Carnegie Mellon University

CEE NEWS

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SUMMER 2013

IMPROVING INFORMATION EXCHANGES

HOW CEE RESEARCHERS ARE USING ENERGY INFORMATICS TO MAKE CONSTRUCTION MORE EFFICIENT

CEE DEPARTMENT HEAD - DAVE DZOMBAK

Dear Alumni and Friends,

It is an honor to greet you as the new head of the Department of Civil and Environmental Engineering. I thank **Irving Oppenheim** for his devoted service as acting head from January through July following the appointment of former CEE Head **Jim Garrett** as Dean of the College of Engineering on January 1.

Thanks to the leadership of Jim Garrett from 2006-2012, and the high level of talent and commitment of our faculty, students, and staff, the Department is in fine shape as we begin the new academic year. The Department is strong in all aspects of our mission, including education, research, and service. Both our undergraduate and graduate programs are in the top 10 civil and environmental engineering programs as ranked by U.S. News and World Report. As I have shared with the faculty and staff, however, we cannot be complacent! We must challenge ourselves to advance to the next level in our mission areas, and to work creatively and hard to get there.

At the start of the 2013-2014 academic year, CEE has 122 undergraduate students (52% female) in the sophomore through senior classes, 231 full-time equivalent graduate students (41% female), 24 faculty members, and 12 staff members. We welcomed in August a diverse, very well-prepared cadre of new MS and PhD students spanning our three focus areas of graduate education and research: advanced infrastructure systems; environmental engineering, science, and sustainability; and mechanics, materials and computing.

There is great excitement on campus about the arrival of President **Subra Suresh**, former director of the National Science Foundation' over the summer and the experience he brings in science, engineering, interdisciplinary education and research, and international partnerships. President Suresh has been working very actively since his arrival on meeting with the campus community, alumni, and friends of the university. He already has some important initiatives underway that you will be hearing about in the coming months.

This issue is rich with information about developments in the Department, with some special attention to our research in energy efficient buildings and in carbon capture, utilization, and storage. We have a substantial and diverse portfolio of projects with the U.S. Department of Energy, and in particular with the National Energy Technology Laboratory, which is based in Pittsburgh and Morgantown, West Virginia.

CEE faculty members continue to be very active nationally and internationally and to receive recognition for their work. Assistant Professor **Kaushik Dayal** was awarded ASCE's Engineering Mechanics Institute Leonardo Da Vinci Award for his groundbreaking research on the interactions between materials and elecromagneticism in relation to new technologies for energy storage and generation. **Jacobo Bielak**, the Paul Christiano University Professor, was elected as a Fellow of the US Association for Computational Mechanics this year. The current issue describes various other activities and achievements of the faculty, and of our students and alumni. We are very proud of the commitment and contributions to society and the profession of CEE faculty, students and alumni

For all alums, please see the note on page three requesting that you send us pictures of yourself at interesting project sites. We hear regularly from many of you about the interesting and important projects in which you all are involved all around the world. We are interested in obtaining images of you at these projects to inform and inspire our current students.

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.

Dave Dzombak
Walter J. Blenko, Sr. University Professor and Department Head

Carnegie Mellon University
Civil and Environmental Engineering

CEE NEWS

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For more news and information about CEE please visit us at: www.ce.cmu.edu

SOMETHING TO SHARE?
We want to hear from you!

Please email news to ceenews@andrew.cmu.edu

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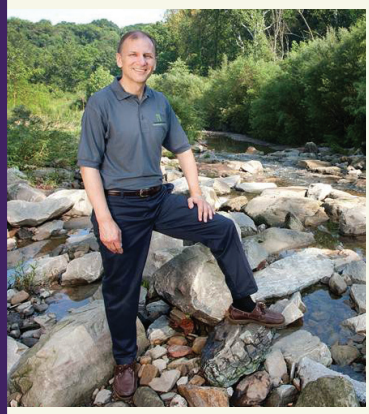
Carnegie Mellon University publishes an annual campus security and fire safety report describing the university's security, alcohol and drug, sexual assault, and fire safety policies and containing statistics about the number and type of crimes committed on the campus and the number and cause of fires in campus residence facilities during the preceding three years. You can obtain a copy by contacting the Carnegie Mellon Police Department at 412-268-2323. The annual security and fire safety report is also available online at http://www.cmu.edu/police/annualreports/.

Dave Dzombak Named Head of CEE



CIT Dean Jim Garrett announced on May 1 that as of August 1, 2013, Professor **Dave Dzombak** would serve as the 16th Department Head of Civil and Environmental Engineering.

Professor Dzombak, who has been with the department for 25 years, joined Carnegie Mellon University as an assistant professor in 1989 and is the Walter J. Blenko, Sr. University Professor. Between 2006 and 2010, Dzombak served as CIT Associate Dean for Graduate and Faculty Affairs, and from 2007 to 2013 also served as Faculty Director of the Steinbrenner Institute for Environmental Education and Research. In addition, he was elected as Faculty Senate Chair for the 2006-2007 academic year, and as CIT Faculty Chair in the 2002-2003 academic year. In 2010, Dzombak was elected as a University Professor, the highest academic rank at Carnegie Mellon.

Between November 2012 and July 2013, Dzombak served as Interim Vice Provost of Sponsored Programs at Carnegie Mellon. His experience with sponsored programs and research compliance will be invaluable in forging new collaborative relationships between CIT and these important administrative units.

Dzombak is an internationally recognized expert in environmental engineering, with particular expertise in water quality engineering and science and environmental restoration. He has published more than 100 articles in leading environmental engineering and science journals, book chapters, newspaper and magazine articles, op-ed pieces, and three books. He also has a wide range of consulting experience. He is a registered professional engineer in Pennsylvania, and a board certified environmental engineer by the American Academy of Environmental Engineers and Scientists.

Dzombak has an extensive record of professional service; he currently serves as a member of the EPA Science Advisory Board, whose various committees he has served since 2002. He also currently serves as Chair of the Board of Directors of the Association of Environmental Engineering and Science Professors Foundation and has been a member or chair of various National Research Council committees since 2000. Dzombak has served on editorial boards for three journals and has been a member or chair of numerous other professional society, state, and local committees. He has served in various advisory roles for Saint Vincent College since 1990, and was elected to the Board of Directors in 2012.

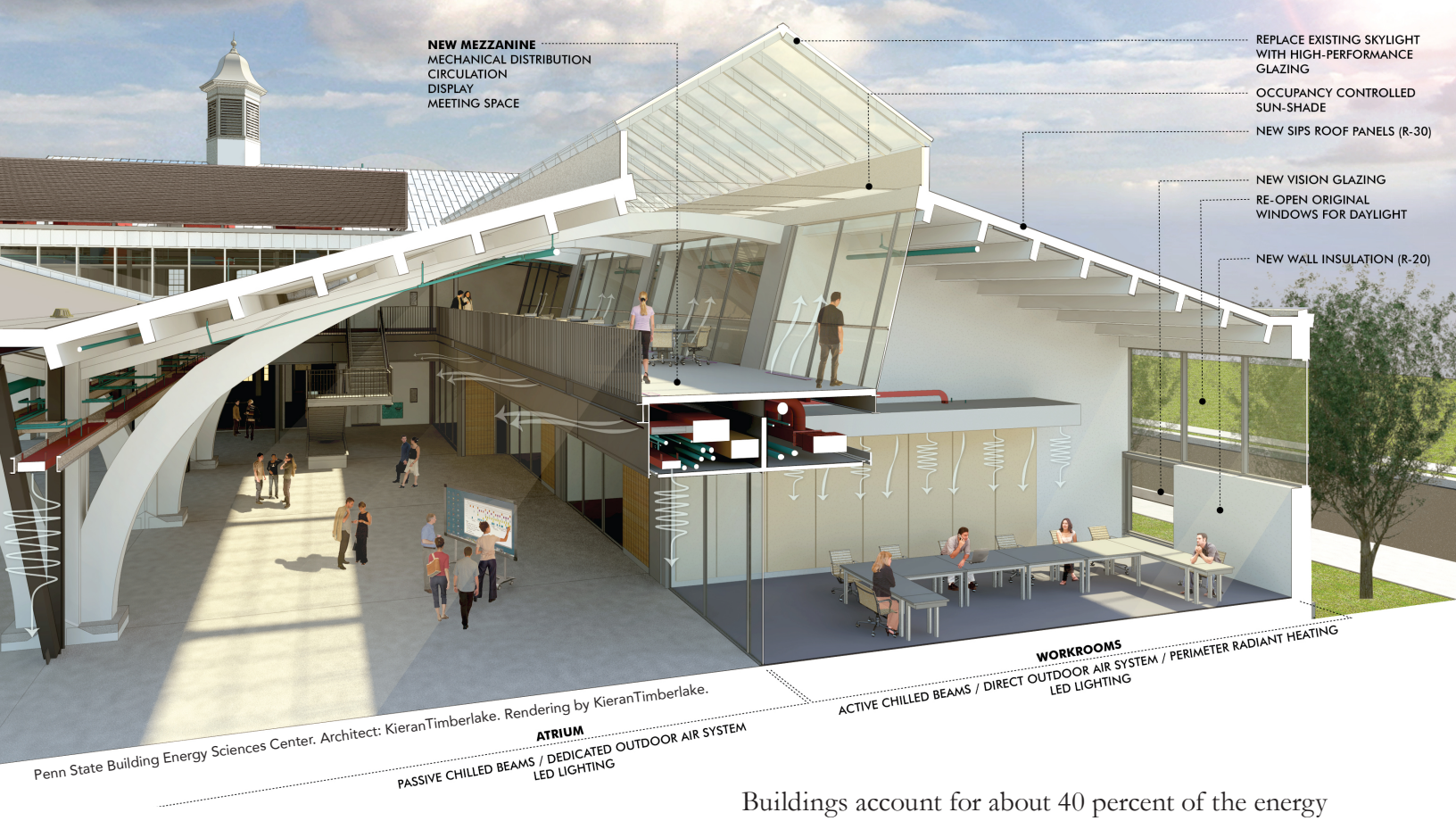
In 2008, Dzombak was elected to the National Academy of Engineering. He is a Fellow of the Water Environment Federation, the American Society of Civil Engineers, and the Association of Environmental Engineering and Science Professors. He is the recipient of numerous other recognitions and awards.

Dzombak holds a BA in Mathematics from Saint Vincent College (1980); a BS (1980) and MS (1981) in Civil Engineering from Carnegie Mellon University; and a PhD in Civil Engineering from the Massachusetts Institute of Technology (1986).

Working on an interesting project? CEE wants to hear from you!

The department is collecting photos of civil and environmental engineering projects in which our alumni are involved - especially photos of you in the field - that can be featured in our newsletter or website.

To submit a picture, please email the photo file and a short written description (2-3 sentences) of the project depicted to **Mireille Mobley** at mmobley@andrew.cmu.edu. Please only send photographs to which you own the rights and that CEE has permission to publish.



Penn State Building Energy Sciences Center. Architect: KieranTimberlake. Rendering by KieranTimberlake.

Improving Information Exchanges

How CEE researchers are using energy informatics to make construction more efficient

Imagine being able to walk through a renovated building and not only admire the newly-redesigned workspace, but also evaluate the cost and energy efficiency of every building material used inside – all before the renovations even begin. It sounds impossible, but CEE has helped to make it possible as part of the department's work with the Energy Efficient Buildings (EEB) Hub. Faculty and graduate students from Carnegie Mellon's School of Architecture are also participating in the EEB Hub.

The EEB Hub, a Department of Energy Innovation Hub, is a consortium of engineers and scientists from many disciplines working toward one common goal: ensuring greater energy efficiency in buildings.

Buildings account for about 40 percent of the energy consumed in the United States; using a "living lab" approach, the EEB Hub is retrofitting several buildings in the Navy Yard in Philadelphia and working with building retrofits elsewhere in the U.S. to find the best practices for energy efficiency.

For the past year and a half, CEE researchers have been working with EEB Hub research teams to develop more efficient practices in energy informatics, which Professor Burcu Akinci calls "the backbone" of energy efficient construction. "Energy informatics streamline the data needed to run simulations and to understand how a building is supposed to behave or is currently behaving," she explained. Akinci has been working with Assistant Professor Mario Berges and Assistant Research Professor Semiha Ergan to develop new ways

EEB Hub's Building 661, which will serve as the Hub's headquarters after the retrofit is completed, was originally a recreation hall for officers in the Philadelphia Navy Yard.


Photo: Peter Woodall

to make sure that the information necessary for efficient construction practices is being properly collected, transferred, and visualized.

Information Exchanges

Berges and Akinci have been working with CEE graduate students and professors from Penn State to understand and identify the information exchange requirements for construction projects involved in a building retrofit. "For example, let's say I'm a designer of software for energy auditing, and I would like to expose some of the information in my energy model to somebody who's going to be conducting commissioning of the HVAC system during construction," Berges explained. "The information items that I need to expose in my software, so that this other person can actually start his job – those are things we're trying to identify."

Last year, Berges and Akinci worked with then-PhD student Pine Liu to determine what information was necessary to detect and diagnose problems in an HVAC system. There are currently hundreds of performance analysis algorithms to detect faults in HVAC systems, but most of these algorithms require so much complex information about the building that they are hardly ever used in real-world facilities. Liu studied multiple algorithms and documented the information exchange requirements for each algorithm, then categorized those information requirements.

Through his work, Liu discovered that the vast majority of the information necessary for these algorithms could be found through existing software. "It's a surprising fact that we have the information and we have the algorithms, but we don't have a way of making them talk to each other," Berges said. So, Liu created a system to perform that necessary integration: He developed mechanisms to automatically extract information items from disparate sources and provide them to performance analysis algorithms, which eliminates much of the manual input necessary for the HVAC diagnosis algorithms and makes those algorithms far more usable in real-world situations.

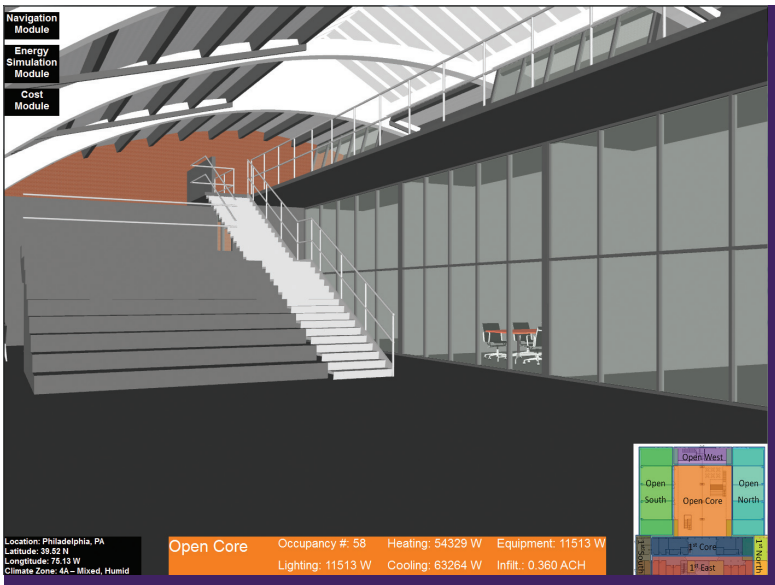
This year, Berges and Akinci are working on information exchanges among parties in order to streamline the quality control process of what Akinci calls the building envelope, which includes walls, roofs, and mechanical elements. "There's a lot that we squeeze into these walls," she said. "It's like a smaller-scale system of systems coming together, and as the designs get complicated, it's very difficult to figure out who's going to install first and how all the pieces will come together." The building envelope and the mechanical systems greatly impact the energy efficiency of a facility, Akinci explained; without a good quality control process that can capture necessary information during construction, that facility could suffer from undetected energy wastes.

Because of the complicated nature of the system, there is plenty of information that needs to be exchanged between the design, testing, and construction stages, but "most of the processes we've focused on have not been documented in detail yet," Berges said.

Energy Visualizations

One way to ensure that the collected information is utilized to its full potential is to create visual tools that help retrofit participants better understand the data. Akinci and Ergan have been accomplishing that through several visualization projects in the EEB Hub.

Last year, they focused on using immersive visualization approaches to improve collaboration between architects and engineers during the retrofit design process. Ergan explained that architects and engineers work separately



CEE's immersive visualization technology allows stakeholders to "walk" through the building designs. For a demonstration of the visualization, scan the QR code or visit: **tinyurl.com/eeb-cave**

to create designs based on the requirements from their discipline's perspective, and meet up approximately once a month to share their findings and to find the best design option that meets all their requirements. "It's not an easy job — in a limited time, they need to share a lot of documentation, including energy simulation results and design information," Ergan said. "It's not efficient to go through the all documents to understand the information and its implications on energy use and life cycle cost." Through this study, they wanted to identify what information was collectively important for all stakeholders involved and what should be displayed in an immersive visual world, so that they could effectively evaluate design choices for energy efficient retrofits.

To make the information sharing process more efficient, Ergan and Akinci worked with several students to use the data from both engineers and architects to create immersive visualizations of the retrofit design process. CEE researchers have been using the three-dimensional immersive visualization technology in the IBM Smarter Infrastructure Laboratory, which is part of the Pennsylvania Smart Infrastructure Incubator. Using that immersive visualization technology, known as the CAVE, CEE researchers made it possible for people to "walk" through the building designs, evaluate the different building materials used, and compare the life cycle costs and energy use associated with different design decisions. The visualization allows different stakeholders to evaluate the design options without working through large amounts of documents. As Sheryl Yang, a PhD student who worked on the project, explained, "We're trying to reach out to a broader audience of stakeholders who might not have an engineering background."

This year's EEB Hub project is furthering that goal of reaching out, but to a different audience. Akinci and Ergan are creating a building energy dashboard for multiple users at the EEB Hub's main building in the Navy Yard. The dashboard — which will be accessible to everyone from facility managers to EEB Hub researchers to curious visitors— will grab information from sensor data across the building and give viewers real-time information on the building's energy usage.

Currently, the research team is wrapping up the requirements identification part of the research, which involves determining what information to include in the dashboard and how to display it to the users. CEE MS student Wei Shao spent the summer interning at the EEB Hub location and compiling questionnaires to find out what information different users would be most interested in seeing. Ergan said that the final product will use the visualizations from the building information model developed last year to present the data in 3D and show how each wing of the building is consuming energy.

By presenting the data in a visual format, Ergan believes that the project will contribute to EEB Hub's goal of reducing energy usage in commercial buildings by 20 percent by 2020. "We'll be helping people be much more aware of their energy usage when they are using the buildings," Ergan said. "They will have much more information on how the buildings work and how they can reduce their energy use."

Documenting Information Exchanges: Wei Shao

After working with master's student **Wei Shao** in the spring 2013 semester, Akinci helped him connect with Ergan and the work that both professors were conducting with the EEB Hub. To help further their research, Shao spent the summer working as an intern at the EEB Hub's location at the Navy Yard in Philadelphia, interviewing Hub participants and documenting the information exchanges that occur during the construction phase.

For his work with Ergan, Shao distributed a questionnaire to various Hub participants to determine how they would use a dashboard with energy usage information. Now that he has collated information about what users want, Shao, who is advised by Professor Irving Oppenheim, is determining how to get them that data through the building's resources.

"They've installed a lot of sensors in the building, so I'm going to access the database of information so I can work on connecting it to the dashboard," he explained.

He has also sat in on meetings with Balfour Beatty, the company completing the construction for EEB Hub, to document information exchanges and create a process model for quality control activities. By creating the process model, Shao hopes to make the communication during construction more efficient. "If you know the information exchange for the quality control, then you can add that information into the building model and help people to better communicate during construction," Shao said.

2013

STUDENT AWARDS

ASCE OUTSTANDING
CIVIL ENGINEERING
STUDENT AWARD
Ranny Zhao

H. A. THOMAS, SR.
DISTINGUISHED
SERVICE AWARD
Sophie Grodsinsky

H. A. THOMAS, SR.
SCHOLARSHIP AWARD
Denise Yam

JAMES P. ROMUALDI
CIVIL AND ENVIRONMENTAL
ENGINEERING AWARD
Alexander McHugh

OUTSTANDING TEACHING
ASSISTANT AWARD
TA Team from
12-755 Finite Elements:
Yigit Isbiliroglu, Prashant Jha,
Haydar Karaoglu, and **Doriam**
Restrepo Sanchez

PAUL P. CHRISTIANO
DISTINGUISHED
SERVICE AWARD
Brandi Eng-Rohrbach and
Amy Nagengast

MAO YISHENG
OUTSTANDING
DISSERTATION AWARD
Xuesong (Pine) Liu

CEE Seniors Leave Their Mark on Campus

When construction of the Sherman and Joyce Bowie Scott Hall began this past school year, Carnegie Mellon's Facility Management Services (FMS) needed to find a new space to store the electric vehicles it uses to maintain the campus. So FMS head and CEE Adjunct Professor **Don Coffelt** worked with Teaching Professor **Lawrence "Larry" Cartwright** to come up with a solution: They turned to CEE's "Design and Construction," a unique course for undergraduate seniors that Cartwright has led for over 20 years, to help solve the problem.

Cartwright and Duquesne Light University Professor **Chris Hendrickson** first brainstormed the course in 1988, with the goal of providing undergraduate students with the holistic experience of designing and constructing a project from start to finish. This semester was the last time that Cartwright will offer the course: He is retiring at the end of June, although he will continue to teach part-time.

For this semester's project, the students broke into five teams to design the structure for the parking lot, which required electrical outlets for FMS' vehicles and a roof to protect them from rain and snow. The groups then presented each of their designs to FMS, who selected elements from multiple proposals to create the final design.

Once the final design was selected, students had to work out all the details, down to "where every little screw goes," Cartwright said. For instance, **Sarah Ramp** (CEE BS '13, MS '14) was assigned to work on the design for the steel roof, which needed to be able to withstand both wind and snow loads. "It's a lot of work that I've never done before," she said. She and several of her classmates spent about a month working on the roof design before they even started drawing the final design. The students then had to implement the design themselves by working on the construction site; the work included creating footings for concrete columns that house the electrical outlets, pouring the concrete, putting in a curb, spreading gravel, and installing 1,200 square feet of permeable pavers.

Site foreman **Brian Choe** (CEE BS '12, MS '13) has worked on three other projects as Cartwright's student employee, but said that this project has been his favorite. "In this project, there are aspects of heavy civil engineering — there's concrete pouring, there's a lot of design factors and structural design factors," he explained.

"And our design is going to be used by FMS, so that makes me feel good to know that we're making something that's going to be used every day," Choe added. **Melissa Daly** (CEE BS '13) also appreciated the greater contributions that the class makes to the campus community. "After you leave, you can come back and see something your class built," she said.

Cartwright believes that the greatest takeaway from the course is the bigger lesson that the students learn, which is "reality," he said. "Students gain appreciation for the built world, as it doesn't seem quite as simple as they originally thought — which means they gain an appreciation for life, because it's not as simple as it looks."

Using a pumper truck, students fill forms that will be the footers for concrete columns.

Jacobo Bielak named the Paul Christiano Professor of Civil and Environmental Engineering

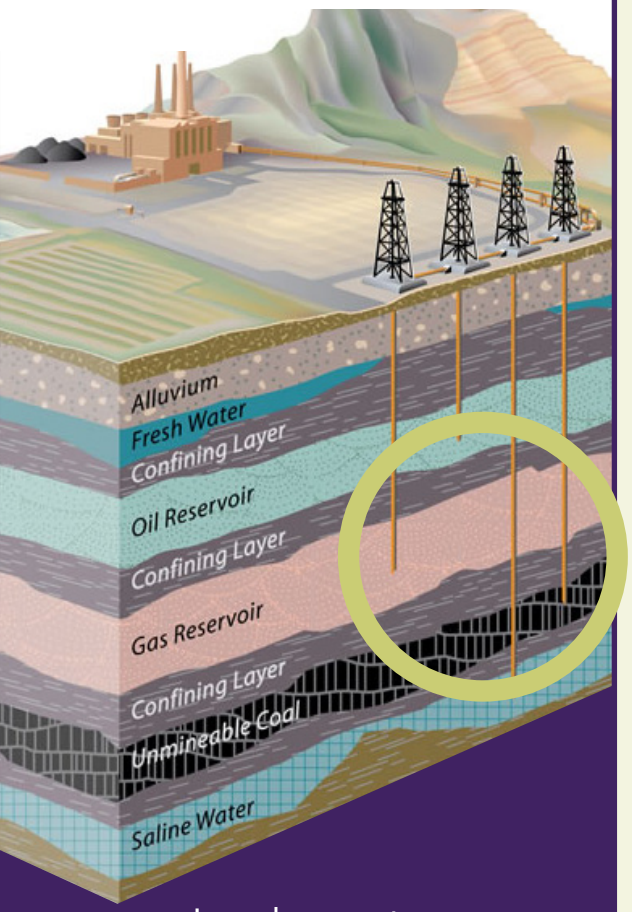
Jacobo Bielak, University Professor of Civil and Environmental Engineering, has been named the Paul Christiano Professor of Civil and Environmental Engineering. Professor Bielak is an internationally known eminent researcher in the area of large-scale ground motion modeling and the effects of ground motion on structural response to earthquakes. He has also been an outstanding advisor and teacher for many graduate students at Carnegie Mellon University over the past 32 years. His technical contributions have significantly impacted the practice of earthquake engineering and the soil-structure interaction formulas he developed are the basis for those adopted in current seismic design codes, including the 2010 version of ASCE/SEI 7.

Professor Bielak's work has been singled out for several computing awards, including the Gordon Bell Prize, ACM/IEEE SCO6 HPC Analytics Challenge Award, and the Allen Newell Award for Excellence in Research from the School of Computer Science, as well as the Outstanding Research Award from the College of Engineering at Carnegie Mellon University. In 2009 he was elected as a University Professor at CMU, and in 2010 he was elected to the National Academy of Engineering for advancing knowledge and methods in earthquake engineering and in regional scale seismic motion simulation. He is also a member of the Mexican Academy of Engineering and of the Mexican Academy of Sciences. In 2011, he was elected as a Distinguished Member of the American Society of Civil Engineers. Professor Bielak has been actively engaged in ASCE committees, seismology societies and the National Science Foundation's Network for Earthquake Engineering Simulation (NEES), which links 15 university laboratories in cooperative, real-time studies of the seismic performance of large structures. He has been an active member of a number of editorial boards, such as the ASCE Journal of Engineering Mechanics and the ASCE Journal of Geotechnical and Geoenvironmental Engineering.

The Paul Christiano Professorship was made possible through the generosity of a group of donors who endowed the professorship in recognition of Christiano's significant and enduring contributions to CEE, CIT, and the university.

OFFSETTING THE GREENHOUSE EFFECT

CEE Achievements in Carbon Storage Research



In carbon capture, utilization, and storage (CCUS), carbon dioxide emitted from industrial sites such as power plants is captured, compressed, and injected into underground reservoirs. Potential storage sites range from depleted oil and gas reservoirs to saline aquifers and unmineable coal deposits.

Image: Larry Scott, Colorado Geological Survey

Carbon dioxide is in the air, and no one is smiling about it. As levels of atmospheric carbon dioxide (CO_2) continue to rise at a sobering rate, CEE researchers are exploring a bold technique that could play a key role in global greenhouse gas reduction. The technique is known as carbon capture, utilization, and storage, or CCUS, and has a straightforward objective: capturing CO_2 and storing it underground before it makes its way to the atmosphere. Through the collaborative efforts of the NETL-RUA, a partnership between the National Energy Technology Laboratory and five nationally-recognized universities (CMU, Penn State, Pitt, Virginia Tech, and WVU), a team of CEE researchers and NETL scientists are researching the potential benefits and risks associated with CCUS.

CCUS: WHAT IT IS AND WHY IT MATTERS

In carbon capture, utilization, and storage, carbon dioxide is "captured" from emissions from industrial sites such as power plants, physically compressed, and injected into brine-filled aquifers and reservoirs far beneath the earth's surface. This prevents the captured carbon dioxide from entering the atmosphere and contributing to the greenhouse effect, in which heat bouncing off the earth's surface encounters greenhouse gases such as CO_2 and is reflected back toward the earth, warming the atmosphere.

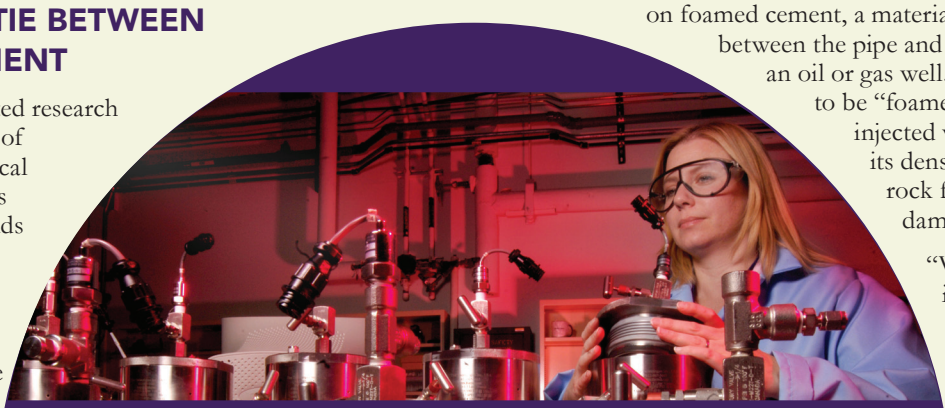
An advantage of CCUS is the sheer scale of its operations; the Intergovernmental Panel on Climate Change estimated in a 2005 report that CCUS could account for up to 55% of world efforts to mitigate the greenhouse effect. However, because the process is complex, researchers need a good understanding of the associated risks—in particular, how and where CO_2 leakage might occur—before it is widely implemented.

CEE Department Head and Walter J. Blenko, Sr. University Professor **Dave Dzombak** is one of the CEE faculty members researching CCUS as part of NETL-RUA's wellbore integrity program. In 2005, he was contacted by NETL researcher **Brian Strazisar**, who was leading the NETL efforts on wellbore integrity, to collaborate on CCUS because of Dzombak's reputation in this area of research. The team evolved to include CEE Professor **Greg**

Lowry and NETL Research Scientist **Barbara Kutchko** (CEE '08), then a CEE doctoral candidate. Dzombak noted that the scale of the project has allowed those involved to form a clear picture of the technique's challenges and opportunities. "What is unique about the CEE approach is that we have a critical mass of people under one roof working on key components of the issue of CO_2 leakage and risk assessment," he said. "We have the whole picture here, from the high-level risk model down to the individual processes involved in CO_2 storage."

THE UNLIKELY TIE BETWEEN CCUS AND CEMENT

Dzombak's CCUS-related research deals with the integrity of wellbore cement, a critical factor in the technique's success. Oil and gas fields contain hundreds of abandoned wells that are typically filled with cement—known as wellbore cement—once exploitation of the underlying reservoirs is completed. These depleted oil and gas reservoirs are desirable CO_2 storage sites for several reasons: They have a high storage capacity, and injecting CO_2 into a reservoir makes it easier to extract the remaining oil and gas in a process known as enhanced oil and gas recovery. Because the cement-filled wellbores penetrate the reservoirs, they are considered to be a likely point of CO_2 leakage, and Dzombak and his collaborators at CMU and NETL are studying the cement's ability to withstand the effects of stored CO_2.



The path between CEE and NETL is a well-traveled one, and many of the researchers studying CCUS have found themselves on it. Barbara Kutchko (PhD '08) began her career at NETL performing research in CCUS, where her efforts were soon recognized and she was encouraged to continue her education toward her doctorate degree. Through NETL's Minority Mentoring Program and the relationship between NETL and CMU researchers, she was teamed with CEE to continue to research cement integrity with Dzombak and Lowry.

As a NETL research scientist, Kutchko says her experiences at CEE were an invaluable part of her research career. "The CEE department is such a supportive, nurturing place; the professors clearly care about their students," she said. "When I graduated, I was fortunate to be able to apply my experience working with Dave Dzombak and Greg Lowry to my research at NETL. It has been a wonderful experience for me."

"When CO_2 is compressed and injected into the ground, it may become supercritical – a high-pressure substance between a gas and liquid state," he explained. "We are looking at the potential of supercritical CO_2 mixed with brine contained in the reservoirs to degrade the cement used to fill these wells."

From 2005 to 2008, the team recreated the temperature and pressure conditions found in these reservoirs and then exposed cement to those conditions in a laboratory setting. Though they expected to find evidence of rapid erosion of the cement, their one-year experiment yielded more positive results: The alteration occurring in the cement as a result of the CO_2 was extremely slow, and did not feature the rapid degradation they were expecting.

"By understanding how CO_2 interacts with the wellbores, and what the impact is on overlying aquifers, we can improve the science base for CCUS risk assessment," Dzombak said. "This knowledge will be critical to the public dialogue on reducing atmospheric CO_2."

MODELING THE BEHAVIOR OF FOAMED CEMENT

Continuing the partnership between CMU and NETL, CEE Associate Professor **Craig Maloney** recently began working with Kutchko and CEE PhD candidate **Eilis Rosenbaum** on foamed cement, a material used to seal the gap between the pipe and the rock formation in an oil or gas well. The cement is said to be "foamed" because it has been injected with nitrogen to lower its density and prevent the rock formation from being damaged.

"We're mainly interested in the short-term stability of the foam," Maloney explained. "The loss of stability in the short term is thought to be one of the main contributing factors to the Macondo well blowout in the Gulf of Mexico. In addition to affecting short-term stability, the structure of the foam, after the cement sets, will also impact the likelihood of CO_2 escape in carbon storage."

Maloney and his collaborators are using computer simulations to try to characterize the structure and *rheology* (how the foam flows in response to applied loads) of cement foams. He noted that modeling the behavior of foam cement is complicated by several factors. First, the air bubbles in the foam are compressible, meaning they will shrink when pressure on the cement is increased. Second, the cement itself is a complex fluid that is difficult to model, even without any air bubbles present. "These are two challenging issues that we're dealing with on the modeling side that haven't really been studied before," he explained.

While there has been a fair amount of research on the behavior of incompressible droplets in a simple fluid (for instance, oil-in-water emulsions), Maloney's team is the first to tackle foamed cement modeling on such a detailed level. Though the research is in its initial stages, Maloney hopes that their work will lead to a quantitative tool that petroleum engineers can use when designing protocols for cementing oil and gas wells.

THE BIG ROLE OF TINY FRACTURES

Craig Griffith, who completed his PhD in CEE in May 2012, studied another potential point of CO_2 leakage: Tiny fractures in the caprock, or seal, which is the layer of rock overlying these reservoir formations. Griffith looked at this slow CO_2 leakage process, known as seal release, by analyzing data from more than twenty proposed CCUS sites in the U.S. and Canada. His research question was deceptively simple: How many microfractures do you need before you start worrying?

Griffith developed a model to evaluate sites for microfracture existence and density, and found that every site had some degree of micro-fracturing. "The lithological and mineralogical properties of a seal can change significantly from one end of a basin to the other," he explained. "I identified the dominant mineral species that would characterize a seal – quartz or calcite, for example – and then developed a model to simulate the geochemical behaviors and fractures that might occur in each site's seal."

Griffith's findings, which include data on the permeability and lithological behaviors of mineral species often found in the seal, contribute to the growing body of CCUS knowledge. "I hope for my research to serve as a resource to help guide basin modeling and experiments in the laboratory," he said. Griffith is currently a Senior Petroleum Engineer with the U.S. Bureau of Ocean Energy Management in New Orleans.

LOOKING AHEAD

Climate change is an issue of great global importance, and the number of minds in CEE at work on the topic of CCUS reflects that reality. For Dzombak, the potential of CCUS to mitigate climate change is reason enough to persevere. "If we as a society are going to get serious about CO_2 control, CCUS must be an important element," he said. "It will be done at a very large scale, and must be done in an environmentally protective way."

This article is Part 1 of a three-part series that explores CEE research on carbon capture, utilization, and storage (CCUS). Part 2 features CEE researchers who are studying how CCUS could impact the underground environment, while Part 3 focuses on CEE efforts to develop a risk assessment framework for use in CCUS operations. To read the full series, visit www.ce.cmu.edu.

CEE Alum Finds Sustainable Solutions for the Happiest Place on Earth

Environmental engineering has more ties to Snow White than you might think. CEE alumnus **Tim C. Lee**, who earned his MS in Environmental Engineering from CMU in 2009, is now working for Disney to reduce the company's environmental impact around the world. In 2012, Lee joined The Walt Disney Company's Corporate Citizenship, Environmental Assessments team in Los Angeles, California.

As part of the Environmental Assessments team, Lee evaluates the environmental impact of sustainable designs for various Disney projects – for instance, he has assessed energy designs for commercial buildings, resorts, and attractions. He also manages the company's greenhouse gas and water inventory and reports its climate change impact to organizations such as the Carbon Disclosure Project.

Even before joining Disney, Lee was aware of the company's long history of environmental stewardship. "Disney has a strong connection with children and nature, so when it encourages children to be environmentally conscious, this perpetuates beyond their Disney experience," he said. "It's a fairly unique position that not many companies have, so the results of Disney's environmental efforts reach beyond the company; they reach the community, families, and so forth."

Lee, whose success at Disney depends on effective collaboration with designers, researchers, and other engineers, enjoys the interdisciplinary nature of his job. "My background is in engineering, but I'm on the corporate side of the company, and the most exciting part is bridging that gap," he said. "There's an opportunity for both sides to work together by translating technical concepts in a way to create value on the corporate side."

During his time at CMU, Lee made the most of the flexibility of the CEE curriculum by taking coursework in engineering, public policy, materials science, and architecture. "**Scott Matthews**' courses about the intersection of public policy and engineering are what prepared me the most for this job," he said. "I needed to know the engineering and I needed to know the public policy side of things, and having him as a professor contributed to my success here at Disney."

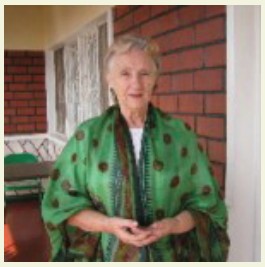
So has Lee run into Mickey at work yet? "Not exactly," he said, chuckling. "But I do see a lot of figurines sitting on desks. Disney's subsidiaries include Marvel Entertainment, Pixar Animation Studios, Lucasfilm, and ESPN, so there's something for everyone."

CEE students take a break from observing giraffes in Rwanda's Akagera National Park. *L to R: Sophie Grodsinsky (CEE '13), Agnes Marszalik (CEE '13), Hermona Tamrat (CEE '13), Juan Medina (CEE '13), Ibi Ogunye (CEE '14), Ruari Egan (CEE '13), and Jule Carr (CEE '13).*

CEE Students Travel to Rwanda for Spring Break Service Project

Over spring break, a group of CEE undergraduates went off the beaten path and traveled to Rwanda for a unique service project. **Ibironke Ogunye** (BS '14), **Jule Carr**, **Agnes Marszalik**, **Juan Medina** (BS '13, MS '15), **Ruari Egan**, **Sophie Grodsinsky**, and **Hermona Tamrat** (BS '13) spent a little over a week in a small, rural community an hour outside of the Rwandan capital of Kigali. They were part of a 16-person team of CEE and Mechanical Engineering students led by Mechanical Engineering Professor **Robert Reid** and PhD candidate **Iryna Zenyuk**.

The CMU group was tasked with re-building an aging basketball court frequently used by the community. "The first part of the project was breaking up the concrete with pickaxes and transporting it away in buckets," Medina explained. "Then we laid the rocks for the foundation and helped mix the concrete and move it for the finishing." The students collaborated on the project with members of the community, and communicated with them through local interpreters. "The people in the community were welcoming and really glad that we were there," Egan said.


Mama Arlene

During their trip, the students lived at Urukundo Village, a children 's home run by a Pennsylvania native affectionately known as "Mama Arlene." Urukundo Village includes a working farm, preschool, and library, and currently houses 47 children. "The really neat thing about this place is that it 's truly a home for children," Medina said. "The children stay as long as they need, and then they move on with their lives when they 're old enough." When the students weren 't working on the court, they assisted Mama Arlene and even found time for a safari in the Akagera National Park.

The project had its fair share of challenges. Electricity and running water were not always available, and the students quickly learned to make the most of occasional rainstorms. However, they were able to apply knowledge gained from CEE courses to make the construction process go smoothly. Ogunye explained that frequent group projects helped prepare them to work efficiently as a team, saying, "The first day we had trouble completing a particular task quickly, but the next day we were able to develop a more efficient system to make the most of such a big group."

Medina also noted that many of the topics discussed in Professor **Burcu Akinci 's** International Collaborative Construction Management course were relevant to their project, saying, "That class taught me to be more aware of cultural differences that can influence a project 's success. For example, the perception of time might vary between cultures; we were talking to Mama Arlene one day about not having enough time for something, and she laughed and told us, 'In Rwanda, you always have time. '"

Each of the students took away something special from the experience. Egan described the group 's half-day trip to the Kigali Genocide Memorial Center as "eye-opening," saying, "Something like 96% of the people above the age of 20 in Rwanda have had first-hand contact with violence. We worked with a lot of people in that age group, so that was really sobering to consider." The Rwanda trip was Ogunye 's first time out of the U.S., and partway through the trip she had the chance to travel to the National University of Rwanda to assist Mama Arlene with a service project for women at the university. "That was a really enlightening experience because it showed me a different aspect of Rwanda," she said. Ogunye now plans to reach out to the people she met at the university to participate in future service projects.

The trip was jointly funded by the College of Engineering and the Mechanical and Civil & Environmental Engineering departments, with the students covering their remaining travel costs. Some of the CEE funds for the trip were made possible by alumni donations. Medina expressed his gratitude to the department, saying, "If it weren 't for the additional funding from CEE, I wouldn 't have been able to go."

So did they have time for a game of basketball on the finished court? "No, the concrete was still wet," said Egan, smiling ruefully. "We 'll have to go back for that."

Alumni Profile: Aurora L. Sharrard

Aurora Sharrard (CEE MS '04, PhD '07) works with the Green Building Alliance (GBA) as their Vice President for Innovation and collaboratively co-leads two major GBA initiatives: DASH (Database for Analyzing Sustainable and High Performance Buildings) and the Pittsburgh 2030 District. The Green Building Alliance is headquartered in Pittsburgh, was founded in 1993, was one of the first U.S. Green Building Council (USGBC) affiliate organizations, and is now a USGBC Chapter.

Recently, Sharrard was invited to reflect upon her studies in the Green Design program in CEE and how it helped to shape the course of her career.

What brought you to Carnegie Mellon University to study?
Upon completing my bachelor's in Civil Engineering at Tulane University, I practiced as a geotechnical engineer in greater New Orleans. I did a mix of office and field work, but quickly realized that there were a lot of opportunities to improve the environmental impact on construction sites and, frankly, to just work smarter.

Due to the reactions I got from existing practitioners when I suggested innovating or doing something different, I knew I needed to have more information ammunition to help guide better decisions and actions that would benefit the greater good. I also knew that if I stayed out of school for too long, I would never return for my graduate degrees. I gave myself a deadline of two years of work experience before going to graduate school full-time.

Even as an undergraduate, I had looked at the work of CMU's Green Design Institute (GDI) online, so when I started looking for graduate schools, it seemed like a really good fit. At the time, there were very few engineering programs that had sustainability foci – and CMU had the strongest. Once I visited campus and the CEE department and met my future advisor, **Scott Matthews**, there was really no question that CMU was in my future.

In Fall 2003, I came to CMU to get my master's degree and work with Scott Matthews on a master's thesis pr oject on quantifying the environmental impacts of construction sites. I liked what I was learning and doing so much that I signed on to complete my PhD on the same topic.

What was your career path and how did your time at CMU help advance your path?
I spent two years as an Assistant Project Manager with Eustis Engineering in Metairie, Louisiana; four years as a Research Assistant and Doctoral Candidate in CEE at CMU; and I have been with the Green Building Alliance for six years. I began with GBA as Research Manager and subsequently was appointed Director of Innovation, VP of Innovation.

My CMU training was integral in helping me develop a more systematic and integrated level of critical thinking and analysis. It was invaluable to be able to take 4 years to learn, thrive, and grow my knowledge and ideas about how to create more sustainable places while surrounded by others who were thinking similar thoughts and undergoing similar explorations. Additionally, CMU's affinity for interdisciplinary work certainly helped shape how I think about getting a project of any type done.

What projects are you currently working on?
My two primary projects are the Pittsburgh 2030 District and DASH. DASH is the Database for Analyzing Sustainable and High Performance Buildings, an evidence-based web tool that works to provide building industry professionals with building performance information that enables better decision-making about building design, construction, operations, and maintenance across the triple bottom line. We're currently determining how to convert our tool into a publicly-available software.

The Pittsburgh 2030 District is a collaborative, local effort to create a community of high-performance buildings in downtown Pittsburgh. District-wide goals include 50 percent reductions in energy, water, and transportation emissions by the year 2030, which would establish Pittsburgh as a national leader in healthy and high-performing buildings. To date, 100 buildings totaling 30 million square feet (54 percent of the square footage in the District) are committed to these inspirational goals.

2013 Alumni Reception - Carnival

Belechak Named COO

Joseph G. Belechak (CE '81) has recently been promoted to chief operating officer, a new position at Pittsburgh-based contractor dck Worldwide LLC. Since joining dck Worldwide in September 2012, he has served as senior vice president of strategy and operational excellence.

Belechak has 25 years of experience in the energy (nuclear, electric, and gas), consulting, energy services, and communications industries. He formerly was a senior vice president of nuclear fuels at Westinghouse Electric Co. and chief operating officer at Duquesne Light. He also was president of a consulting firm, Transformation Services.

dck Worldwide ranks at No. 172 on ENR's list of the Top 400 Contractors, with $315 million in 2011 revenue.

Oberoi & Finger Win Best Paper Award

Sharad Oberoi (CEE MS '06, PhD '11), CEE Professor **Susan Finger**, and **Eric Rose** (ISR) recently won the Best Paper Award at the 10th ASME International Conference on Design Education for their paper entitled "Online implementation of the Delta Design game for analyzing collaborative team practices."

Oberoi is currently a research scientist with the Sanborn Map Company, based in Colorado Springs, Colo., where he coordinates Sanborn's spatial modeling research initiative by utilizing the recent advances made in a variety of 3D technologies including laser scanning, photogrammetry, and computer vision.

We would like to feature YOU!

CEE News is always looking to hear from alumni doing interesting things around the world.

If you would like to be part of our alumni profile series, please contact us at **ceenews@andrew.cmu.edu**.

2013 Alumni Reception - Carnival

Wilson Named to PHLF Board

Todd M. Wilson (CEE, EPP '06) was recently named to the Board of Trustees for the Pittsburgh History and Landmarks Foundation. An Associate Engineer at Trans Associates Engineering Consultants, Inc., Wilson has served as Practitioner Advisor to Carnegie Mellon University for ASCE since 2007. In 2009, he founded the Historic Bridge Weekend, an annual event that brings together historic bridge enthusiasts to attend presentations and visit bridges. In 2010, Wilson was named one of the American Society of Civil Engineers Ten New Faces of Civil Engineering, and in 2011, he was named one of Pittsburgh's 40 Under 40.

"The Pittsburgh History and Landmarks Foundation is one of the most important and influential historic preservation organizations in the country," Wilson said. "The Landmarks [Foundation] has demonstrated that historic preservation projects can successfully become the catalyst for urban renewal and community improvements. I am thrilled to become part of the organization."

Creech to Receive 2013 Alumni Award

CEE alumnus **Richard T. Creech** (CE '84) will receive the 2013 CMU Alumni Distinguished Service Award during Céilidh Weekend this fall.

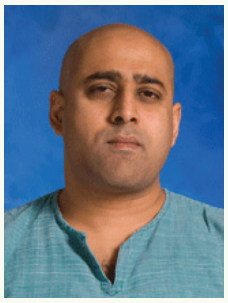
Rick is president and principal of Creech Engineers, a 50-person civil engineering, surveying, and mapping firm headquartered in Stuart, Fla. He has served in numerous roles on behalf of the university, including Board of Trustees, Dean's Leadership Council, Alumni Association Board (member and president), and Civil Engineering Advisory Board.

Rick was designated Engineer of the Year by the Florida Engineering Society (Treasure Coast Chapter) and FES Young Engineer of the year (Treasure Coast Chapter). He was awarded the Florida Surveying and Mapping Society award for "Outstanding Civic Contribution."

The Alumni Distinguished Service Award is intended to recognize both longevity and consistency of service over a lifetime of dedication to the university.

2013 Alumni Reception - Carnival

Dayal Wins EMI Leonardo Da Vinci Award



Associate Professor **Kaushik Dayal** has won the prestigious Leonardo Da Vinci Award from the American Society of Civil Engineers (ASCE) Engineering Mechanics Institute (EMI) for groundbreaking research on the interactions between materials and electromagnetism that can be applied to new technologies for energy storage and generation.

"I'm delighted to receive this recognition of our research into the behavior of electromechanical and electrochemical materials at the nanoscale," said Dayal, a professor in the mechanics group of the Department of Civil and Environmental Engineering at CMU.

Dayal researches materials that could have major applications in large-scale energy harvesting. Intermittent power sources, such as solar power, may benefit from being able to store excess energy in large batteries where the sun shines in the daytime, and then use the stored energy at night when it is in demand. Research in this field is aimed at creating smaller batteries with higher energy density and faster recharge times. His research is funded by the Army Research Office (ARO), the Air Force Office of Scientific Research (AFOSR), and the National Science Foundation (NSF).

"This is great recognition for an innovative researcher who is making important contributions to the modeling of materials critical to renewable energy systems and other technologies," said David A. Dzombak, head of CMU's Department of Civil and Environmental Engineering and the Walter J. Blenko, Sr. University Professor.

The EMI Leonardo Da Vinci Award, established in 2011, recognizes outstanding young investigators early in their careers for promising developments in the field of engineering mechanics and mechanical sciences with specific relevance to civil engineering.

Dayal's pioneering work has garnered many accolades. In 2012, he was honored with the Army Research Office Young Investigator Award, the Air Force Office of Scientific Research Young Investigator Prize, the National Science Foundation Career Award, and the Eshelby Mechanics Award for Young Faculty.

Bielak Elected as USACM Fellow

Jacobo Bielak, the Paul Christiano University Professor of Civil and Environmental Engineering, has been elected as a Fellow of the U.S. Association for Computational Mechanics.

The award recognizes individuals with a distinguished record of research, accomplishment and publication in areas of computational mechanics, and demonstrated support of the Association through participation in its endeavors. Bielak is currently a member of the Executive Council of the Association.

Bielak is widely recognized for his accomplishments in the fields of earthquake modeling, structural health analysis, and engineering education.

Dayal Awarded CIT Dean's Early Career Fellowship

Associate Professor **Kaushik Dayal** is one of four recipients of the newly-established Dean's Early Career Fellowship. The award was established in Spring 2013 by Dean **Jim Garrett** to recognize deserving untenured faculty members in the Carnegie Institute of Technology. Candidates of the award are nominated by their Department Head, after which the CIT Faculty Review Committee reviews the nominations and makes a recommendation to the Dean.

Dayal joined the CEE faculty in January 2008. His selection for the award was based on his research accomplishments, which are recognized as being highly creative and influential in the field of Applied Mechanics.

CEE Diploma Ceremony

Washington Speaker Series: Protecting Critical Infrastructure

CMU's Scott Institute & NAE Host Symposium on Shale Gas

Engineers, environmental specialists, and members of the energy industry gathered in Carnegie Mellon University's McConomy Auditorium this spring to discuss the implications of shale gas exploration and production for the U.S. manufacturing sector. The symposium, entitled "Shale Gas: Implications for America's Regional Manufacturing Economies," was hosted by CMU's newly-formed Scott Institute for Energy Innovation and by the National Academy of Engineering (NAE). Shale gas is rapidly expanding the nation's natural gas supply, and many view it as a key component of U.S. energy independence.

CEE Head and symposium moderator **Dave Dzombak** welcomed the crowd of several hundred attendees and spoke about the increasingly central role that shale is playing in the energy sector.

President Emeritus and University Professor **Jared L. Cohon** opened the panel discussion by speaking on the significant opportunities associated with shale gas production, but urged industry leaders to acknowledge uncertainties. "If ever there was a region that knows about the long-term impacts of national resource exploitation, it's this one," Cohon said. "Shale gas extraction does have impacts [...] and we have to acknowledge that and do something about that."

The symposium was organized into three panels of researchers and professionals with expertise in energy-related issues. In the first panel, moderated by Scott Institute Co-Director **Andrew Gellman**, members of the energy industry addressed the implications of shale gas on industrial developments. U.S. Steel Dean of Engineering Gerald D. Holder from the University of Pittsburgh described the move toward shale gas as a "renaissance" with the potential to create thousands of new jobs in Pennsylvania.

The remaining panels focused on the use of natural gas for transportation and on the environmental impact of shale gas production. The third panel was moderated by **M. Granger Morgan**, Co-Director of the Scott Institute, and included CEE Professor **Jeanne VanBriesen,** who offered a summary of water use in shale gas development, potential impacts on water resources, and research needs to protect water resources.

The symposium provided an important overview of the current situation regarding shale gas development, prospects for the future, and research needs. CEE faculty members and students have been and will continue to be engaged in research on shale gas development, including ways to develop the resource responsibly.

VanBriesen and Mauter Awarded PITA Grant

Professors **Jeanne VanBriesen** (CEE) and **Meagan S. Mauter** (ChemE and EPP) have recently been awarded research funding from the Pennsylvania Infrastructure Technology Alliance (PITA) for their project, "Evaluation of Membrane Fouling Potential of Dissolved Organic Matter using Parallel Factor Analysis of Fluorescence Spectroscopy."

The team will evaluate a recently-developed organic carbon characterization method, Parallel Factor Analysis of Fluorescence Spectroscopy, as a way to better predict membrane fouling potential in wastewaters. Membrane fouling is a major cause of operational downtime and increased costs and energy use at water, wastewater, and produced water treatment facilities.

Lowry & Gregory Awarded 2012 Best Feature Article: ES&T

Professors **Greg Lowry** and **Kelvin Gregory** were awarded the 2012 Best Feature Article in Environmental Science & Technology (ES&T) Journal. Their article, *Transformations of Nanomaterials in the Environment*, explores various scenarios in which released nanomaterials can impact the environment.

Nanomaterials, which are used in a variety of applications, can undergo drastic transformations when released into the environment, but the ways that the release of nanomaterials affects their toxicity, stability, and interactions with other materials are not well understood. In their article, Lowry and Gregory discuss the potential chemical reactions and altered states that can result when nanomaterials are released. They also highlight the need for research that illuminates these transformations and the risks associated with them.

Professors Akinci and Sinopoli Tapped to Head PSII

As new co-directors of the Pennsylvania Smarter Infrastructure Incubator (PSII), an interdisciplinary research lab at CMU, **Burcu Akinci** (pictured) and **Bruno Sinopoli** are fostering the creation of technologies to help cities, governments, and industries worldwide develop smarter infrastructures.

"I am very pleased that professors Akinci and Sinopoli have agreed to co-lead the PSII. They are well known and highly regarded for their respective research activity related to smarter infrastructure," said Jim Garrett, CIT Dean. "Together, they will bring exciting new ideas and research programs to the PSII. They will also continue the excellent PSII tradition of cooperation among the Department of Civil and Environmental Engineering, the Department of Electrical and Computer Engineering, the Institute for Complex Engineered Systems (ICES), and many other departments in the College of Engineering and other colleges."

"We plan to explore joint research in a variety of critical technology areas to enable more efficiently and effectively managed and sustainable civil infrastructure," said CEE Professor Akinci. Her work focuses on leveraging information models and a variety of sensors to streamline construction and facility/infrastructure-management practices.

Sinopoli, an Associate Professor of Electrical and Computer Engineering at CMU, develops tools for securing and controlling cyber-physical systems.

"We want to improve the robustness and security of critical infrastructures," said Sinopoli. "But to do this, we also need to improve the reliability, efficiency, and integration of information and communication technologies so critical to developing performance indices."

PSII is a Commonwealth of Pennsylvania-supported economic development initiative developed to advance infrastructure technology in partnership with industry and the state. Both IBM and Bombardier were founding partners in 2010.

The world's trillion-dollar network of rails, roads, bridges, buildings, water distribution systems, and power networks have varying amounts of automated management and monitoring, but the CMU research collaboration is designed to improve these critical emerging technologies and train a new generation of employees who have the multidisciplinary perspective and skillsets to design and operate them.

2013 Graduate Student Orientation

NEW FACULTY

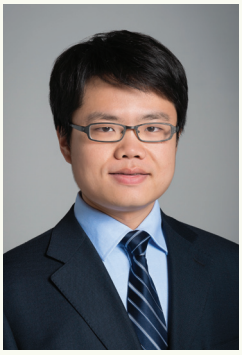
Constantine Samaras, an engineer at the RAND Corporation and CEE alumnus, will be joining the CEE faculty in January. In addition to his work at RAND, Samaras is a professor at the Pardee RAND Graduate School. He will be joining the EESS research group with a focus on energy systems infrastructure analysis, including life cycle assessment, energy use, and analysis of open data to inform infrastructure decisions.

Samaras received his PhD in Engineering and Public Policy and Civil and Environmental Engineering from Carnegie Mellon in 2008. "It's really an honor to return to such a great place and to work with some old colleagues and a lot of new colleagues in this type of important research on energy and energy systems," he said. Samaras will begin teaching both graduate and undergraduate classes in the Fall of 2014, and will remain an adjunct senior researcher at RAND.

President Emeritus and University Professor **Jared L. Cohon** has joined the CEE faculty after completing his tenure as CMU's eighth president. An authority on environmental and water resource systems analysis, Cohon has worked on water resource problems in three continents, served as chairman to the federal Nuclear Waste Technical Review Board, and was appointed by two US presidents to the Homeland Security Advisory Council. He has been named a distinguished member of the American Society of Civil Engineers and is a member of both the National Academy of Engineering and the American Academy of Arts and Sciences. This year he was named University Professor, the highest academic position university faculty members can achieve.

Cohon will be taking a sabbatical this year before joining CEE full time. He is considering using his year off to visit other universities with strong programs in his field, and looks forward to returning to his "true love," teaching.

New CEE Faculty Member Highlights Relationship Between CEE and University Traffic Center



As transportation systems become increasingly connected to other urban infrastructure systems, the need for collaborative, interdisciplinary management of these systems rises. CEE faculty have been actively involved in efforts to align urban infrastructure systems research with transportation research. One such effort is T-SET, Carnegie Mellon's U.S. DOT University Transportation Center (UTC). The UTC brings together researchers from CEE, Electrical Engineering, Robotics, and other departments to develop interdisciplinary engineering solutions to urban transportation issues.

CEE's most recent faculty appointment, Assistant Research Professor **Zhen (Sean) Qian**, brings his expertise in transportation infrastructure systems to the transportation research taking place at CMU. Qian completed his PhD in Civil Engineering at the University of California, Davis and his postdoctoral work at Stanford University. He has a joint appointment with Heinz College and with the Institute of Complex Engineered Systems (ICES), whose programs include the UTC.

"CEE researchers are involved in several different projects with the UTC, which focuses not only on transportation systems but also on physical infrastructure," said Duquesne Light University Professor **Chris Hendrickson**, whose current research deals with the long-term impacts of connected autonomous vehicles. He noted that research on infrastructure systems is increasingly tied to transportation systems research, and cited the research on bridge structural health monitoring being conducted by CIT Dean **Jim Garrett** and Paul Christiano University Professor **Jacobo Bielak** as one example. "Fortunately, the lines of communication between CEE and the UTC are very open."

This active sharing of information is part of what drew Qian to CEE. "What most interests me about urban systems research at CMU is the unique interdisciplinary research environment," said Qian. "All of these professors work together. They constantly exchange ideas with each other and their research complements each others' research, and that's pretty exciting. You won't find that level of collaboration anywhere else in the country." In addition to teaching a course on intelligent transportation systems this fall, Qian will be applying his expertise in network analysis to construct a data engine that brings together datasets from various urban systems—vehicle tracking, bridge structural health monitoring, and more—to enable public agencies to manage urban systems in a more holistic manner.

Dzombak Shares Prestigious Environmental Engineering Award

CEE Head **David Dzombak** and University of Pittsburgh Professor **Radisav D. Vidic** were recognized by the American Academy of Environmental Scientists and Engineers (AAEES) at the National Press Club in Washington, D.C., for helping to address the global water shortage for use in power plant cooling systems. Dzombak and Vidic received the 2013 Grand Prize in the University Research category of the AAEES Excellence in Environmental Engineering and Science competition for a project titled *Use of Treated Municipal Wastewater as Power Plant Cooling System Makeup Water.*

"This is a wonderful honor for seven years of work, supported by the U.S. Department of Energy, to develop an integrated approach for use of municipal wastewater for cooling systems in electric power plants," said Dzombak, the Walter J. Blenko, Sr. University Professor of Civil and Environmental Engineering and director of the Steinbrenner Institute for Environmental Education and Research at CMU.

The CMU-Pitt research shows that treated municipal wastewater is a common and widely available alternative source of cooling water for thermoelectric power plants across the U.S. However, the biodegradable organic matter, ammonia, carbonate, and phosphates in the treated wastewater pose challenges, including fouling and corrosion issues. The researchers, along with their graduate students from both CMU and Pitt, investigated how to address these challenges.

Dzombak Chairs EPA Research Advisory Panel

The U.S. Environmental Protection Agency's (EPA) independent Science Advisory Board (SAB) named CEE Head **Dave Dzombak** as chair of the Hydraulic Fracturing Research Advisory Panel. The panel was responsible for peer reviewing the findings of the EPA's draft report of results for its national study on potential impacts of hydraulic fracturing on drinking water resources, as well as providing scientific feedback on request.

As part of his duties as chair, Dzombak was one of four expert witnesses testifying at a U.S. Congressional subcommittee hearing this summer. The hearing, titled *Lessons Learned: EPA's Investigations of Hydraulic Fracturing*, was co-hosted by the Subcommittee on Environment and the Subcommittee on Energy.

CEE Spring Pancake Breakfast

Fenves Travel Grants Awarded

The Steven J. Fenves Travel Grant was created to provide students the opportunity to travel to professional conferences in order to present a paper discussing their research.

The following students were awarded support to attend various conferences:

Vaibhav Agrawal - Society of Industrial and Applied Mathematics (SIAM-MS13) - Providence, RI

Sumon Giri- European Group for Intelligent Computing in Engineering - Vienna, Austria

Towards Automatic Classification of Appliances: Tackling Cross Talk in EMF Sensors Using Blind Source Separation Techniques

Prashant Jha - Mathematical Aspects of Materials Science - Philadelphia, PA

In-Soo Jung - ASCE International Workshop on Computing - Los Angeles, CA

Interpreting the Dynamics of Embankment Dams through Time-Series Analysis of Piezometer Data Using Non-Parametric Spectral Estimation Method

Arka Roy - Soft Solids and Complex Fluids 2013 Meeting - Amherst, MA

Yuxin Wang - World Environmental & Water Resources Congress - Cincinnati, OH

The Effect of Sampling Strategies on Assessment of Water Quality Standards Attainment in Large Rivers

Xue Yang - ASCE International Workshop on Computing - Los Angeles, CA

Lessons Learned from Developing Immersive Virtual Mock-ups to Support Energy Efficient Retrofit Decision Making

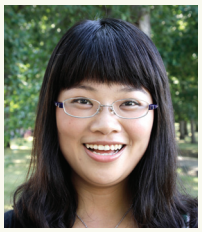

Vaibhav Agrawal

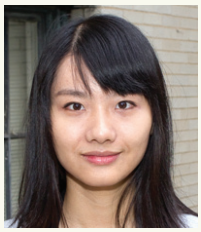

Sumon Giri


Prashant Jha


In-Soo Jung


Arka Roy


Yuxin Wang


Xue Yang

Chi Epsilon Inducts Three New Members

The Chi Epsilon Carnegie Mellon Chapter inducted three new members this spring: CEE undergraduate students **Jeffie Chang** ('14), **Jennifer Chan** ('13), and **Melissa Daly** ('13). Chi Epsilon is the National Civil Engineering Honor Society in the United States. The organization honors engineering students who have exemplified the principles of "Scholarship, Character, Practicality, and Sociability" in the civil engineering profession.

Two PhD Students Awarded NSF Research Fellowship

CEE is pleased to announce that PhD students **George Lederman** *(pictured top)* and **Joe Moore** *(pictured bottom)* have each been awarded an NSF Graduate Research Fellowship (GRF). This competitive fellowship supports their research efforts and studies for three years and provides international research and professional development opportunities.

As the oldest graduate fellowship of its kind, the GRF has a long history of selecting recipients who achieve high levels of success in their future academic and professional careers.

George is jointly advised by professors **Jacobo Bielak**, **Jim Garrett,** and **Haeyoung Noh**. Joe is advised by professor **Kelvin Gregory**.

CEE Intramural Soccer Team Wins Tournament

A team of seven CEE grad students and one Biomedical Engineering grad student is proud to have won the CMU Intramural Indoor Soccer Tournament. The team, called Civilization, beat Fuego FC 6-2 on the evening of April 25 after winning the semifinals with a score of 10-3. Civilization included CEE students **Arka Roy**, **Mehmet Kosa**, **Navid Kazem**, **Suman Giri**, and **Neil Patel** and BME student **Tyson Montidoro**. The team's captains were CEE students **Milad Memarzadeh** and **Enze Li**.

Pictured: (top row - left to right) Neil Patel, Mehmet Kosa, Milad Memarzadeh and Arka Roy. (bottom row - left to right) Enze Li, Suman Giri, Navid Kazem and Tyson Montidoro.

New EWRI Chapter Provides Opportunities for Students

As a PhD student, **Liwei Zhang** (CEE PhD '13) became interested in the Environmental and Water Resources Institute (EWRI), a specialty institute of ASCE that focuses on environmentally sound and sustainable infrastructure. While there already was a Pittsburgh EWRI Chapter, Zhang thought CEE students could benefit from a student chapter on campus. "I wanted to help CEE graduate students get access to the environmental engineering professional network in Pittsburgh, develop students' professional skills, and make students competitive in the job market," he explained.

In September 2011, he, **Sean Ma** (CEE MS '11), and **Frank Fan** (CEE MS '12) founded the EWRI Graduate Student Chapter at CMU with support from professors in CEE and the parent organization. The chapter, which is open to any student interested in sustainable infrastructure, organizes seminars, field trips, lectures, and numerous networking events.

The CMU chapter has quickly established itself as an effective way for students to build connections with the professional community. "With the full support of the EWRI Pittsburgh Chapter," Zhang said, "many graduate students are able to find internships or full-time positions through that professional network."

EWRI's networking opportunities impressed Ph.D. student **Negin Ashoori**, whose research is related to the sustainability of the Los Angeles water resources system. "Liwei and the other students on the EWRI committee did a great job of organizing networking events last year," she said. "It really made me realize how beneficial this organization is, and I decided to get more involved this year because of that."

As the new president of the EWRI chapter, Ashoori has plenty of plans for the school year. "This school year will start off with a lot of social events to engage students," she said. "We're also planning field trips to a wastewater treatment facility and hydraulic fracking sites." The CMU EWRI chapter will also be teaming up with the recently-established EWRI chapter at the University of Pittsburgh to host social events, lectures, and webinars related to water resources.

EWRI Members (L to R): Fiona Zhang, Brandi Eng-Rohrbach, Liwei Zhang, Agnes Marszalik and Negin Ashoori

Guevel Named to UAA President Scholar-Athlete Team

Jacqueline Guevel (CEE '14) is one of 10 CMU student-athletes who have been named to the University Athletic Association (UAA) Presidents Scholar-Athlete Team. To achieve this recognition, a student-athlete must earn first-team All-UAA honors and must carry a 3.50 or greater cumulative grade point average during the playing season.

At the close of the 2013 academic year, Guevel was also named to the College Sports Information Directors of America (CoSIDA) Academic All-District Team for women's cross country and track and field for the 2012-13 season. CoSIDA recognizes outstanding academic and athletic accomplishments by honoring deserving athletes with All-Academic recognition.

CEE Undergraduate Research Awards at CMU Meeting of the Minds Competition

Elissa Goldner (BS '13) (pictured in right photo on right), **Agnieszka Marszalik** (BS '13, MS '14) (pictured in right photo on left), and **Sarah Ramp** (BS '13, MS '14) (below) all received awards at Carnegie Mellon's Meeting of the Minds, the university's annual undergraduate research symposium. In total, 10 projects from the CEE department were presented at the May event.

Elissa and Agnieszka's project *Regional Economic Impact of the Twin Ridges Wind Farm*, advised by Social & Decision Sciences Professor **Paul Fischbeck** and Engineering and Public Policy Professor **Paulina Jaramillo** (CE MS '04, PhD '07), used various economic models to analyze the impact of the construction of a wind farm and proposed a more accurate method through the use of survey data to measure the economic impact of local energy developments. Their efforts won them the Toyota Ideas for Good Scholars Award, a $750 prize that recognizes environmental research "with applications designed to improve people's lives."

Sarah's project, *Implementing a Stormwater Sustainability Ratings System for Distressed and Vacant Urban Properties*, proposes a sustainability ratings system for stormwater management practices that could apply to properties with any sort of development. Sarah, who worked with the Western PA Brownfields Center and was advised by CEE Professor **Chris Hendrickson**, was a runner-up in the Undergraduate Environmental Research Award, sponsored by the Steinbrenner Institute for Environmental Education and Research and the Green Design Institute.

Leitch Awarded GROW Travel Grant

CEE graduate student **Megan Leitch** has been selected by the National Science Foundation and the Academy of Finland for a Graduate Research Opportunities Worldwide (GROW) travel grant to conduct research at Aalto University in Helsinki. Leitch will be advised by Academy Professor **Olli Ikkala**, whose molecular materials research group has made exciting advancements in nanocellulose aerogel fabrication techniques.

Throughout the Fall '13 semester, Megan plans to analyze the suitability of these aerogels for use in membrane water desalination, a project which opens a new international research collaboration between professor Ikkala and Megan's CMU advisors, professors **Greg Lowry** (CEE) and **Meagan Mauter** (ChemE/EPP).

2013 ASCE/AISC Steel Bridge Competition

CEE undergraduate students competed this spring in a multi-university Student Steel Bridge Competition, sponsored by the American Society of Civil Engineers (ASCE) and the American Institute of Steel Construction (AISC). The team included **Jeffie Chang** ('14), **Christopher Ejiofor** ('14), **Alex Warzinski** ('14), **Andrew Bakert** ('15), **John Carchi** ('15), **Dolly Hsu** ('15), **Michelle Kraynock** ('15), and **Amir Nour** ('15).

Teams were given 45 minutes to construct their bridges while adhereing to strict guidelines: Stepping in the wrong place or dropping a bridge part could lead to a penalty. Once completed, the bridges were then tested for strength and stability in a series of load tests. "We passed the first test, which was a fifty-pound lateral pull at two locations," Chang said. "Unfortunately, the next test was whether your bridge could hold 2,500 pounds, and although our bridge only moved a sixteenth of an inch vertically, it had a side sway of greater than half an inch and we weren't allowed to go further."

The experience gave the team a taste of the challenges of real-world engineering projects. To comply with the competition rules, they had to consider cost restrictions, meet deadlines, supervise part manufacturing, and work effectively as a team.

The team received valuable assistance from the CEE alumni who contributed over a thousand dollars toward material, tool, and travel expenses. Though their bridge didn't perform as well as they had hoped, the CEE Steel Bridge Team returned from the competition in good spirits and ready for next year's competition. "We improved a lot," said Chang. "We're going to use all of our resources next year to build something completely different that we've never done before."

Recent PhD Theses

CATHERINE IZARD – *How the Timing of Climate Change Policy Affects Infrastructure Turnover in the Electricity Sector: Engineering, Economic, and Policy Considerations* – Advisor: Matthews

RUI MA – *Environmental Transformation of Metal and Metal Oxide Nanoparticles* – Advisor: Lowry

ARVIND MURALI MOHAN – *Microbial Ecology of Flowback and Produced Water from Hydraulic Fracturing of the Marcellus Shale* – Advisor: Gregory

SAURABH TANEJA – *A Framework for Evaluation and Generation of Navigation Models for Map-Matching of Indoor Positioning Data* – Advisors: Akinci, Garrett, and Soibelman

ARANYA VENKATESH – *Towards Robust Energy Systems Modeling: Examining Uncertainty in Fossil Fuel-Based Life Cycle Assessment Approaches* – Advisor: Matthews

DANIEL WESTERVELT – *Characterizing the Sources of Cloud Condensation Nuclei Using a Global Aerosol Modeling Approach* – Advisor: Adams

JESSICA WILSON – *Challenges for Drinking Water Plants from Energy Extraction Activities* – Advisor: VanBriesen

YUJIE YING – *A Data-Driven Framework for Ultrasonic Structural Health Monitoring of Pipes* – Advisors: Garrett, Oppenheim, and Soibelman

LIWEI ZHANG – *Acid Gas Interactions with Pozzolan-Amended Wellbore Cement Under Geologic Sequestration Conditions* – Advisors: Dzombak and Nakles

CEE Night at PNC Park

Mapping Uncharted Territory: Developing Indoor Positioning Tools

Good news for those of us without a sense of direction: CEE's **Saurabh Taneja** has developed a tool to improve the performance of map-based navigation systems for the indoors. Taneja recently graduated with a PhD in Advanced Infrastructure Systems, during which he was advised by Professor **Burcu Akinci**, Adjunct Professor **Lucio Soibelman**, and CIT Dean **Jim Garrett**. In his thesis, Taneja outlined a framework that he developed for improving the accuracy of indoor positioning via a technique known as map-matching.

Taneja's research addresses the increasing need for a reliable indoor positioning tool, which is tied to a rise in the complexity of indoor environments like airports and office buildings. In situations such as emergency response and disaster management, such a tool would be invaluable in guiding building occupants to safety. It could also be used to provide support to construction and maintenance workers or to help individuals with disabilities navigate unfamiliar environments. However, satellite-based technologies such as GPS won't do the job; the signals from the satellites cannot penetrate buildings and walls. So what's the alternative?

Cue an innovative technique called map-matching, which was originally developed to improve the accuracy of outdoors GPS. Map matching is overlaying raw positioning data—for instance, data obtained from wi-fi or GPS—onto the map of a physical environment, then correcting the position of the sensing source to accurately place you in the map. "We need map-matching because raw positioning data does not always reflect the limitations on your motion," Taneja explained. "For example, if you overlay raw positioning data on a map, it might suggest that you're walking through walls or flying in space; map matching allows you to say, no, you did not walk though this wall, you went through this particular door."

Taneja saw the potential for improving the accuracy of positioning data in indoor environments through map-matching. While map-matching for GPS and the outdoors is well understood, much less is known about achieving it indoors. "Outdoors, GPS provides your position in latitude and longitude, and then it is overlaid on a map and converted to a street address," Taneja said. "But inside buildings, you can describe your position as a room number, a floor, a zone… not just as a point. There are different formats of indoor positioning data, and to map-match those different formats, you need different types of maps."

Taneja developed a series of algorithms that generate maps of indoor environments using digital building information models and then map-match raw positioning data onto them. To ensure that his approach would work for a variety of buildings, he designed his algorithms to automatically generate three different types of maps for six types of indoor environments that vary in shape and density of spaces.

Taneja envisions his work being used in a mobile platform such as Android. An application such as Google maps could use the tool he developed to decide which type of map to use for map-matching in a particular building. For instance, imagine a traveler is navigating an unfamiliar airport to catch a connecting flight. An app on the traveler's smartphone would select the type of map for map-matching that best represents that airport's layout. The traveler would then receive an accurate estimate of their position and could take the quickest path to their destination.

This summer, Taneja joined a Pittsburgh firm specializing in supply chain management to work as an algorithm developer. As for what the future holds, he's dreaming of data. "I have always wanted to work with the kind of huge, enterprise-level datasets that we see today, such as data coming from trade markets, news streams, and live video feeds," he said. "I'd like to get some more experience in that field, and will then decide whether to return to research or stay in industry."

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Once again, Spring Carnival was a great success! Several of our students were part of booth and buggy and several alumni came back to campus to enjoy the reunions and festivities.

Pictured: (TOP) Corrine Clinch ('14) and Brandon Mittman ('15) pose with their team's buggy. (MIDDLE) (left) Brian Choe (BS '12, MS '13) and (right) Ling Qu ('12) in front of the ASA booth: Finding Ariel, which took 1st place in the Independent Organization category. (BOTTOM) Bryan Lewis (BS '13, MS '14) pushes for buggy team Spirit A on hill one.

A MESSAGE TO OUR ALUMNI

Thank you.

You are an essential and valuable resource for the department. The CEE alumni network spans hundreds of different companies and industries. Internship opportunities that you make possible are extremely important for our students. As alumni, you not only give the department greatly appreciated financial support, but you also help our current students to gain experience through internships, and to network and build their own company connections.

Many new graduates end up working within our current alumni network. These placements would not be possible without your continuing involvement and support. Thank you so much for your lasting commitment to both the Civil and Environmental Engineering Department and Carnegie Mellon!

Stay connected! It's as easy as 1, 2, 3.

1. **To receive information on CEE alumni events,** update your contact information in the online alumni database. Visit **alumni.cmu.edu**.
2. **To network with CEE alumni,** join the Carnegie Mellon University Civil & Environmental Engineering Group on LinkedIn.
3. **To stay informed about current CEE projects and events,** like us on Facebook. Search for "Carnegie Mellon University Civil and Environmental Engineering."