PURDUE CIVIL ENGINEERING I SPRING 2014

IMPACT

EXPLORING UNDERGRAD EDUCATION


Photo by Steven Yang

HISTORIC TIME FOR CIVIL ENGINEERING

Just as we are putting the final touches on this Spring 2014 issue of *Purdue Civil Engineering Impact* magazine, our school has received thrilling news.

On Feb. 21, the Purdue Board of Trustees announced the extraordinary generosity of CE alumni Bill, Gerald and Will Lyles, who, in conjunction with the Lyles Foundation, have committed $15 million to the School of Civil Engineering. In appreciation for this remarkable gift, our school will now be named the Lyles School of Civil Engineering.

The Lyles' gift will contribute richly to our ongoing mission to take on the grand challenges that civil engineers are uniquely positioned to address. This support will enlarge our capacities for learning and discovery, and for preparing graduates who take an active role in generating solutions to critical problems that will expand our impact on the world.

Among those grand challenges are the world's aging infrastructures for transportation, the power grid, and water- and fuel-supply systems. As we build on our strengths in big-data systems and computational solutions, we will continue to seek answers to long-term questions of sustainability and resiliency. These are key goals in our work on materials for infrastructures, and in the quest for affordable renewable energy sources.

To address these challenges and others, employment of civil engineers is projected to grow 20 percent by 2022 — more than the average for any other occupation. Our school will graduate civil engineers who are prepared to be leaders among their peers in this growing workforce and also in their communities.

In our classrooms and labs, in collaboration with our alumni and industry partners, our students and faculty continue to set the pace for civil engineering that moves society forward. Our students are given experiential learning opportunities recommended by the latest engineering education research. We also engage them with research-recommended teaching and active-learning paradigms, enhanced global opportunities and advanced laboratory spaces. We continually seek new ways to engage and challenge students through varied experiences that will provide them with an enriching, well-rounded education.

We have listened to our industry partners and recognize the increasing importance of strong communication skills for our graduates joining the global workforce. Starting this fall, all civil engineering undergraduate students will be required to take Technical Communications in Civil Engineering. One course will focus on written communication, and a second will address oral communication. Communication assignments also will be woven into the core curriculum to provide continuous development of communication skills.

Purdue civil engineers already are known for their impact on the world — from engineering the Hoover Dam and the "Chunnel" beneath the English Channel, to one of the world's most ambitious civil engineering projects, the current expansion of the Panama Canal.

As we express our gratitude to the Lyles family, we add our thanks to all of our alumni and friends who give of their time and resources to enable even greater heights in all that we do to be known for our impact on the world.

RAO S. GOVINDARAJU
Bowen Engineering Head of Civil Engineering and Christopher B. and Susan S. Burke Professor of Civil Engineering

TO FOLLOW OUR PROGRESS, VISIT:
WWW.PURDUE.EDU/CE/MOVINGFORWARD

STUDENT TEAMS COMPETE IN NATIONAL, REGIONAL COMPETITIONS

Applying what's learned in the classroom, Purdue Civil Engineering students participate in multiple competitions that give an in-depth look at challenges they may face in the workplace.

In 2013, the Purdue team (above) placed first overall in the Great Lakes Regional Student Steel Bridge Competition and 17th nationally. CE students (left) also compete in the ASCE National Concrete Canoe Competition, where teams apply classroom engineering principles.

Students also participate in the Earthquake Engineering Research Institute competition to design balsa wood models of commercial office buildings that combine architectural aesthetics and structural integrity.

These competitions emphasize necessary team and project management skills.

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EA/EOU
Produced by Purdue Marketing and Media
ENG-14-3422

NEVER TOO EARLY TO START

For CE undergraduates, now is the time to begin their research careers

■ BY KIM MEDARIS DELKER

Madeline Nelson
Purdue University photos/Mark Simons

When you think of academic research, what comes to mind? Professors diligently working on a project, hoping to find exciting outcomes they can publish or teach to students? Or maybe professors working alongside graduate students, usually doctoral students?

Well, thanks to an effort at Purdue to engage more students in undergraduate research, that perception is rapidly changing.

Partially due to programs like the College of Engineering's Summer Undergraduate Research Fellowship (SURF) program, as well as increased visibility about the importance of undergraduate research University-wide, more and more students are becoming involved in research long before they earn their undergraduate degrees.

For Madeline Nelson, a civil engineering student who graduated in December 2013, having an undergraduate research experience helped shape her future after graduation.

Nelson worked with Santiago Pujol, associate professor of civil engineering, and graduate students Anna Klenke and Enrique Villalobos on a project that was inspired by earthquakes that devastated South American countries in recent years. The goal of the research was to determine how best to reinforce concrete structures via rebar to make them more resistant to damage by earthquakes.

Because few undergraduate students are involved in research, having that background set her apart with employers and graduate schools.

"I think it's important to get your hands dirty and not just study engineering on paper," Nelson says.

She began a full-time position at Chicago firm HNTB just days after she graduated and is now planning to pursue a master's degree in civil engineering while working full time. She credits her undergraduate research as turning her on to that path.

"It was my research experience that made me interested in graduate school," she says. "I'm glad to represent women in the field in graduate school and excited about the opportunities it will bring."

Nelson connected with Pujol after having him as a professor for a statics class. That's one path to undergraduate research opportunities. Another path is via more structured programs like SURF.

The SURF program began in 2003 to give undergraduate students in engineering and scientific disciplines at Purdue the opportunity to spend a summer on a research

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> — MADELINE NELSON

project with a professor and a graduate student, who often serve as direct mentors to the undergraduate.

One civil engineering student who completed an undergraduate research project through SURF in summer 2013 is Barnard Mondal, a senior in civil engineering. He worked with Cary Troy, assistant professor of civil engineering; Ernest Blatchley, professor of civil engineering; and graduate students Mehrnaz Afifi and Shih-Chi Weng on a project that examined the disinfection byproducts that can linger in indoor chlorinated swimming pools.

Chlorine can react with pollutants in the water, such as sweat and urine from swimmers, which produce volatile byproducts that may be inhaled once they are in the air. Children are particularly at risk from exposure. The issue is further complicated by the fact that the transfer of these compounds from the liquid to the gas phase — where they are ingested by swimmers and spectators — is enhanced by splashing and other movement. The goal of the research was to clarify the relationships between swimmer movements in the pool, the water motions they create and the transport of these harmful substances in order to predict their behavior so that swimmers and scientists can be aware of how different movements affect the levels and dispersion.

Mondal, whose emphasis is on hydraulics, was tasked with running the equipment to measure water turbulence. However, the team ran into an unexpected problem early in the study: the instrument wouldn't work in the ultra-clean swimming pool water because there are no particles in the water. The team had to come up with alternative ways to measure water turbulence, a task that delayed the project.

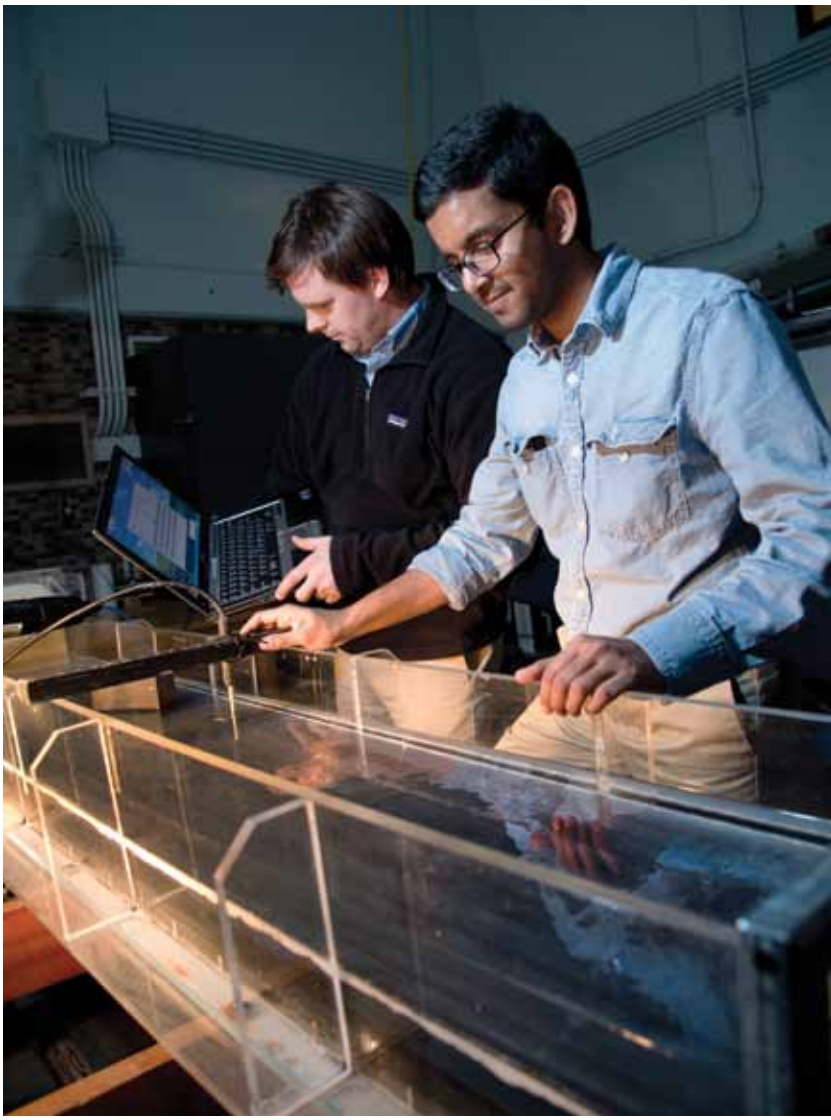
Mondal says that although the delay meant the project had to be completed without him, he still took a lot away from his undergraduate research experience.

"It gave me an opportunity to learn how to carry out research," he says. "It was a valuable experience for me. It has greatly prepared me for research during graduate school, even though I expect to work on a different topic in the future."

Troy says the project was a great learning tool when it comes to research.

"It was a good first research experience for him, because it taught him that you can only plan so much," Troy says. "Unexpected things always come up in research."

Another civil engineering student who completed a SURF project in summer 2013 was senior Andrew Martin. He worked with Ming Qu, assistant professor of civil engineering, on a project to measure environmental conditions before and after the installation of a green roof. For this project, Knoy Hall was selected, and Martin was involved in collecting the "before" data on the building's roof, including temperature, moisture and runoff data. The project's goal was to assess the environmental impact of green roofs. Since on most roofs, sensors are installed at the same time or even after the green roof is installed, there is little before-and-after data available.



Barnard Mondal (right), a senior in civil engineering, worked on a project that examined the disinfection byproducts that can linger in indoor chlorinated swimming pools. He was tasked with running the equipment to measure water turbulence.

Senior Andrew Martin (left) worked with Ming Qu, assistant professor of civil engineering, on a project to take measurements on environmental conditions before and after the installation of a green roof. Sensors, like those shown at right, can be installed at the same time or even after the green roof is installed. Purdue University photos/Mark Simons

> "I FEEL I GAINED A LOT MORE INDEPENDENCE AND IT HELPED TO BROADEN MY EXPERIENCE, MAKING ME MORE MARKETABLE."
>
> — ANDREW MARTIN

Budgetary constraints prevented those in charge of Knoy Hall from proceeding with the installation of the green roof, so the "after" data will not be available for this project. However, Martin says he still got a lot out of his research experience.

"It helped to reinforce concepts you learn in class, but you go more in-depth and have a narrower focus," he says. "I feel I gained a lot more independence and it helped to broaden my experience, making me more marketable."

Qu, the faculty member on the project, witnessed Martin's development through the summer.

"Andrew developed a lot of critical thinking skills and discovered that school is not just about the classwork. He can find the answers, too," she says.

TEACHERS LEARN, TOO

Faculty who work with undergraduate researchers also gain from the experience. Qu believes that it is important for faculty to work with undergraduate students because it can improve not just their teaching and mentoring skills, but also their research.

"Faculty learn to be strong mentors, and the projects they work on with students are good for their later research. It's mutually beneficial."

Troy, who has been working with the SURF program since 2007, estimates that he has worked with about 20 undergraduates on research projects, often about two to three per summer, many of them through the SURF program.

Troy says that without some kind of a structured experience, many undergraduate research experiences are sink or swim. "SURF is 100 percent effective in giving students a positive research experience that can lead them to graduate school," he says. And he believes that it's not only undergraduates who learn, but faculty, too.

"I've had to think more about the process of research, which you often don't think about," he says. "It's fun for me to go through the process with students learning to do science for the first time — the questions and hypotheses, the scientific method. It's like learning again how to do science."

WELCOME NEW FACULTY

Daniele Perissin, who joined the Purdue Civil Engineering geomatics faculty as an assistant professor in October, has developed award-winning methods for detecting surface movement that can pose a threat to buildings and structures throughout the world.

A Milan, Italy, native, he authored software called SARPROZ that processes data using a monitoring technique called interferometric synthetic aperture radar (InSAR). InSAR is an alternative technique to obtain measurements of surface displacement providing better spatial resolution and comparable accuracy at an extremely lower cost per area than conventional surveying methods. InSAR is becoming more popular in monitoring urban deformations; however, the technique requires advanced tools and high-level competence to be applied successfully.

Perissin received an MSc in telecommunications engineering and a PhD in information technology cum laude from Politecnico di Milano in 2002 and 2006, respectively. He joined the Signal Processing research group at the school working on the permanent scatterers (PS) technique in the framework of radar remote sensing. The PS technique is a powerful operational tool that exploits a long series of synthetic aperture radar data for monitoring ground deformations with millimeter accuracy on a high spatial density grid of point-wise targets. The technique has been applied successfully to a number of applications, from subsidence and volcano monitoring to slow-landslide detection.

His research combines satellite radar images of the same place taken at various times. From the images, colored bands called interferograms show the intensity and extent of ground deformation. Perissin says that his software is so accurate that even movements of a few millimeters can be detected.

■ DELLA PACHECO

DANIELE PERISSIN

To learn more about Perissin, view his Web page at https://engineering.purdue.edu/~perissin/index.htm

KONSTANTINA "NADIA" GKRITZA

Konstantina "Nadia" Gkritza received her diploma in civil engineering from the National Technical University of Athens, Greece, in 2001, and her MS in civil engineering in 2003 from Virginia Polytechnic Institute and State University. In 2006, she received her PhD in civil engineering at Purdue.

Before joining Purdue in 2013 as an assistant professor, Gkritza was an assistant professor in the Department of Civil, Construction, and Environmental Engineering at Iowa State University and director of the Sustainable Transportation Systems Program (STSP) at the Institute of Transportation.

She has led several federally, state- and industry-funded projects/programs, totaling more than $3.5 million in awards focused on economic analysis of highway investments and modeling, transportation and energy interdependencies, highway safety and sustainability.

Gkritza has taken on challenges that are often considered too complex or wide-ranging to be addressed without such cross-disciplinary teams. Her research has contributed significantly to an enhanced understanding of the relationship between transportation and economic development.

She hopes to develop new courses on agricultural transportation and on transportation energy, and sustainability that can be offered as advanced topics in transportation engineering while continuing to teach undergraduate and graduate courses in transportation engineering. Gkritza will also continue outreach activities to improve gender diversity in transportation engineering.

■ DELLA PACHECO

To learn more about Nadia's research, visit http://docs.lib.purdue.edu/dissertations/AAI3259995/

FROM IDEAS TO INNOVATION

Lyles i2i Lab offers undergraduates hands-on learning

■ DELLA PACHECO

Purdue University photos/Steven Yang

Engineering students are addressing some of the greatest problems facing society today through team-based projects. And they're doing it in classrooms that are revolutionizing the way engineering is taught.

In the lower level of Hampton Hall of Civil Engineering, the Lyles Ideas to Innovation (i2i) Laboratory emulates the workplace and puts design at the heart of the educational process. And it's all about flexibility.

The lab can be divided into four modules where students can work on different functions along the way to making a design become a solution. It allows the integration of lectures, hands-on experimentation and computer simulation in undergraduate student labs.

This facility includes large-scale testing equipment, advanced geotechnical equipment and a digital image correlation system. Classroom laptops can be used to develop numerical models, which can be compared with the results from more conventional testing equipment. The lab is also used for outreach activities to demonstrate civil engineering concepts to K-12 students.

Pablo Zavattieri, assistant professor of civil engineering and director of the Computational Multi-Scale Materials Modeling Lab, teaches Engineering Materials I. He says that the Lyles i2i Lab introduces students to new equipment, materials and concepts that relate classroom lectures with real materials.

"We use the lab equipment to take the materials to their limits," he says. "In that sense we can understand the fundamental behavior of materials under extreme conditions."

Junior Jeneé Christensen appreciates the lab's full range of testing equipment.

"Time spent in the lab has provided me with a valuable opportunity to engage in hands-on civil engineering practices, interacting closely with materials and testing practices that I will be using regularly out in the field after graduation," says Christensen, who is a cadet captain in the Air Force ROTC 220th Cadet Wing at Purdue.

Advance equipment is used to explain geotechnical principles not typically included in an undergraduate curriculum.

"As an aspiring construction engineer for the United States Air Force, the knowledge I have gained through work in the Lyles i2i Lab with premier faculty will be invaluable."

STATE-OF-THE-ART LEARNING ENVIRONMENT

One of the key pieces of lab equipment is a large universal testing machine. Zavattieri says the students apply extreme loading conditions to specimens to study how materials behave and relate those observations with what they learn in class.

"We use state-of-the-art stereo cameras and imaging software to capture detailed images of the experiments. Then, the students will use the laptops to simulate the material," Zavattieri says, adding that giving the opportunity to apply concepts learned in class on real materials is one of the pillars of engineering education.

Senior Kevin McKeon, who is studying structural engineering, agrees. He has conducted several experiments in the lab. Two favorites relate to concrete and asphalt testing.

"Our lab team mixed the materials following ASTM standard procedures," McKeon says. "Next we went through the process of curing the concrete and compacting the asphalt samples. Finally we used the universal testing machine to introduce the samples to compressive forces to measure their responses."

This new equipment has significantly impacted the way faculty teach classes, Zavattieri says.

"It opened the door to a myriad of new possibilities that we are still exploring," he explains. "We challenge the students to figure out the best way to solve open-ended problems with the tools and theories available to them."

Marika Santagata, associate professor, agrees that the lab has improved the experience students have in her Geotechnical Engineering I class. In the course, students explore fundamental topics such as the consolidation and shear behavior of soils making use of state-of-the-art, computer-controlled 1D compression, direct shear and traxial stations. They are also exposed to numerical methods, both the finite difference and the finite element method.

"These are advanced topics typically not included in an undergraduate geotechnical curriculum," Santagata says.

She says the i2i space allows faculty to alternate different types of laboratory sessions throughout the semester from hands-on experiments to numerical analyses and problem-solving sessions.

Recently Santagata's students studied the problem of packing granular materials. From a geotechnical perspective this problem is critical in a variety of contexts, for example in determining the resistance to earthquake-induced liquefaction of sand deposits. Soil liquefaction is another advanced topic that the Geotechnical Engineering I students learn about in the Lyles i2i Lab. The way granular materials pack is of interest in many other applications outside of geotechnical engineering.

"We want to stimulate students' thinking on this topic," she says, "and to push them to adapt their knowledge to different situations."

The space allows students to work in teams to explore solutions to civil engineering challenges. This has been especially rewarding, says McKeon, who will graduate in May.

"The biggest asset the Lyles i2i Lab offers is in its collaborative design," he says. "The movable tables and chairs allow students to form group work stations and tackle labs as a team rather than as individuals. This directly impacts our future jobs by preparing us to work together within company hierarchies."

Undergraduates can use large-scale testing equipment and a digital image correlation system in the Lyles i2i Lab. Classroom laptops can be used to develop numerical models, which can be compared with the results from more conventional testing equipment.

TACKLING GLOBAL CHALLENGES

Abigail Moyer, a 2006 civil engineering graduate, has traveled the world overseeing megaprojects for ExxonMobil. She shares her thoughts on her career path and how Purdue Civil Engineering prepared her for a global career.

What led you to pursue an engineering degree at Purdue?

My dad had a degree in industrial technology and my mom is a registered nurse, one grandfather was an engineer and the other, a physician, so math and science run in the family.

I attended a Women in Science and Technology conference in high school, where I learned that I could combine my interest in math and science with whatever I liked doing and have a career as an engineer. Not long after that, my dad and I attended a Women in Engineering Day at Purdue and the rest is history.

What is your role at ExxonMobil?

I work for ExxonMobil's Development Company – so our role within the broader corporate organization is to develop our mega projects, often costing many billions of dollars. Early on, during my time with ExxonMobil, I worked on the Papua New Guinea Liquefied Natural Gas project. We are building two pipelines, a gas conditioning plant, an air field (to counter balance our logistics challenges), and a two-train liquefaction plant (essentially this processing facility super-cools the natural gas we get out of the ground into a liquid, so that we can transport it by ship). And we were doing this in a country where we had done little work before and which had little established infrastructure — no small feat. I also worked on a deepwater project in West Africa and while we have worked for a long time in West Africa, we still faced challenges. There is very little that is routine when it comes to safely drilling wells and installing equipment under 1000m of water.

One thing that is different about our projects — and a lot of people don't necessarily realize this — is that from exploration to concept design to design to construction and then finally start-up may take decades. I've concentrated much of my career in the middle part of that cycle, coming in once the concept is selected and working through the challenges of actually starting to execute the project.

Since coming to ExxonMobil, I've had five assignments: three engineering roles, a technical lead role and now a supervisor role.

What is your current role?

Most recently, I moved into a supervisor position where I am responsible for an entire portfolio of projects. I have a team of approximately 30 engineers, leads and managers, located in eight countries throughout the Middle East and in the Asia-Pacific, all working various cost, schedule, planning, or project controls positions. I'm responsible for the organizational aspects of what we do — working to get the right people in the right assignments at the right time to support our business. I spend a lot of my time on career development and process improvements. My role also allows me to be connected to the technical/analytical aspects and use my engineering skills, yet perform in the company leadership world where I can leverage the problem-solving skill set I developed as an engineer. It's quite fun to be in a position like that.

What has been the biggest lesson you have learned in working in the industry?

Not long into my first lead role after making the transition from an individual contributor to a leadership position, I quickly realized that you can't engineer people. Everyone brings his or her own experiences to the table and vast differences can exist in team dynamics. You can still apply systematic thinking to solving the problems, but how you apply the solution takes practice.

■ **DELLA PACHECO**

(Photo by Jaclyn Boutwell)

STUDENTS EXPLORE REAL-WORLD PROJECTS

Study abroad expands classroom learning

Twenty-six Purdue students traveled to Australia this past May for a two-week study abroad experience to explore the culture and work environment in the land down under. This course, led by Associate Professor Satish Ukkusuri, was geared toward the analysis of civil engineering and global issues linked to the sustainability of facilities and infrastructure being developed and built in Australia.

Topics included global impact, project management, transportation and infrastructure issues, labor relations, and safety standards. With the generous support of Bechtel Corp. and Fugro Australia, students were able to experience hands-on civil engineering at job sites in Gladstone, Sydney and Perth.

Site visits included liquified natural gas (LNG) projects with Bechtel on Curtis Island outside of Gladstone. Students were given the rare opportunity of living on the island at the work camp for three days. Experiencing life as a local worker, students visited three separate LNG sites and viewed the various stages of plant development. Work on the island provided an opportunity for students to explore methods of transporting goods and workers to and from a remote work site, procurement of goods and construction issues in a foreign country.

The course also took students across Australia to the western town of Perth to explore several of the Fugro geospatial and geotechnical projects. Topics there included global impact, project management, transportation and infrastructure issues, labor relations and safety standards.

"Studying abroad in Australia opened my eyes to the global aspect of engineering and the different people involved in the industry. Not only was it the best experience of my life, but it has given me leadership qualities and confidence as I move out of the classroom and into industry."

— Ellesse Lunde, senior (third from left)

UPCOMING STUDY ABROAD OPPORTUNITIES

New Zealand (May 21 – June 1, 2014)

Ayhan Irfanoglu, associate professor of civil engineering, will show the devastating effects of earthquakes from 2010 and 2011 in Christchurch, New Zealand. Students will gain insight into designing, retrofitting and construction in seismically active areas and the impact of earthquakes on communities. Students also will see the rebuilding efforts and hear lectures by faculty from the University of Canterbury. They will view damage including geotechnical aspects (failing cliffs) and social consequences (abandoned communities). Cultural activities and excursions are also included.

UK (May 12-25, 2014)

The goal of this study abroad opportunity led by Darcy Bullock, professor of civil engineering and director of the Joint Transportation Research Program, is to blend experience-based learning about 18th and 19th civil engineering infrastructure (canals, locks, lift bridges) with field visits to modern 21st century civil engineering systems under construction or recently brought online. Students will also explore London Bridge, Churchill's Bunker and modern transportation projects in London. From there, they will stay on a narrow boat barge and navigate through the English countryside. Students will operate locks, lift bridges and navigate across viaducts and tunnels, while visiting historical sites.

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