Institute of Technology. He will join the CMU Department of Civil and Environmental Engineering in Fall 2019 after completing a postdoc in Chemical Engineering at MIT.

Wang brings an interdisciplinary background to the study of civil and environmental engineering, utilizing a foundation in physics to achieve a computational understanding of the small-scale movement of atoms. Wang says his goal is to use advanced computerized study of nanoscale transport to solve real-world problems. He describes his work as understanding and developing a travel log of the movement of atoms, much like tracking the movement of millions of people traveling every day.

“Jerry Wang brings a broad range of expertise in mechanics and computing, and great enthusiasm to our educational and research mission,” says CEE Department Head Dave Dzombak. “Jerry is already engaged with our community and we are very much looking forward to having him with us full time.”

His field of research, could be used to determine how to remove heat more quickly from insulation materials, or how to effectively develop opportunities for clean water or clean energy technologies.

“I really want to bring nanoscale computational techniques to civil and environmental engineering,” he says.

Wang says the culture at CMU was a significant part of his decision to join the faculty. The character of the university was made clear when, as part of the interview process, he was asked, “How do you plan to participate in diversity and inclusion?”

Wang, who grew up in a diverse environment, says that question touched him. It signaled to him the commitment that CMU has to a diverse population was more than words on paper: that the expectations for a well-rounded campus community were great, and when combined with the expectations for academic and research excellence, joining CMU would give Wang the opportunity to make a genuine difference in the world.
CEE professors Costa Samaras and Sean Qian will head a Department of Energy-funded analysis of next-generation delivery networks composed of aerial drones, robots, autonomous vehicles, electric vehicles, and “intelligent delivery zones.”
In the future, fleets of drones may carry packages overhead while autonomous robots as small as a dog or as large as a box truck may roll along our sidewalks and streets.

A team of faculty from Carnegie Mellon’s College of Engineering, School of Computer Science, and Heinz College received funding from the U.S. Department of Energy (DOE) to help understand the energy implications of this vision. The DOE provided $2.5 million to fund two CMU projects that will improve energy efficiency and increase mobility intelligence.

The goal in this particular project is to create a comprehensive analysis of how drones, autonomous vehicles, robots, and intelligently managed infrastructure can improve the first and last mile of goods transportation—the most cost- and energy-intensive portions of delivery. The team is led by Associate Professor Costa Samaras and Assistant Professor Sean Qian, and Senior Systems Scientist Sebastian Scherer of the School of Computer Science.

Parallel advances in artificial intelligence (AI), drones and robotics, and vehicle electrification have opened a window into a new future for the transportation of goods. The shipping industry, still dominated by diesel vehicles, could see major energy reductions through intelligent integration of these technologies.

“What we set out to do is measure and understand how these delivery networks might work,” says Samaras. “Our question was, ‘Can we reduce the energy required to deliver these goods in this last mile by 20% or more? We think we can.’”

Many of the technologies in question are already being tested by companies across the country. A company in Washington, D.C., is experimenting with using small, wheeled robots that can travel on sidewalks or streets for food delivery—an option also being explored by companies like Uber and Lyft with autonomous passenger vehicles. And most people are already familiar with Amazon’s testing of a drone delivery fleet.

Organizations like Amazon that hold a major stake in the future of delivery systems will provide valuable input toward the project. Amazon, Pittsburgh Region Clean Cities, and the City of Pittsburgh will interact with the team to ensure that their experimental design closely aligns with the challenges of real-world deployment.

The city, while not involved in the delivery industry itself, is the primary interested party in related aspects of the network: infrastructure, safety, and sustainability. This provides the basis for an important research focus for the team. Their empirical testing and modeling will encompass not only the various vehicles through which deliveries will one day reach us, but also the system they will have to navigate to get there. They’ll look at how changes in timing, weight, routing, and physical infrastructure resources could best work in conjunction with delivery vehicles within what they’ve termed the “intelligent delivery zone.”

“It’s like an airport gate,” says Samaras. “We’re thinking about how we can allocate the limited space in an urban delivery zone to make traffic, energy, and congestion least intensive.”

Ultimately, the team will publish their results and share them with the Department of Energy and the general public. As a leader in the field of autonomy, Carnegie Mellon is now helping analyze and guide the way these emerging technologies will create an improved, more energy-efficient future. With a team of experts gathered from across many schools and disciplines, Samaras is confident the project will help light the way ahead for stakeholders in industry, research, and government.

“There are companies that are testing and fielding these types of systems right now,” says Samaras. “Full deployment isn’t right around the corner, but it’s not too far away.”
Professor Peter Adams was recently named the 2019 Lyman A. Ripperton Environmental Educator Award winner by the Air and Waste Management Association (A&WMA). The award is presented annually to an educator who has inspired students to achieve excellence while teaching with rigor, humor, humility, and pride. “The recipients of this award are representative of the educators we would have chosen if we had a choice. They are known by the accomplishments of their students,” according to the A&WMA award selection committee.

Adams’ reputation in the classroom spans engineering, science, and policy. CEE Department Head Dave Dzombak says that Adams “has demonstrated excellence in teaching first-year undergraduates to senior PhD students, in settings from seminars to large classes. As an example, he worked with two colleagues from the Dietrich College of Humanities and Social Sciences at Carnegie Mellon to develop an innovative seminar class for first-year students on the societal grand challenge of climate change. The course has inspired a number of students to pursue majors and minors in environmental engineering and science.”

Adams has taught in both the College of Engineering and the Dietrich College of Humanities and Social Sciences at CMU. He’s a Fulbright Scholar and has published 80 articles in peer-reviewed science, engineering, and policy analysis journals. Adams was also a contributing author to the Third Assessment Report of the Intergovernmental Panel on Climate Change.

Adams’ research is focused on modeling the physical and chemical processes affecting atmospheric aerosols, and he is globally recognized as an expert in connecting detailed treatments of fine particle physics and chemistry to cloud processes in climate and air-quality models.

Currently, he is working to identify the role of aerosols in air-quality degradation and global climate change and has made major contributions to the areas of particle and precursor gas emissions from sources and their transformations in the atmosphere, and impacts of atmospheric particles on global climate change.

Adams brings his knowledge and curiosity into the classroom—creating a learning environment that blends scientific rigor and high expectations with compassion and humor. Adams’ past students have gone on to become air-quality research and practice leaders in academia, industry, and government.

Adams will be recognized at the A&WMA 12th Annual Conference and Exhibition in Quebec City.
Samaras Named Professor of the Year by ASCE Pittsburgh

Associate Professor Costa Samaras was recently named the 2019 ASCE Pittsburgh Section’s Professor of the Year. Samaras is known for his ability to get students excited about engineering. Students and graduates value him as both a mentor and a friend because of his dedication to preparing them for a career in engineering—and his personal commitment to lifelong learning.

“Professor Samaras is welcoming and supportive with all of his students and colleagues. He is a humble person motivated by a spirit of service and has unique abilities to connect with and inspire students,” says CEE Department Head Dave Dzombak.

Samaras led the development of the CEE master’s concentration on Climate Change Adaptation for Infrastructure, one of the first graduate programs of its kind in the nation.

His instructional focus on climate change earned Samaras a Wimmer Fellowship from the Carnegie Mellon Eberly Center for Teaching Excellence and Educational Innovation.

The fellowship allowed Samaras to develop digital, open-source instructional materials for climate change adaptation classes. The resources, available with a Creative Commons license, allow educators globally to collaborate and develop materials to reinforce classroom instruction.

Samaras’ research focuses on topics relevant to modern civil engineering—including design, construction, and operation of infrastructure that utilizes new technologies, minimizes environmental impacts, and addresses future climate change impacts.

Samaras currently directs the Center for Engineering and Resilience for Climate Adaptation and is an affiliated member in CMU’s Scott Institute of Energy Innovation. He also is an adjunct senior researcher at the RAND Corporation.

Noh Awarded Best Paper Award

Associate Professor Hae Young Noh was recently awarded a Best Paper Award from IEEE Machine Learning Conference.

MedAL: Accurate and Robust Deep Active Learning for Medical Image Analysis discusses her research with CMU ECE colleague Asim Smailagic in which they have developed an active learning technique that uses a limited data set to achieve a high degree of accuracy in diagnosing diseases like diabetic retinopathy or skin cancer.

The researchers’ model begins with a set of unlabeled images. The model decides how many images to label to have a robust and accurate set of training data. It chooses an initial set of random data to label. Once that data is labelled, it plots that data over a distribution, because the images will vary by age, gender, physical property, etc. To make a good decision based on this data, the samples need to cover a large distribution space. The system then decides what new data should be added to the dataset, considering the current distribution of data.

They also tested the model on other diseases to show that it could apply to a variety of different medical images. The method is generalizable, since its focus is on how to use data strategically rather than trying to find a specific pattern or feature for a disease. It could also be applied to other problems that use deep learning but have data constraints.
Innovators are problem-solvers, constantly generating ways to fix big and little issues. But an exceptional innovator might also think about impact: the impact of a new piece of technology on how people communicate, or how a tiny particle affects the environment and could lead to a sustainable future.

This recipe of innovation plus impact makes for scientists and engineers who are truly leaders in their field.

CEE Professor Greg Lowry has been working to advance new environmental nanotechnologies while studying how nanomaterials behave and interact with the environment.

To recognize his efforts in both innovation and impact, Lowry has been elected to the American Association for the Advancement of Science (AAAS) as part of the newest class of fellows.

Fellows are elected by their peers in honor of their scientifically or socially distinguished efforts to advance science or its applications.

“It is an honor to become an AAAS Fellow,” says Lowry. “It is wonderful recognition for the hard work of many students and post-docs who have performed research in my lab over the past 18 years.”

Lowry was elected for his distinguished contributions to safe and sustainable use of nanomaterials, remediation methods for contaminated sediments and brines, and mitigation of fossil-fuel-use impacts.

His current research focus is on water quality and environmental nanotechnology, contaminant fate and remediation, and how nanomaterials behave in complex environmental systems. Lowry leads a collaborative research consortium called NanoFARM that studies the effects of nanoparticles on agriculture and how they could be used as fertilizers and fungicides for crops.

Lowry is one of 416 members awarded this honor, including Carnegie Mellon School of Computer Science Adjunct Professor Dave Farber. The AAAS’s first class of fellows was elected in 1874, when the society began recognizing individuals for their achievements across disciplines, from research, teaching, and technology, to administration in academia, industry, and government.

“I am energized by this award and recognition,” says Lowry, “and I am excited to continue to develop and deploy innovative nanotechnology-enabled solutions to solve society’s grand challenges, including providing clean water and making agriculture more sustainable.”
Collaborating with Port Authority

Associate Professor Hae Young Noh and members of the CEE Smart Infrastructure Monitoring Lab worked with the Port Authority of Allegheny County and tested monitoring equipment on Pittsburgh-area bridges and rail lines as part of an indirect structural health monitoring project.

Their project is developing a system that can provide continuous monitoring of bridges and rail tracks by collecting vibration data from sensors on in-service light rail vehicles.

Hendrickson and Morse Recognized as ASCE Life Members

Professor Emeritus Chris Hendrickson and his former PhD student David Morse were among the Life Member honorees at the ASCE Pittsburgh Section November meeting.

An ASCE Life Member is an individual who has made a lifetime commitment to ASCE and the civil engineering profession by remaining a member for the full length of their professional career. An inspiring summary of the career of each honoree with accompanying photos was provided by Patrick Sullivan, ASCE Region 2 governor.

Garrett Inducted as Distinguished Member of ASCE

At the 2018 ASCE National Meeting in Denver, Provost Jim Garrett was inducted as a Distinguished Member of ASCE in recognition of his pioneering work in bringing advanced computing technologies into civil engineering and for continued academic and professional leadership in engineering and engineering education.

Among his notable contributions is the integration of data analysis with sensor technologies for monitoring of buildings and civil infrastructure. His work has earned him and his colleagues several patents that hold promise for the future enhancement of efficiency, safety, and sustainability in the built environment.

In the photo, Provost Garrett (center) is pictured with two other CEE alumni who are also ASCE Distinguished Members: Sue McNeil (inducted in 2015) and Larry Feeser (inducted in 2000).

CEE Assistant Teaching Professor Jim Thompson doesn't just construct buildings. When he's not working with students, he's busy constructing harmonies with his barbershop quartet, The Sweatermen, a passion he's had for as long as he can remember.

Find out more: bit.ly/behind-researcher-thompson
Rusali Wins SAF Mackin Achievement

CEE sophomore Ryan Rusali was recently awarded the Italo V. (Ody) Mackin Achievement Award, presented by The Student Award Foundation of the American Society of Civil Engineers (ASCE), Pittsburgh Section. Rusali received the commendation during ASCE Pittsburgh’s annual Engineers’ Week awards banquet.

Rusali has shown great leadership during his time at the university. He’s currently a board member of the ASCE student chapter, will serve as chapter communications chair during the next academic year, and is responsible for planning many successful ASCE student chapter events.

“This award will mark a milestone on Rusali’s path to becoming a leader in our profession,” says ASCE chapter advisor Assistant Teaching Professor Jim Thompson.

Alongside Assistant Teaching Professor Sarah Christian, Rusali is researching non-typical construction materials. For his project, Rusali is looking at bamboo, which he believes could replace wood as a sustainable building resource.

Rusali has also served as a summer resident assistant and an orientation counselor for incoming first-year students and is a member of the Kiltie Band and Scotch’N’Soda.

Competing at MIT EnergyHack

Six CEE graduate students traveled to participate in MIT EnergyHack, an annual hackathon that takes place over an entire weekend.

The team of CEE students included Rahim Ali, David DeSmet, Aradhana Gahlaut, Parth Nabar, Akash Pushkar, and Kandasamy Sivasubramanian.

They worked on the challenge presented by CustomerFirst Renewables, a renewable energy advisory company based in Maryland.

The students proposed a solution that would enable MIT to power its campus using only renewable energy while also accounting for hourly load matching. They suggested using an energy mix of viable off-site renewable energy resources along with required grid energy to match MIT’s hourly energy demand in a given year while also justifying energy sustainability, the social cost of carbon, and financial viability.
SPRING 2019

Two CEE Seniors Named Andrew Carnegie Scholars

Gabriel Bamforth is a CEE senior who is also pursuing a minor in creative writing. As a member of the Varsity Swim/Dive Team, earning the designation of NCAA Division III All-American Diver in 2017 and 2018, Bamforth also acts as a mentor for younger teammates.

He was selected to participate in North Carolina State University’s Research Internship Summer Experience (RISE) where he worked on a bio-geotechnical project and presented his results at the NC State Summer Research Symposium.

At CMU, Bamforth works as a resident assistant, providing guidance and programming for his residents. Off-campus, he extends his service activities into the greater Pittsburgh area, as a mentor and vice president (2017) of the East End Youth Project.

CEE senior Lauren Mueller is completing an additional major in Engineering and Public Policy and is a member of the volleyball team. Her abilities in academics and athletics have earned her recognition as University Athletic Association All-Academic Volleyball Team and NCAA All-American Honorable Mention. She has been known to act as a mentor to her younger teammates and to new students in the CEE Department.

Mueller also serves as a member of the university Student Athletic Advisory Council and the CEE Undergraduate Student Advisory Council. She has been a regular member of the executive board of the American Society of Civil Engineers student chapter, most recently as the service and social chair. In this role, she has led community service and awareness activities both on campus and in the community.

Both Bamforth and Mueller exemplify the qualities of an ACS Scholar by excelling at academics, having strong leadership abilities, and demonstrating a heart for community service.

Lau Wins George Washington Prize

CEE senior Noel Lau was awarded the George Washington Prize. The honor is presented yearly to a College of Engineering senior who demonstrates qualities of academic excellence, service, and leadership.

At CEE, she has become an unofficial mentor to younger students—especially those who transferred into the department. Lau uses her personal experience to help other students. “Her determination, compassion, and amiability have led her to success in her courses, student activities, and work experiences,” says CEE Department Head Dave Dzombak. She has also established herself as a skilled maker—working in both the IDeATe Makerspace and TechSpark.

Lau is strongly committed to giving back to the engineering community. As the president of the civil engineering honor society, Chi Epsilon, Lau created a popular series of CEE faculty research seminars for students. The programs allowed students to learn about research in the department while getting to know professors outside of the classroom. She also worked to research and execute an Engineers Without Borders PET Thatch Project in Vietnam.

Her local volunteerism includes serving as a chair for Partners Allied in Civic Engagement. Lau led environmentally themed projects and took the time to manage volunteers and debrief with the entire volunteer team after each project.

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Recent PhD Theses

**Jonathan Callura** - *Ligand-Functionalized Adsorbents for the Extraction and Recovery of Rare Earth Elements*
Advisors: Dzombak and Karamalidis

**Lauren Cook** - *Using Climate Change Projections to Increase the Resilience of Stormwater Infrastructure Designs Under Uncertainty*
Advisors: Samaras and VanBriesen

**Arnab Debnath** - *Numerical Solution of the Non-equilibrium Boltzmann Equation using the Discontinuous Galerkin Finite Element Method*
Advisor: Dayal

**Kelly Good** - *Coal-Fired Power Plant Wastewater Contributions to Bromide Concentrations in Drinking Water Sources*
Advisor: VanBriesen

**Chelsea Kolb** - *Drinking Water Quality and Risk Challenges from Increasing Source Water Bromide: Climate and Energy Changes*
Advisors: VanBriesen, Pozzi, and Samaras

**Eric McGivney** - *Understanding the Relationship Between Nanoparticles and Bacterial Group Behavior: Autolysis and Quorum Sensing*
Advisors: Gregory and VanBriesen

**Greg Schivley** - *Environmental Implications of Energy Transitions*
Advisor: Samaras

**Irem Velibeyoglu** - *Model Identification and Fault Detectability Assessment for Air Handling Units: Statistical Methods and Empirical Validation*
Advisor: Pozzi

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**Rick Grahn**

**Mina Karimi**

CEE Dr. Elio D’Appolonia Graduate Fellowship

Mina Karimi completed her master’s in computational mechanics and her bachelor’s in civil engineering at the University of Tehran, Iran. She is advised in her PhD studies by professors Kaushik Dayal and Matteo Pozzi and is researching integrating computational mechanics modeling of geomaterials and uncertainty analysis to develop a probabilistic model that will predict triggering of ruptures and induced seismic activities.

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**Rick Grahn**

CEE Julia and Michael Ellegood Strategic Doctoral Fellowship

PhD candidate Rick Grahn earned his undergraduate degree in Civil Engineering from the University of New Mexico and joined the department in January 2018.

He is co-advised by professors Sean Qian, Scott Matthews, and Chris Hendrickson. His research centers on the interaction between ride-hailing services (Uber, Lyft) and the existing public transit system. He is looking at strategies to improve the efficiency and equity of modern transportation systems.

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**Sarah Hordern**

**Jiaan Wang**

CEE Mao Yisheng Graduate Fellowship

Jiaan Wang received her BE in Chemical Engineering from East China University of Science & Technology, China, and BS in Environmental Engineering from Luebeck University of Applied Sciences, Germany.

Advised by Professor Mitchell Small, Wang’s research impacts of leaking CO₂ on groundwater quality. Currently, she is working on CO₂ leak detection in overlying aquifers at enhanced oil recovery sites.

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**Sarah Hordern**

CEE Jared and Maureen Cohon Graduate Fellowship

Sarah Hordern received her undergraduate degree in Civil Engineering at the University of Texas at Austin. She is working with professors Greg Lowry and Dave Dzombak to investigate the reuse of saline waters in energy and agriculture.
Matthew Grasinger  
CEE Neil and Jo Bushnell Graduate Fellowship

Matthew Grasinger completed his undergraduate studies at the University of Pittsburgh, with a bachelor’s degree in civil and environmental engineering. Advised by Professor Alexandre Jacquillat, he researches molecular-to-continuum scale modeling of electroelasticity, instabilities, and dissipation of electroactive polymers (EAPs). EAPs are a class of soft material that stretch and/or contract in the presence of an electric field and are a promising material for applications in soft robotics, biomedical devices, and energy harvesting.

Alexandra Newby  
CEE Ruth Furman Miller and David H. Miller Presidential Fellowship

Alexandra Newby received her undergraduate degree in Chemical Engineering and Engineering and Public Policy at the CMU. She is working with Associate Professor Meagan Mauter to develop optimization models to investigate novel water desalination technologies.

Shoham Sen  
Travel Award: American Physical Society

Advised by Professor Kaushik Dayal, Shoham Sen is working on Density Functional Theory (DFT). This is a method for predicting the properties of materials from information such as the atomic number of the constituting elements and (to a lesser extent) the structure of the material.

Jade Peng  
Travel Award: American Society of Mechanical Engineers

Jade Peng, who is advised by Professor Kaushik Dayal, researches extension of the phase field dislocation dynamics method (PFDD) from face-centered cubic metals, such as copper, to body-centered cubic metals, such as Tantalum and Tungsten, which are important high-temperature applications.
In Their Words:
Civil and Environmental Engineering in 2030

What will the civil and environmental engineering world be like in 2030?
What roles will civil and environmental engineers play in that radically transformed world?

Developed nations will have to consider making changes to aging infrastructure as well as be at the forefront in guiding developing nations with the newer and greener technologies that we are developing right now. With the advancement of artificial intelligence, CEE in 2030 will be more automated. Also, new materials and technologies might take over the old ones in construction, wastewater treatment, etc.

I hope that in 2030, civil engineers will act as community contacts that can change cities on the local level. Civil engineers in my world would be in close contact with the communities that they serve and come up with novel design solutions for community-specific problems.

Definitely more data science, law, machine learning, and operations management. We’ll be dealing with problems that require more political spotlight and public acknowledgement, and have higher stakes than ever. And more than anything, we will be pulled in both directions of developing for the fruits of capitalism and the need for sustainability/climate change resilience.

Because of the fast effects of climate change, I hope that there will be a stronger push toward renewable energy and environmental engineering solutions. I believe civil and environmental engineers will have the significant role of preserving the resources we have and developing technology to slow the rate of waste.
Leading the Way on Corporate Environmental Sustainability

When IBM's environmental executive Wayne Balta was growing up, it was the built environment more than the natural one that caught his attention. He'd construct his own tree houses, forts, and shacks in the woods, and it was that constant fascination with building that led him to study civil engineering as an undergraduate at Carnegie Mellon. Here, Balta developed strong problem-solving abilities along with specialized knowledge. “The civil engineering program at Carnegie Mellon taught me how to make decisions about complex matters. That's what I do today,” he says.

After completing his bachelor’s degree in 1982, Balta earned a master’s degree at the Massachusetts Institute of Technology. In 1984, he joined IBM as a real estate and construction project manager and, within five years, became executive assistant to the corporate vice president of global real estate.

In 1989, when IBM's CEO brought up the topic of environmentalism, the real estate VP turned to his assistant Balta for support. Immediately, Balta set out to understand the company's current state and to start defining a strategy that would elevate IBM to an environmental leader. Balta presented to the CEO a portion of that proposed strategy, which was in many ways ahead of its time.

That experience marked Balta's shift in focus to the natural environment. He soon became IBM’s Director of Corporate Environmental Affairs and, in 1997, was instrumental in making IBM the first major multinational company to earn single global registration to the ISO 140001 standard for environmental management.

“Our management system is what guides IBM employees all over the world, over 300,000 of them, to keep environmental leadership in mind as part of whatever their daily job may be,” he explains, citing creating that system as his most important project.

As Vice President of Corporate Environmental Affairs and Product Safety at IBM, Balta now leads the environmental efforts he helped to start nearly 30 years ago. Today, more than 41% of the electricity IBM consumes is from renewable sources, with a goal of reaching 55% by 2025. IBM has reduced its CO₂ emissions by over 42% from 2005 with ongoing reduction goals.

Balta explains, “We’re very interested in leveraging environmental data and analytics using the Internet of things, artificial intelligence, machine learning, and blockchain to attack difficult problems like urban air quality, water quality, plastics recycling, and even protection of endangered species.”

Beyond IBM, Balta has shared his expertise with organizations that include the Environmental Law Institute, the World Environment Center, and The Conference Board. In 2012, the White House named him a Champion of Change for advancing corporate environmental sustainability.

Balta is also a long-time supporter of Carnegie Mellon and received the Carnegie Mellon Distinguished Alumni Service Award in 2009. He is currently IBM’s Partnership Executive for the university and a member of the Dean's Advisory Council for the College of Engineering.

“I am grateful for how well Carnegie Mellon prepared me to succeed. My civil engineering background has been extremely valuable. I rely on it all the time,” says Balta, who enjoys visiting the campus whenever possible. “Carnegie Mellon is one of the world’s most fascinating and compelling institutions. It is truly a feast for the mind.”

In 2018 Wayne Balta received the prestigious Lifetime Achievement Award from the National Association for Environmental Management, recognizing his significant contributions to the environmental health and safety field.

In 2019 Balta was elected to the National Academy of Engineering for advancing corporate environmental sustainability practices.
Connecting Native Alaskan Villages to Critical Sanitation Infrastructure

When Agnes Marszalik (BS ‘13) decided to focus her job search on areas near mountains, she had no idea that she’d end up in an area reeling from the impacts of climate change.

Working as an engineer for the Division of Environmental Health and Engineering at the Alaska Native Tribal Health Consortium, Marszalik sees firsthand that native communities are relocating—or planning to relocate—due to the changing environment.

“The melting of permafrost, which causes the ground to thaw and shift, is resulting in damage and failure of current infrastructure,” she says.

The moving ground is a challenge that engineers must take into consideration when creating designs for the future.

Marszalik’s current work is focused on providing design and construction administration services for sanitation projects in Alaskan native villages.

Marszalik credits her education at CEE with preparing her for a challenging career. She says that coursework in fluid mechanics, fundamentals of water quality engineering, and water chemistry were particularly beneficial—and directly applicable to her work. Her involvement in Engineers without Borders (EWB) while at CEE also provided real-world experience in the design, construction, and monitoring of a water collection and distribution project in the Ecuadorian Andes.

She takes pride in the tangible benefits her work provides to native villages. Marszalik is especially interested in water treatment pilot studies, which are projects that evaluate water quality, test scenarios, and determine the best solutions to bring systems efficiently into compliance.

“These [studies] have been the most rewarding because once we find a solution for the water source, it then becomes the basis of the water treatment plant design.” Marszalik says that bringing critical infrastructure to remote Alaskan areas is a big challenge. Many native villages are accessible only by small aircraft or boat. Some lack basic water and sewer connections to their homes—and have been waiting for decades for improvements.

“These challenges, along with the extreme weather, require creative design and significant planning. We need to provide systems that can be constructed and operated in these areas while maximizing the public health benefits,” says Marszalik.
Bay Area CEE alumni gathered in January to reconnect and meet other area alumni.

Watch out for alumni events in your area. Hope to see you there!

CEE on the Road

Sriram Named ACM Distinguished Member

Congratulations to CEE alumni Ram Sriram (MS'82, PhD'86) for being named a 2018 Association for Computing Machinery Distinguished Member.

Sriram was recognized for his outstanding scientific contributions to computing, and was one of 49 individuals awarded this title.

Sun Awarded 2018 Young Civil Engineer of the Year

Congratulations to Sylvia Yunlin Sun (MS ’14), who was awarded the 2018 Young Civil Engineer of the Year award from the American Society of Civil Engineers (ASCE), Pittsburgh Section.

Sun has been an estimator/project engineer at Fay, an i+iconUSA Company, since 2015. As a registered professional engineer, she focuses on heavy highway and heavy civil cost estimation. She is also a leader of the ASCE Pittsburgh Section Younger Members Forum.

We Want To Hear From You!

Share your good news. Please email us at mmoblely@andrew.cmu.edu

The Carnegie Mellon University Alumni Association hosted “An Evening with President Farnam Jahanian” in Seattle, and Jingkun Gao (MS ’14 PhD ’17) met up with Provost Jim Garrett!
Bob Pease (CE ‘49) knows how to make a mark. With a 60-year career in urban redevelopment, he has shaped cities around the world, including participation in redesigning Pittsburgh after World War II. At Carnegie Mellon University, Bob has created a lasting legacy through a gift in his estate plan that will create new opportunities for students and faculty in the Department of Civil and Environmental Engineering. Bob’s gift will also fund undergraduate student scholarship support throughout the university.

Learn how easy it is to achieve your philanthropic vision through a planned gift by visiting giftplanning.cmu.edu.

Contact the Office of Gift Planning today at 412.268.5346 or askjoebull@andrew.cmu.edu.