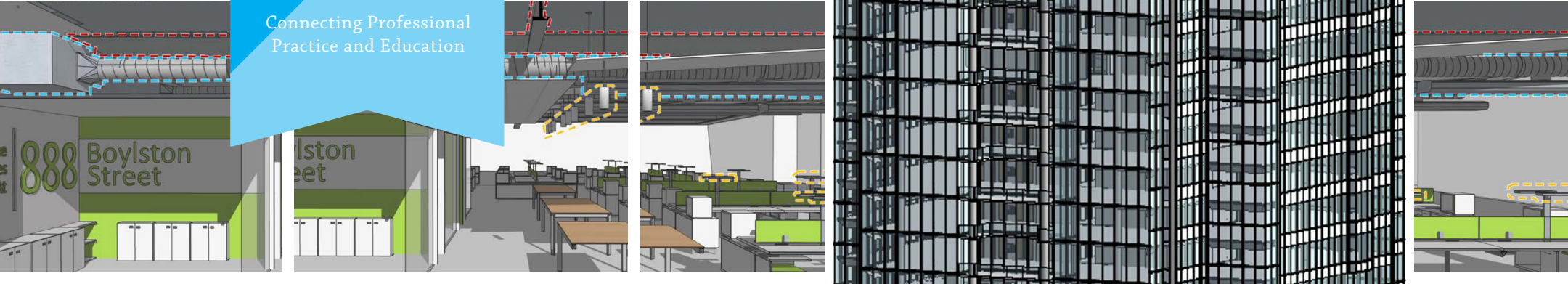
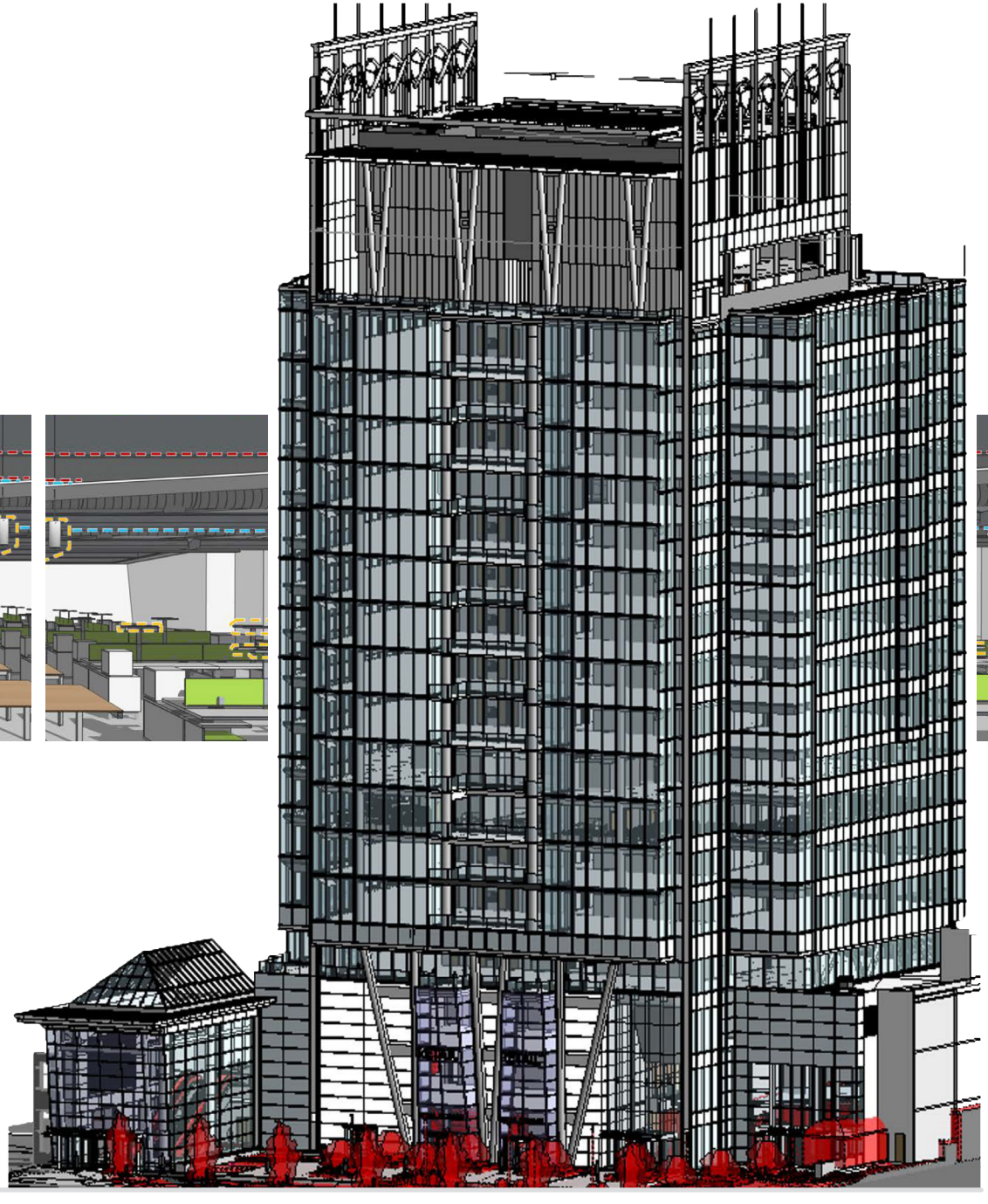
NCEES
advancing licensure for engineers and surveyors

2016 NCEES Engineering Award

Connecting Professional Practice and Education



Engage. Enrich. Inspire.



2016 NCEES Engineering Award

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Piston Assembly Simulation
Innovative Solutions Discovered through a Multidisciplinary Effort
PROJECT DESCRIPTION
APPLIED LEARNING VALUE FOR STUDENTS
RELATING PROJECT TO SIX SIGMA PRINCIPLES
ANALYZE
DESIGN
CHANGING THE WORLD
THERMAL ENERGY REDUCTION

President's **Message**

The NCEES Engineering Award was launched in 2009 to recognize engineering programs bringing students and professional engineers together to work on collaborative projects. Advancing licensure for engineers is a top priority for NCEES, and bringing these two groups together ensures success for everyone. The projects give students the opportunity to take lessons outside of the classroom and apply them to real-world issues in order to increase students' knowledge of engineering principles, and the professional engineers benefit from watching the capabilities and enthusiasm of the students.

Engineering reaches all parts of our lives. These projects show students how working with licensed professional engineers safeguards public health, safety, and welfare. Students not only work with professional engineers but also collaborate with their peers, faculty, other engineering disciplines, and other professions to enrich their experience. These award-winning projects can serve as models for other engineering programs to develop collaborative projects and opportunities for students.

We at NCEES thank the students, faculty, and practitioners who participated in this year's projects. We appreciate and applaud their efforts to connect professional practice and education and to inspire the next generation of professional engineers. We give special thanks to the jury members for giving their time and expertise to support this initiative.

NCEES has published this book to recognize the 2016 winners, and we hope these projects will encourage other engineering programs to develop collaborations with the professional engineering community and continue to engage, enrich, and inspire.

D Turner

Daniel S. Turner, Ph.D., P.E., P.L.S.
2016–17 NCEES President

About the **Award**

The NCEES Engineering Award was established to promote understanding of the value of licensure and to encourage collaboration between the engineering profession and education.

Academic programs accredited by the Engineering Accreditation Commission of ABET were invited to submit projects that demonstrate a meaningful partnership between professional practice and education. The competition was open to programs from all engineering disciplines.

Projects did not have to offer academic credit, but they were required to meet other eligibility requirements. The projects had to be in progress or completed by March 14, 2016. If a project had been entered in a previous award cycle, the engineering program was required to explain how the project had been further developed since the previous submission.

The 2016 NCEES Engineering Award jury met in Clemson, South Carolina, on June 7, 2016, to conduct a blind judging of the 21 entries. Each submission consisted of a display board, abstract, and project description. These materials were sent electronically for the jury to review prior to the judging and were also available at the judging.

The jury considered the following criteria in its deliberations:

- Successful collaboration of faculty, students, and licensed professional engineers
- Protection of public health, safety, and/or welfare
- Multidiscipline and/or allied profession participation
- Knowledge or skills gained
- Effectiveness of display board, abstract, and project description

The jury selected the University of Nebraska–Lincoln Charles W. Durham School of Architectural Engineering and Construction to receive the $25,000 grand prize. The jury chose five additional winners to each receive $7,500 awards.

2016 NCEES Engineering Award Jury

Jury members from each of the four NCEES geographical zones were chosen to represent state licensing boards, academia, and professional engineering societies.

Michelle Roddenberry, Ph.D., P.E., Jury Chair
Florida Board of Professional Engineers

Christopher Duhamel, P.E.
Rhode Island State Board of Registration for Professional Engineers

Kevin Skibiski, P.E., P.L.S.
Missouri Board for Architects, Professional Engineers, Professional Land Surveyors, and Landscape Architects

David Whitman, Ph.D., P.E.
Wyoming Board of Professional Engineers and Professional Land Surveyors

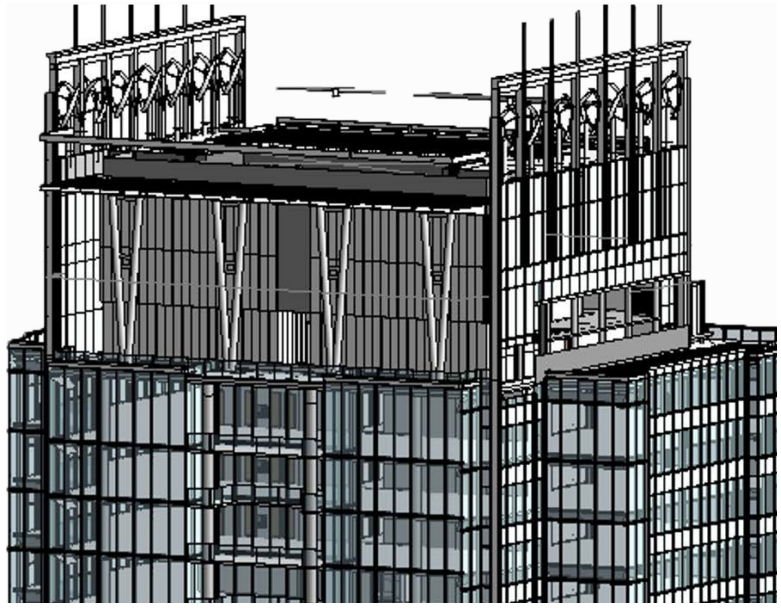
Ethan Brue, Ph.D., P.E.
Dean, Dordt College Engineering Program

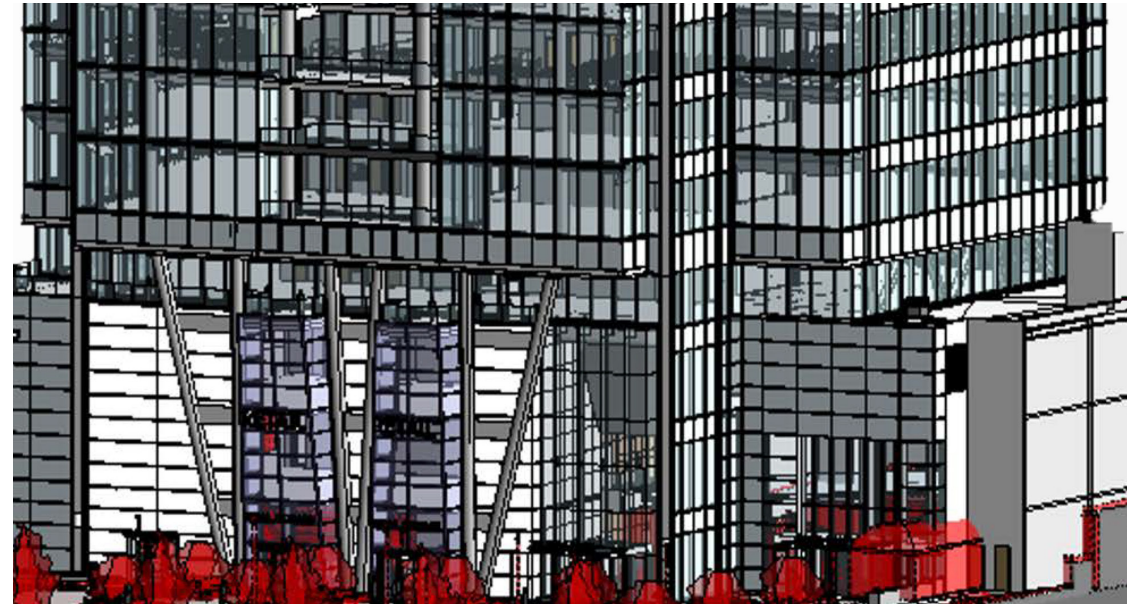
Steven Schreiner, Ph.D., P.E.
Dean, The College of New Jersey School of Engineering

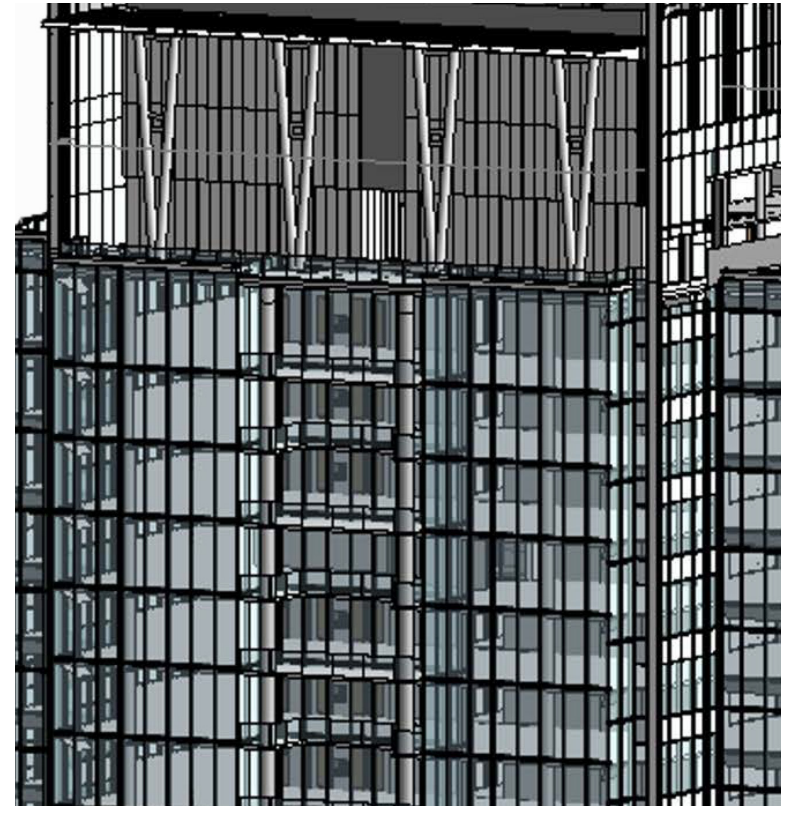
Ronald Welch, Ph.D., P.E., COL (Retired)
Dean, The Citadel School of Engineering

Robert Green, P.E., F.NSPE
National Society of Professional Engineers

Michael Smith, D.Eng.
DiscoverE Diversity Council





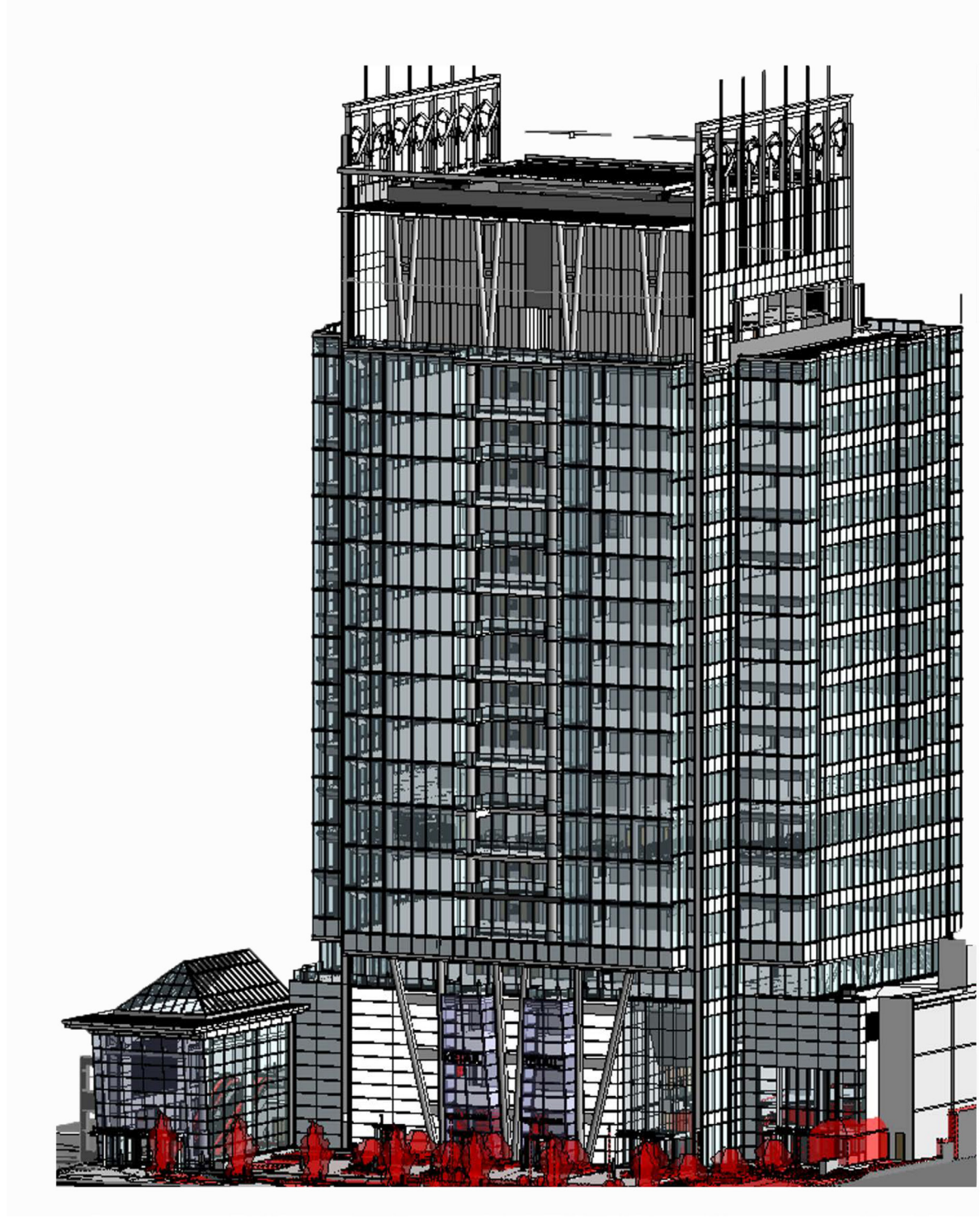


2016 NCEES
Engineering Award
$25,000 Grand Prize Winner

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction

888 Boylston Street–Interdisciplinary Team Design



$25,000 Grand Prize

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction

888 Boylston Street–Interdisciplinary Team Design

Participants

Students

Brianna Brass
Derek Brooks
Jim Butler
Josh Christensen
Sean Christensen
Jacob Clatanoff
Clet Dewispelare
Kate Fickle
Katie Gilg
Mark Hanigan
Kristin Hanna
Garrett Johnson
Mary Kleinsasser
Adam Mackenzie
Ben Mackenzie
Rob McClenahan
Rachel Obenland
Jacob Pulfer
Nathan Ritta
Geoffrey Wright

Faculty

Stuart Bernstein, Ph.D.
Ece Erdogmus, Ph.D., P.E.
Terence Foster, Ph.D., P.E., F.NSPE
Gary Krause, Ph.D., P.E.
Jay Puckett, Ph.D., P.E., F.ASCE
Clarence Waters, Ph.D., P.E., F.AEI

Professional Engineers and Engineer Interns

Ryan Adrian, P.E.
Doug Alvine, P.E.
Dustin Brand, P.E.
Linsey Rohe Brown, E.I.
Adam Brumbaugh, E.I.
Becky Cherney, P.E.
Shane Cherney, P.E.
Kim Cowman, P.E.
Ryan Curtis, P.E.
Todd Feldman, P.E.
Andy Gilliam, E.I.
Steph Guy, P.E.
Brian Hadfield, P.E.
Dan Hahn, S.E.
Joe Hazel, P.E.
Brendan Headley, E.I.
Brian Hoagland, S.E.
Brian Isley, P.E.
Tyler Jensen, E.I.
Drew Johnson, P.E.
Eric Kamin, P.E.
Kyle Kauzlarich, E.I.
Brian Kolm, P.E.
Todd Mack, P.E.
John Mascarello, P.E.
Jake McConnell, S.E.
Nancy Melby, S.E.
Ken Morgan, P.E.
Doug Nelsen, P.E.
Beth Redding, P.E.
Andrew Reinke, E.I.
Andrea Reynolds, P.E.
Brandon Rich, P.E.
Sara Robbins, E.I.
Tony Staub, P.E.
Adam Steinbach, E.I.
Wyatt Suddarth, E.I.
Tom Thibodeau, P.E.
Kevin Vander Kolk, P.E.
Aaron Wascher, P.E.
Kyle Weber, E.I.
Kevin Wenninghoff, S.E.
Andy Wilson, P.E.
Josh Wilson, E.I.
James Wingert, S.E.
Rich Woodson, P.E.
Steve Yanke, P.E.
Andy Yosten, P.E.
Jacob Zach, E.I.

Mentors

Gary Cooper
Bill Deroin, A.I.A.
Bernie Gehrki, A.I.A.
Kelly Hiskey
Scott Pfeiffer
Katie Ramsbottom, A.I.A.
Todd Shackelford
James Stauch
Leslie Suhr
Kris Tourek
Chris Turner, A.I.A.
Brant Yantzer

Jury Comments

"The jury appreciated the complexity and multidisciplinary aspects of the project."

"This project's breadth of interaction with practicing professional engineers was impressive."

"The project was innovative and showcased student, faculty, and professional engineer collaboration very well."

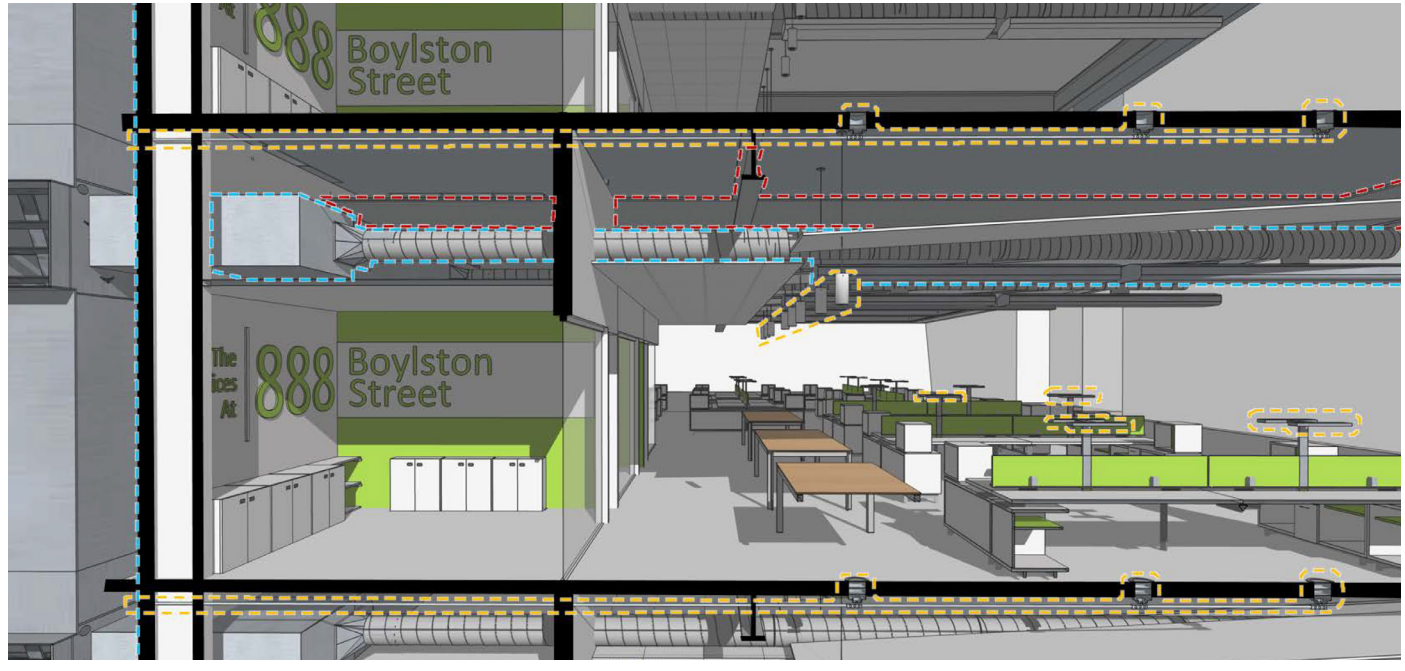
Abstract

Three separate multidisciplinary teams of six or seven graduate students each were challenged to design a proposed 17-story mixed-use high-rise building located in Boston, Massachusetts. The structure will have 14 stories of offices above three levels of retail and two levels of sub-grade parking. The teams were to meet guidelines, which include energy efficiency 50 percent better than ASHRAE 90.1 energy use baseline, structural design for resiliency against hurricane wind speeds with a 100-year mean recurrence interval (MRI), the ability to provide 48 hours of runtime for critical office tenants in the case of a power outage, and synthesis and safety for the surrounding environment and people. In an effort to further improve building performance, students adopted several design practices defined in ASHRAE 189.1 (Design of High Performance Buildings), resulting in a LEED Platinum building.

The students, preparing to be electrical, structural, mechanical, lighting, and acoustical engineers, worked to create their own interdisciplinary team designs for the complex structure. The primary objective was the development and integration of innovative and original design solutions with a multidisciplinary approach. Further objectives were robust collaboration with over 50 industry professionals that mentored and evaluated the work and the opportunity to gain real-world technical skills, experience, and knowledge through this collaborative project. These criteria, along with specific goals of the company, led to designs that demonstrate sustainability, resilience to environmental threats, safety, and synthesis with the surrounding built environment.

In order to ensure public safety, the structural teams designed the lateral system to withstand the 100-year MRI for hurricane wind speeds. The mechanical and electrical teams coordinated to develop the fire protection systems. The electrical teams also designed emergency systems to provide safety and standby power. Public health and welfare was partially addressed by designing for occupant health, productivity, and comfort through indoor air quality control, noise and vibration control, and daylighting. Additionally, the design must connect to the adjacent shopping mall and convention center, and the structure must be designed for a 60-ft long cantilever over the I-90 Massachusetts turnpike without traffic interruptions during construction.

Over the course of two semesters, more than 50 licensed professional engineers and architects from industry, licensed professors from the university, and other allied professionals mentored the students in the myriad aspects of the project. These volunteers were matched with student teams to review progress and direct students' understanding of the design process and to serve as mentors aiding in practical design and system selection. These professionals met with students on a weekly basis outside of class time. Industry mentors were also tasked to review the building design, narratives, construction documents, and oral presentations of their assigned team. Of the 20 students involved with the project, 13 have taken and passed the Fundamentals of Engineering (FE) exam. The remaining seven have planned to take it by this summer. Further, each will be completing an EAC/ABET-accredited degree, will work under licensed engineers, and plan to pursue licensure for themselves.



$25,000 Grand Prize

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction
888 Boylston Street–Interdisciplinary Team Design

Perspectives On

Protection of public health, safety, and welfare

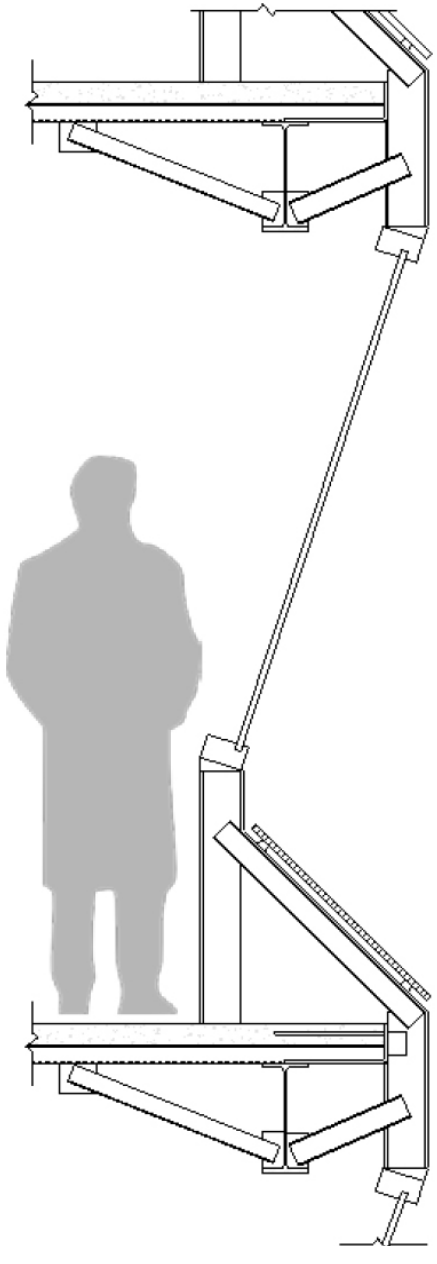
The design of 888 Boylston protects the health, safety, and welfare of the public through code compliance, emergency system design, hurricane-resistant structural design, and indoor air quality for the mechanical system design.

For public safety, each structural design team met the 100-year MRI wind speed for lateral system design. A hurricane impact-resistant curtainwall system was also researched and specified. Safety was a primary concern throughout the design of all structural components, including the I-90 braced-frame cantilever truss and column transfer girders.

A specialized development, which will serve to enhance aesthetics while providing multiple aspects of protection, were the concrete planters on the plaza. Students designed these to act as bollards to prevent vehicles from driving or accidentally entering pedestrian areas. Not only do the concrete planters protect pedestrian safety, they also increase the blast standoff distance from the building for any vehicle-transported bomb threats.

Public safety is also achieved through the electrical and mechanical system designs. The mechanical designs provide fire protection with automatic sprinklers, fire pumps, smoke control, and pressurization of spaces per IBC 2009 and NFPA requirements. The electrical emergency systems protect lives by providing lighting during emergency and provide legally required standby power. Designs also include security systems, fire alarms, overcurrent protection, and lightning protection for the building.

Public health and welfare was further addressed by designing for occupant health, productivity, and comfort through mechanical, acoustical, daylighting, and structural floor vibration design. Indoor air quality standards were met for the mechanical system design with proper ventilation and exhaust movement, filter selection,



and humidity control in order to support occupant health and prevent proliferation of airborne pathogens. Daylighting in the office spaces also promotes occupant well-being, while decreasing energy use, which in turn decreases the negative health effects due to energy production. Designs minimize occupant distractions and increase well-being through acoustics and structural vibration control. The office and retail levels meet AISC Design Guide 11 vibration limits for the office and retail areas. Additionally, many design decisions were made to reflect the elegant downtown ambience for building tenants and the community.

Knowledge and skills gained

The student participants gained real-world skills as a result of this collaborative effort. First, using an actual building design project provided an opportunity to consider synthesis and integration outside of theoretical parameters. It gave the students the opportunity not only to form their own interdisciplinary approach but also to witness and learn from people who have made their life's work on this very basis. By having industry mentors, the students became better prepared to enter the profession with a clear understanding of the skills an engineer must develop and possess.

Further, professionals gave feedback at periodic phase presentations, which challenged the students to accept criticism, learn from it, and continue to fine-tune their projects for a wholly realistic design. Finally, this close relationship illuminated the different opportunities and specializations available to pursue as a career and created potential connections for future employment or collaboration when the students have transitioned into professional engineers. The significant guidance and evaluation of over 50 experienced professionals raised the bar by having the expectation of real, workable solutions to inherent problems in design. The value of professional input was made clear from day one, which made students take this investment in their work very seriously.

Multidiscipline or allied profession participation

For this engineering capstone project, three student design teams consisting of six or seven mechanical, structural, and electrical option students each, had support and constructive feedback from professional engineers, professional architects, an acoustical consultant, and faculty advisors in architectural engineering. Each team was given a full set of professionals: an architect, several engineers (structural, mechanical, and electrical), and an acoustical consultant. There were 23 non-faculty mentors in all—16 P.E.s or S.E.s, one E.I., five professional architects, and an acoustical consultant.

Additionally, the design teams sought insight from construction contractors, estimators, deep foundation specialists, and construction engineering faculty to discuss construction sequencing, equipment clearances, methods, and cost. Professional engineering mentors shared their experiences and insights on technical design, detailing, and interdisciplinary coordination.

After each design milestone, teams prepared a presentation and narrative showcasing the progress of the entire building design within each discipline. Another set of professionals participated as evaluators providing feedback on presentation and document submissions. This group included 31 P.E.s, S.E.s, E.I.s, and three others, for a total of 34. They graded the presentations and narratives according to competition rubric. Follow-up questions and comments were then discussed with the professionals. This allowed students the opportunity to defend and improve their design. The presentation and discussion process was similar to one that would be found in a professional setting.

$25,000 Grand Prize

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction
888 Boylston Street–Interdisciplinary Team Design

Points of View

Clarence Waters, Ph.D., P.E.
Faculty advisor

What value does a real-world project bring to the students?

In addition to allowing students to understand the constraints and requirements of the project stakeholders, working on a real-world project also gives the students the opportunity to work alongside potential future employers and colleagues. These experiences help the students by giving them the valuable resources of both on-the-job training and networking.

How do you decide which projects to work on?

Currently, Nebraska Architectural Engineering (AE) Team Design AE 8030-8040 participates in the Architectural Engineering Institute (AEI) student competition. This project is used every year for the course. The project requires the design and integration of mechanical, electrical, and structural systems together and into the building. The project varies from year to year, including everything from a high-rise building in San Francisco to a vertical farm in Milwaukee, providing new challenges and opportunities for industry involvement. The AEI is the most highly regarded student competition in AE education and is continuing to raise the bar.

How did this project prepare students for professional practice?

The majority of Nebraska AE alumni will be designing and specifying the mechanical, electrical, and structural systems for buildings and working on teams of engineers in their careers. Nebraska AE Team Design gives the students these experiences with the mentorship and evaluation from professionals. In working with these industry professionals, the students are also able to learn some tricks and tips of their trade before entering the workforce, which makes them competitive candidates for future employment. It is excellent preparation for professional practice.

What was the biggest challenge on this project?

For me, as the course instructor, the biggest challenge is the recruitment and coordination of the over 50 industry professionals that mentor and evaluate the students. The students' major challenges were designing and specifying the mechanical, electrical, and structural systems for a very significant structure and presenting their work to the professionals that they may work with in the near future. Structurally, a corner of Level 2 of 888 Boylston cantilevers over the Massachusetts turnpike underground tunnel nearly 50 feet. This required the students to design a cantilever truss that would support the many floors above.

What advice do you have for other programs wanting to add similar collaborative projects to their curriculum?

Industry relations are critical to the Durham School of Architectural Engineering and Construction, yet mutually beneficial to all stakeholders. Our industry partners mentor and evaluate our students, in addition to partnering on research opportunities. In return, we provide them with an excellent pool of interns and graduates, as well as research to transform and enhance their business practices. I highly encourage all engineering programs to develop these strong, mutually beneficial relationships.

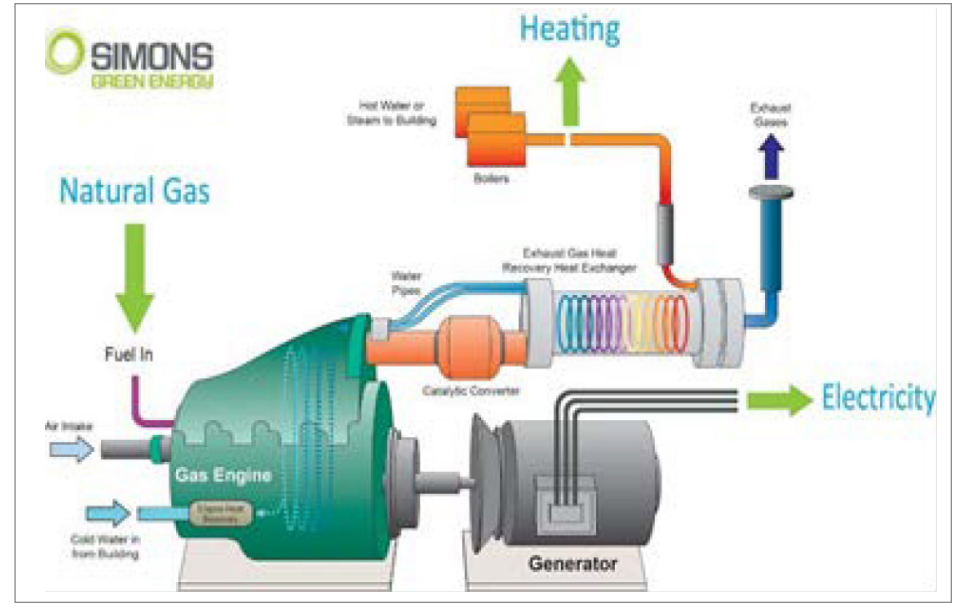
How does the University of Nebraska–Lincoln plan to use its $25,000 prize?

Nebraska AE is very fortunate to be located in Omaha, Nebraska, which is home to a very large and supportive design industry (maybe the highest density of design professionals anywhere). In the AE 8030-8040 Interdisciplinary Team Design Project (our two-semester capstone sequence), we divide the students into teams that include all of the AE options of mechanical/acoustics, electrical/lighting, and structures. Each of these teams are given a full set of professional mentors. At a minimum, there is an electrical, mechanical, and structural engineer, as well as an architect. We have additional engineers and architects that evaluate the student's design presentations and documents. There were over 50 professionals helping with this year's project. We are currently using local engineers and architects to serve as mentors and evaluators, but we have had many companies around the country (including Dallas, Minneapolis, Denver, Detroit, Chicago, and Kansas City) inquire about participating. The $25,000 award from NCEES will be used to improve the access and quality of our communication technologies, allowing us to connect with mentors and evaluators remotely. This will allow the Durham School of Architectural Engineering and Construction to expand our base of mentors and evaluators, giving our students the highly valuable skills, tools, and experiences of working with remote professionals, which are very common in today's building design environment. We are considering having our local mentors and evaluators use distance technologies so that all of the students have this experience.

Nathan Ritta
Student

What did you like best about participating in this project?

With a project of this scale, specialization was a must for all student team members. While the entire design process was incredibly collaborative from start to finish, each team had to efficiently allocate tasks between members. As a result, I was able to focus on the things I was most passionate about throughout the entire project, while I also learned to rely on the work of my teammates to carry the project forward. The project presented many complex design problems much bigger than one individual or design discipline could hope to solve alone, and we were constantly required to work together to determine the most effective design solutions. I enjoyed feeling like the expert in the group on certain topics, but I also enjoyed having to come together as a team to collaboratively work through the most important design challenges.



What did you learn?

Prior to this project, I was unsure of how specialized I wanted to try to become within my future career in architectural engineering. I knew I had a passion for lighting design, but I also enjoyed power systems design. Working on this project gave me opportunities to flex multiple design muscles, which gave me valuable experience working on all aspects of building electrical systems design. I discovered that, while I do love lighting, I don't want to limit my career opportunities to just those that offer me lighting design experience. Through this project, I learned that there is immense value in becoming as well-rounded as possible in my knowledge of building electrical systems. As a result, I hope to pursue career opportunities that will not limit me to one facet of design but will allow me to expand my knowledge in all areas of building electrical systems.

How did the participation of professional engineers improve the experience?

We (students) would have had no idea where to even begin on this project without the constant input and guidance of the many professional engineers involved. These professionals gave us suggested workflows, helped us to break down and prioritize complex problems, and offered constructive feedback through virtually every step of the design process.

$25,000 Grand Prize

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction
888 Boylston Street–Interdisciplinary Team Design

Points of View

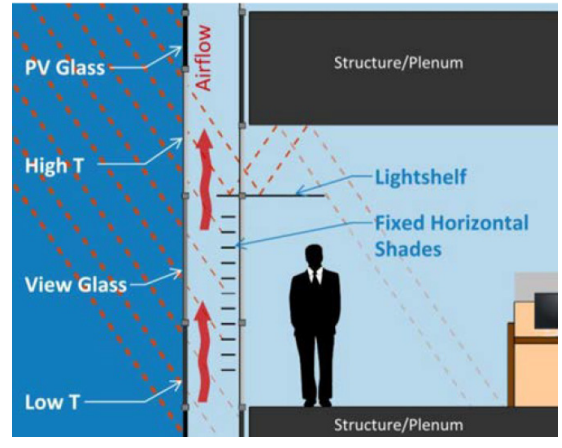
What do you think the engineers learned from working with students on this project?

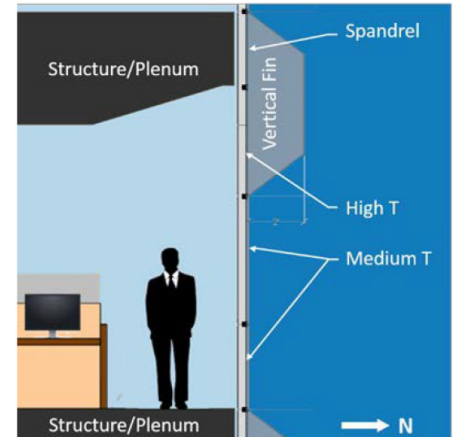
The UNL architectural engineering program is heavily dependent on feedback and guidance from industry professionals, many of whom served as mentors on this design project. Through working with students on this project, these professionals were granted an intimate look at the inner workings of our program, enabling them to identify both strengths and weaknesses of UNL architectural engineering. This knowledge will be invaluable as they continue to advise our AE program in the years to come.

Aaron Wascher, P.E.
Mentor—mechanical engineer

Why did you get involved with the University of Nebraska–Lincoln's project?

I am an architectural engineering graduate from Kansas State University. Our profession relies heavily on real-world applications of the knowledge obtained in college. By participating with a project like this, it gives the students experience on how to apply what they've learned in multiple classes to a single project.





How did you assist the students in the 888 Boylston Street Interdisciplinary–Team Design project?

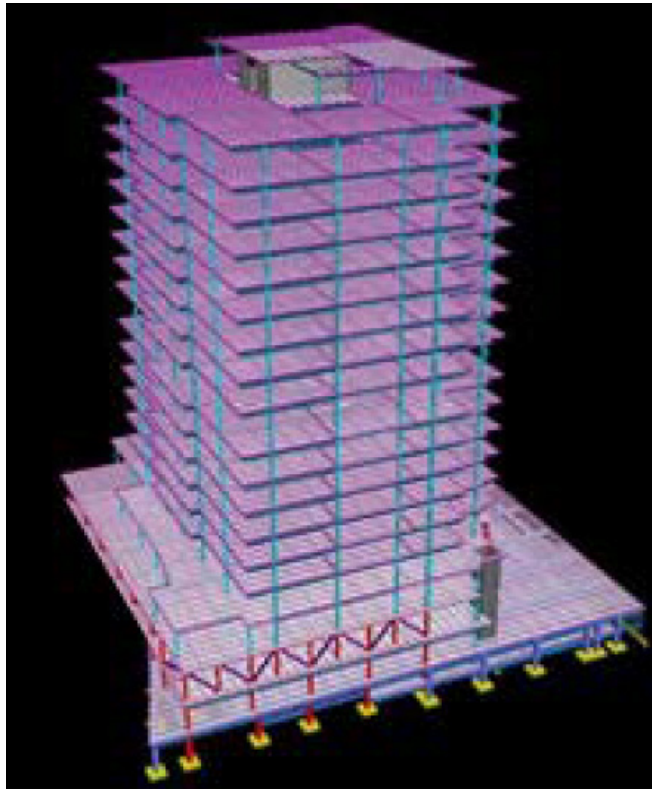
The professionals working with the students guided them through the process of designing a building. We showed the processes involved with making owner's requirements, code requirements, and building system requirements work together to create a building.

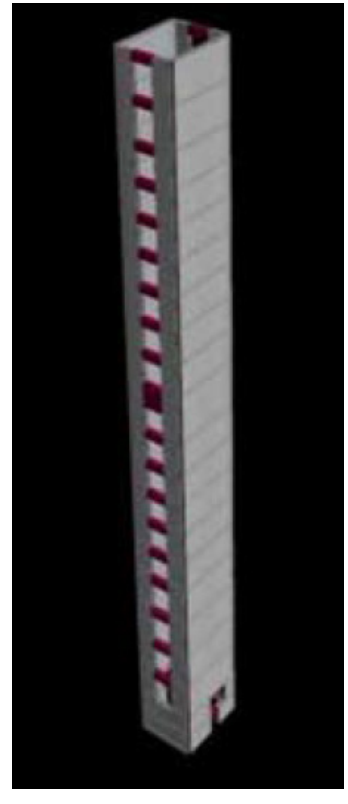
What did you learn from working with the students?

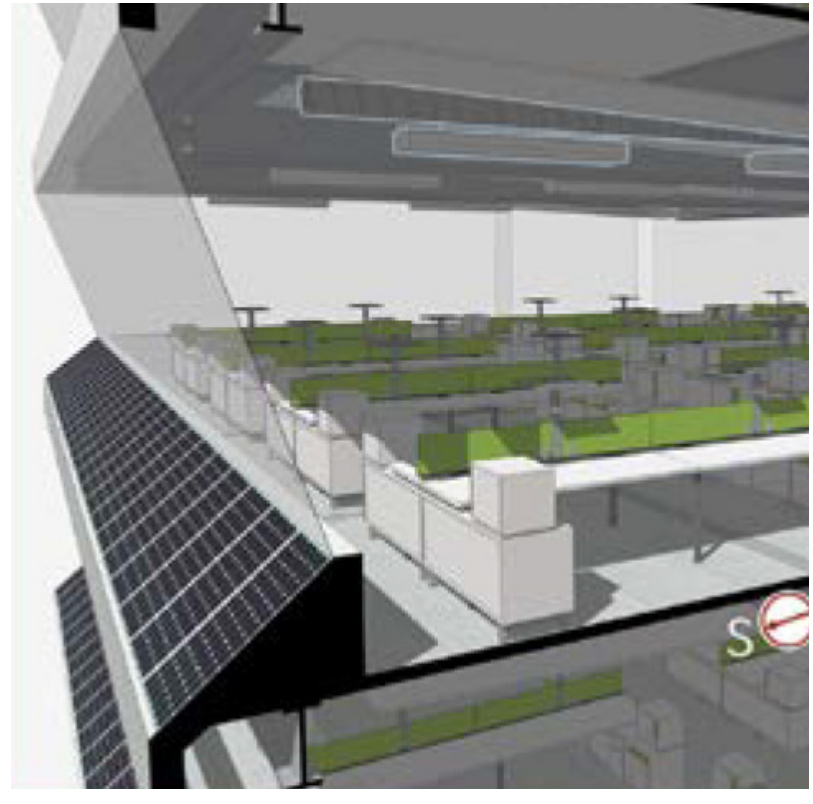
I learned about many new systems and products that are available for buildings. They found cutting-edge designs and decided if they could be applied to the building type. I learned how the next generation is approaching working together by using smart phone apps to coordinate project tasks.

What did you want students to take away from working with professional practitioners?

I wanted the students to learn that collaboration with all disciplines will improve the quality of their projects. Building systems are very complex, and being able to work with others and see the situation from another point of view will ultimately produce the best possible project for the owner.



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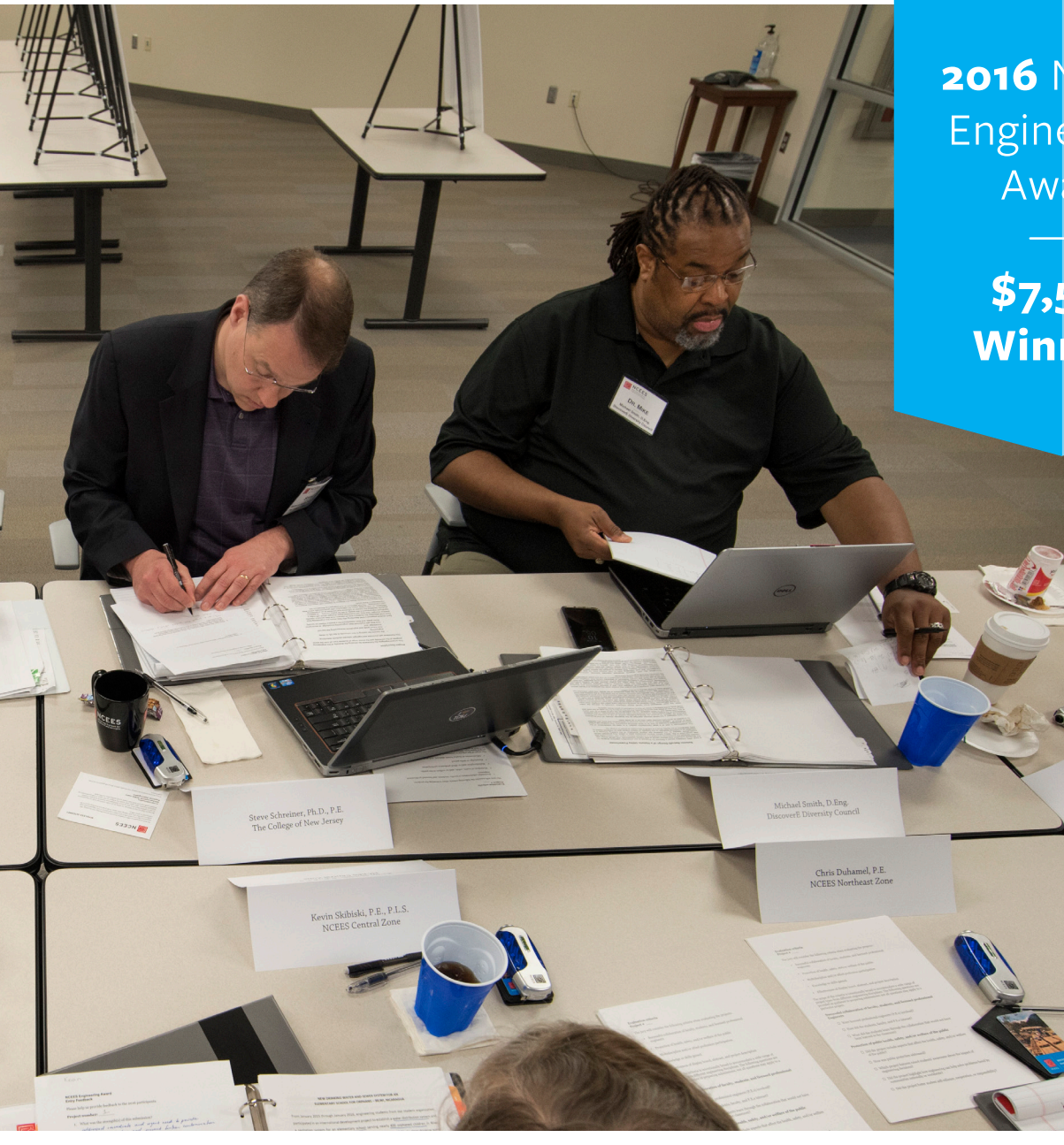
Ron Welch, Ph.D., P.E., COL (Retired)
The Citadel
Ethan Brue, Ph.D., P.E.
Dordt College
NCEES
Robert Green, P.E., F.NSPE
NSPE



2016 NCEES Engineering Award

$7,500 Winners

George Mason University

Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering

New Drinking Water and Sewer System for an Elementary School for Orphans—Bilwi, Nicaragua

George Mason University

Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering

Water and Sanitation Project—Children's Feeding Center—Puerto Cabezas, Nicaragua

Seattle University

Department of Civil and Environmental Engineering

Design Development of a Cultural Village for Migrant Workers

Seattle University

Department of Civil and Environmental Engineering

Design of Habitat-Sensitive Erosion Hazard Mitigation Near a Bridge

Seattle University

Department of Electrical and Computer Engineering

Solar Microgrid in Rural Zambia with Real-Time Cloud-Based Monitoring

$7,500
Award
Winner

George Mason University

Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering

New Drinking Water and Sewer System for an Elementary School for Orphans—Bilwi, Nicaragua

Participants

Students

Lauren Alger
Liz Anderson
Jennifer Arias
Abigail Armuth
Rony Avalos
Dan Bentley
Oscar Espinoza
Kumar Karra
Scott Leary
Laura Meadows
Badana Mohamadi
June Park
Vaij Raja
Roberth Vallejo
Zoe Waide
Whitney Woodcock
Anne Zheng

Faculty

Anthony Battistini, Ph.D.
Liza Durant, Ph.D.

Professional Engineers and Engineer Interns

Matthew Doyle, P.E.
Maria Angel Londono, E.I.T.
Mike Morningstar, P.E.
Basil Mouneimne, E.I.T.
Ali Nemati, E.I.T.
Sean O'Bannon, P.E.
Mike Rumsford, P.E.
Kenex Sevilla, E.I.T.
Michael Shular, E.I.T.
Chris Triolo, P.E.

Additional Participants

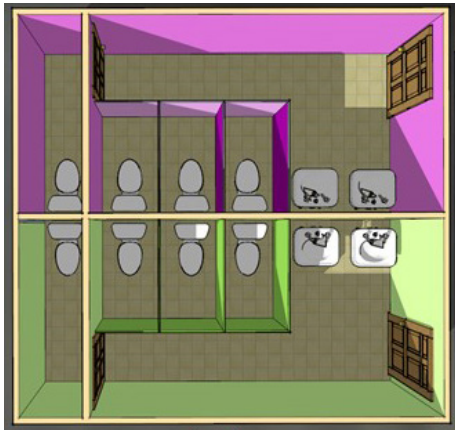
Kristin Amaya
Amy Mackintosh
Craig Rice

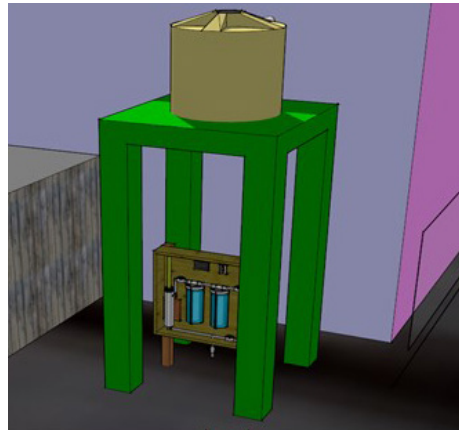
Jury Comments

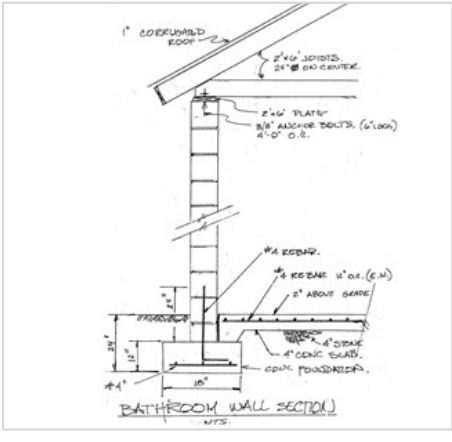
"This project could be implemented in other places and potentially could have a positive impact on hundreds of people."

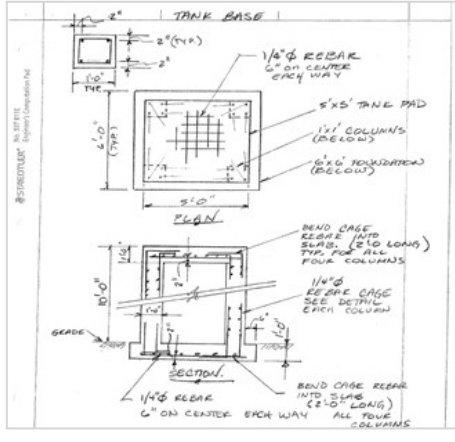
"The collaboration across multidisciplines addressed the basic health needs of a community."

"The project plan was well developed and focused on a true public health and safety issue."









Abstract

The lack of potable drinking sources poses the number one priority in global risk based on the impact to society, as announced by the World Economic Forum in January 2015. Regrettably, many less-privileged rural communities are unable to afford adequate sustainable systems to address this complication, negatively impacting the welfare of hundreds of communities worldwide. Our student-directed organization is associated with our university and aims to fundraise, design, and develop stable and innovative engineering systems to alleviate such critical issues revolving around the safety and health of other humans and the natural environment. This document summarizes the contributions and activities of approximately 40 engineering students of multidisciplinary backgrounds, university faculty members, multiple licensed professional engineers, several technical advisors, and various members and leaders of the local community to establish a sustainable water disinfection, water distribution, and septic system at a school of more than 400 orphaned children. Consequently, a project of this magnitude demanded practices of various technical fields, such as surveying, water resources engineering, geotechnical engineering, structural engineering, mechanical and control systems engineering, and electrical engineering.

Findings from an initial assessment trip to the community in January 2015 reported that (a) the current single well being used for the school was a shallow, exposed hole which posed serious health and safety concerns for the community, (b) the water in use contained numerous contaminants and harmful bacteria and viruses, (c) the community did not have a reliable method of storage and distributing water, and (d) the school's septic tank and bathrooms had failed to provide adequate sanitation. In response to each of the documented problems, the project team proposed (a) the construction of a concrete lid for the well in use to improve the safety of the school children and prevent future contamination, (b) the installation of a chlorine and ultraviolet ray disinfection system, (c) the construction of a sustainable storage and distribution system for the disinfected water, and (d) the drawings and calculations for a new bathroom and septic system. Throughout the course of the project, we, with the collaboration of licensed faculty members and practicing professional engineers, employed a myriad of solutions through significant planning, engineering, constructing, analyzing logistics, and fundraising to propose a new system, which resolves the various risks stemming from the unsafe source of water. With the support of the organization members, the university, and various professionals in multidisciplinary technical industries, the project came to a successful completion in January 2016 with an implementation trip spanning over seven days with over 700 man-hours. The efforts of the team resulted in fulfillment of the school's critical needs and provided opportunities for the engineering students to collaborate with professionals and gain technical field experience.

$7,500
Award
Winner

George Mason University

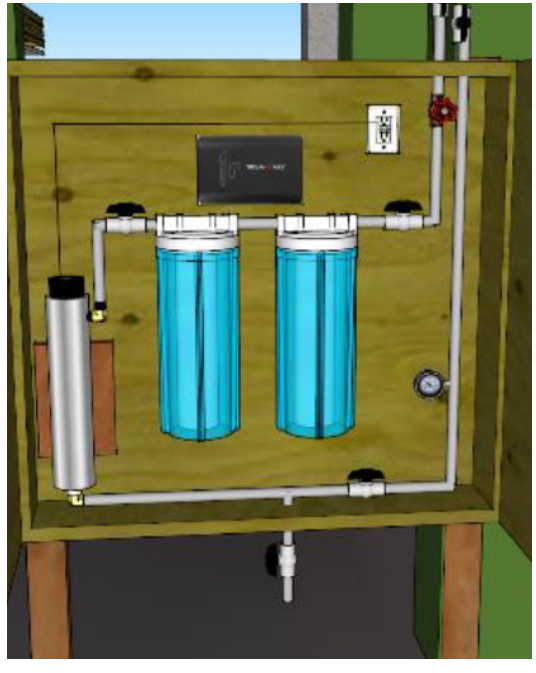
Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering
New Drinking Water and Sewer System for an Elementary School for Orphans—Bilwi, Nicaragua

Perspectives On

Collaboration of faculty, students, and licensed professional engineers

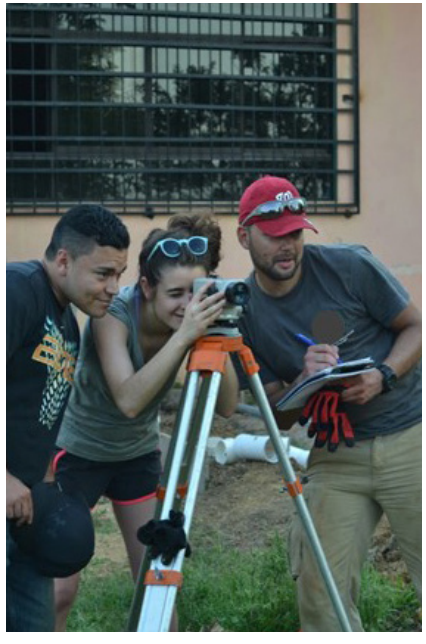
Since the first assessment trip in 2015, as many as 40 students and multiple licensed professional engineers and faculty have contributed to this project. Our organization has been under the guidance of a practicing licensed professional in civil engineering since the establishment of the organization in 2010. The students hold weekly project meetings that typically include the attendance of the professional engineers (P.E.s) or engineers in training (E.I.T.s).

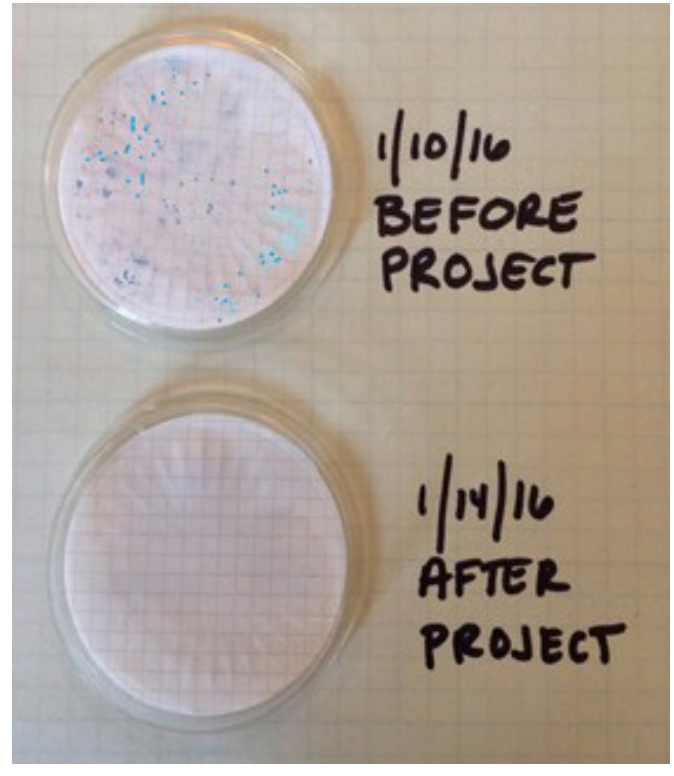
Our members conducted extensive research with professional engineers during the assessment trip to further enhance their design for the school. The data consisted of GPS coordinates, water quality tests, soil properties from sample excavation sites, knowledge of local construction practices, associated safety measures, and community survey analysis to understand daily water consumption. Based on the data collected, students and faculty designed the system for future development and water demand growth. As part of the research and planning process, professional engineers, faculty, and students exhaustively simulated the system and began testing to avoid delays in the field. With forward thinking by the engineers, the project at the elementary school for orphans was completed within seven days.



Knowledge and skills gained

The knowledge gained through this incredible experience ranges from field experience in engineering to cultural learning for everyone involved. The students improved their understanding of surveying while working alongside professional engineers who taught them beyond





a classroom curriculum. The students also gained knowledge in water resources engineering by understanding the fundamental importance of having the correct design for both water treatment and septic systems.

The significance of relations with the community positively impacted the students and facilitated the understanding that although a perfect design may be constructed, if it does not meet the community's needs, it is a worthless effort. There was no better feeling than when members of the community thanked our team for their hard work in taking the time to improve their quality of life. The lessons these students learned from this project and the Bilwi community is something they will carry with them and appreciate for a long time to come; in doing so, they will continue to realize that, as engineers, they have a responsibility to society to never overlook a community's declining public welfare.

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George Mason University

Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering

Water and Sanitation Project—Children's Feeding Center—Puerto Cabezas, Nicaragua

Participants

Students

Lauren Alger
Liz Anderson
Jennifer Arias
Abigail Armuth
Rony Avalos
Dan Bentley
Oscar Espinoza
Kumar Karra
Scott Leary
Laura Meadows
Badana Mohamadi
June Park
Vaij Raja
Roberth Vallejo
Zoe Waide
Whitney Woodcock
Anne Zheng

Faculty

Anthony Battistini, Ph.D.
Liza Durant, Ph.D.

Professional Engineers and Engineer Interns

Matthew Doyle, P.E.
Maria Angel Londono, E.I.T.
Mike Morningstar, P.E.
Basil Mouneimne, E.I.T.
Ali Nemati, E.I.T.
Sean O'Bannon, P.E.
Mike Rumsford, P.E.
Kenex Sevilla, E.I.T.
Michael Shular, E.I.T.
Chris Triolo, P.E.

Additional Participants

Kristin Amaya
Amy Mackintosh
Craig Rice

Jury Comments

"The project provided a significant improvement in public health, safety, and welfare."

"The skills and knowledge gained by the students was evident, as was the public welfare impact of this project on the community."

"The first step to good health is clean water. This project is bringing better health through clean water."

Water and Sanitation Project — Children's Feeding Center — Puerto Cabezas, Nicaragua

Abstract

The Puerto Cabezas Feeding Center, located along the northeastern shore of Nicaragua, is a nonprofit facility whose primary mission is to provide one nutritious meal per weekday to nearly 700 impoverished children in the community. The feeding center provides for these hungry children, as many parents of the region have various physical and economical restraints making them unable to afford sufficient meals for their families. Unfortunately, the water systems that were in use at the premises were found to be extremely inefficient and to have critical health risks due to a non-operational water and wastewater system. The lack of these systems resulted in large delays during meal preparation and poor wastewater management. The members of the feeding center, already overwhelmed with the dependence of many children for their only source of food, did not have the financial capacity to rehabilitate the established systems to their full potential, which as a result, negatively impacts hundreds of local members of the community.

This report discusses the details of the findings, collaboration, lessons, and results of the assessment and implementation of two systems designed and constructed by a team of engineering students, practicing professional engineers, and university faculty. The project sought to improve the lives of these approximately 700 children and countless adults by increasing efficiency in water distribution and decreasing the risks associated with consumption of bacteria ridden water. The project encompassed various multidisciplinary aspects of engineering, such as structural analysis, electrical engineering, mechanical engineering, and hydraulics, as well as humanitarian factors such as health, safety, and welfare of the public.

An initial field assessment in late 2014 revealed that the feeding center had abandoned its distribution system due to inadequate water pressure and was collecting the needed water directly from an open hole in the ground. During implementation, a new water distribution system was constructed to address this issue in the kitchen and garden and at various hand-washing stations. The assessment also exposed a collapsed septic tank that resulted in improper disposal of sewage. In response, the team installed a new septic system to allow biological treatment and storage of sludge from the generated waste. The contribution of 40 engineering students of various concentrations and 10 technical advisors and practicing professional engineers made it possible for a large improvement in the protection of public health, safety, and welfare. Furthermore, working as part of the larger project team created a collaborative experience for students and industry leaders alike. The group was pleased to work with local community leaders and facility managers during the construction of the water distribution and wastewater management system, which came to a rewarding finish in 2015.

$7,500
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George Mason University

Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering
Water and Sanitation Project—Children's Feeding Center—Puerto Cabezas, Nicaragua

Perspectives On

Collaboration of faculty, students, and licensed professional engineers

Professional civil engineers and professional electrical engineers were involved during the entire project. They mentored the students on how to think through the challenges faced when working abroad. Some of the areas that needed to be focused on were substitution of materials and alternative ways to design when obstructions occur in the field.

Since the students working on the design ranged from freshman to seniors, a primary focus for the faculty and professional engineers was to mentor the students so each could begin discerning which field of engineering he or she is most interested in pursuing. Faculty are able to help the students better their understanding of the engineering curriculum and to demonstrate the importance of learned concepts and equations in real-world projects. Having the students work with professional engineers enables them to take their academic knowledge and be able to express and format their work in a professional manner. The collaboration of a professional engineer and student demonstrates how they were able to mentor the organization's students throughout the entire project.

Students were separated into various teams, each representing a necessary task within the project: water distribution, structural, wastewater, and electrical systems. The students coordinated with faculty and professional engineers to conduct biweekly meetings. These meetings updated everyone on the status of the project and created a forum to discuss problems and reach proactive solutions.

In the field, students learned how to construct a water distribution system in a hands-on environment with the collaboration of P.E.s. By allowing students to physically construct these components, they are able to identify potential problems before they occur, which will only improve their work as a designer. An engineer's work is only good if constructed properly.

Additionally, students learned the importance of providing a design that is formatted to the needs of the client, the Puerto Cabezas community. With the experience from the professional engineers, students were able to open their minds to not just designing a functional water distribution system as you would for a class assignment, but also to learning to manage all aspects

of the project. For instance, all materials within the system needed to be readily accessible, cheap, and durable so the community can fix the system if any problems arise in the future.

Knowledge and skills gained

To successfully execute this project, students' communication skills were monitored by faculty and professionals. This taught the students to respond in a courteous and professional nature as it would be done in a professional setting. Throughout the design process of the feeding center, our students were continuously improving their presentation skills as memorandums and updates were provided to the organizational member and the university leadership teams. Members of the board, professional engineers, and faculty who are able to attend asked questions as if they were the students' future employer. The emphasis on communication refines the students' skills and prepares them for when they enter the professional world. Every student involved was able to better his or her engineering skills and knowledge by having small group learning sessions with professional engineers. In this manner, they were able to expand their level of thinking and ask questions that were more focused on the engineering practice outside the classroom setting. The process of design was new to many students, and they learned the difference of including feasibility, cost, and clients' needs.

$7,500
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Winner

Seattle University

Department of Civil and Environmental Engineering

Design Development of a Cultural Village for Migrant Workers

Participants

Students

Mia Bernadino, E.I.T.
Robert Long, E.I.T.
Kelsey Rau
Svyatoslav Rubashka, E.I.T.
Jordan Sewell, E.I.T.
Demetria Swendseid
Hillary Tervet, E.I.T.
Evan Yamamoto

Faculty

Nathan Canney, Ph.D., P.E.
Nirmala Gnanapragasam, Ph.D., P.E.

Professional Engineers

Jeff Dye, P.E.
Eric Kelley, P.E., S.E.
Haritha Venna, P.E.
Michael Chamberlain, P.E., S.E.

Additional Participants

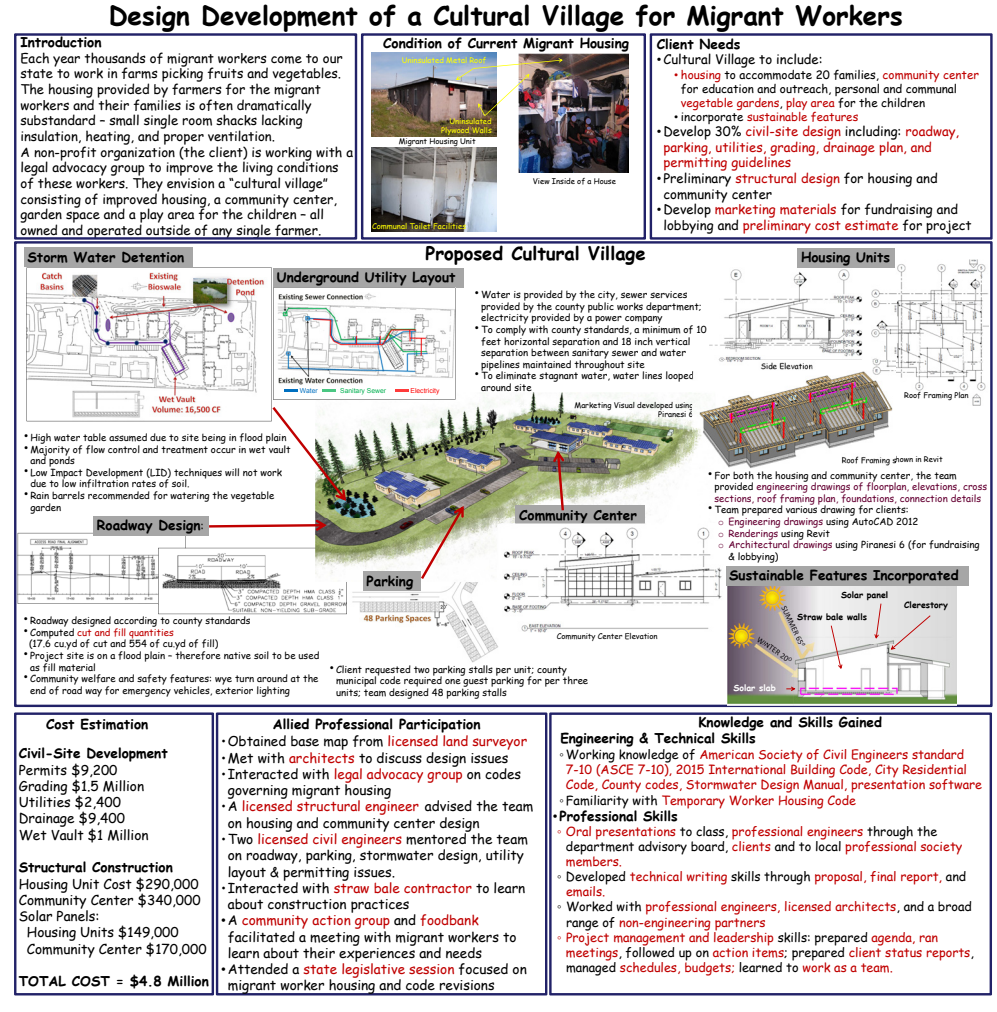
Aaron Allen
Cole Bitzenburg
Gloria Burton
James Coan, P.L.S.
Sara Layrer
Jose Ortiz
Bill Singer

Jury Comments

"The project addressed a critical need for a migrant class of workers—health and safety."

"These types of projects help focus our nation's leaders to require necessary improvements in how we treat our workers."

"This team tackled an important social issue and did it well."



Abstract

Every year, farmers around the U.S. hire hundreds of thousands of migrant workers to manually harvest seasonal fruits and vegetables. In many cases, farmers provide temporary housing for these workers during the picking season. Often times, these houses are stark, offering inhumane living conditions and adversely affecting the safety, health, and welfare of the migrant workers and their families. A local nonprofit organization (NPO) is attempting to provide a new model for migrant worker housing in our region that is independent of the farmers. The NPO hopes to seek funds from state legislature and private foundations to enact this new vision. Working with the NPO, our goal was to develop the engineering design of a "cultural village" that provides housing, a community center, gardens, and a play area for the migrant workers and their families.

Our engineering students are required to complete a team-based, year-long, senior capstone project prior to graduation. In this project, a team of eight students worked under the supervision of three licensed engineers from a local company that served as the project sponsor, and a faculty advisor, also licensed. The eight-person team was subdivided into two teams—one was responsible for the civil-site design and the other for the structural design of the main buildings on site. In fall quarter, the team submitted a written proposal to the NPO outlining the project scope and approach, deliverables, and schedule. In spring, the work culminated in a final report describing the design methods, engineering drawings, calculations, and recommendations.

The cultural village consists of housing for 20 families: five structures containing two units each. Each unit has four bedrooms to support two families with shared living rooms, bathrooms, and a kitchen. At the center of the cultural village is a community center that consists of a flexible space for community events, laundry, public kitchen, health clinic, and bathrooms. In order to reduce operation costs for the migrant families, the structural team incorporated sustainable features into the buildings, including solar panels, straw bale walls, and passive solar techniques such as clerestories, roof overhangs, and solar slabs for heating. The civil-site team designed the site layout, including roadway alignment and parking stalls per applicable codes, storm water detention ponds, and a wet vault. The team researched required development permits and prepared utility plans for water, sewer, and power. Because of the broad range of stakeholders, the final design package comprised of AutoCAD engineering drawings, three dimensional renderings using Revit, and architectural visuals using Piranesi 6.

Each team member served as the project manager for part of the year, running meetings, setting agendas, assigning tasks, and following up on action items. The team interacted with two architects, a straw bale contractor, and a legal advocacy group; volunteered in a food bank serving migrant workers; and attended a state legislative session about migrant worker housing. The project strengthened the team's ability to work together, to communicate effectively with engineering and non-engineering audiences, and to hone professional and leadership skills.

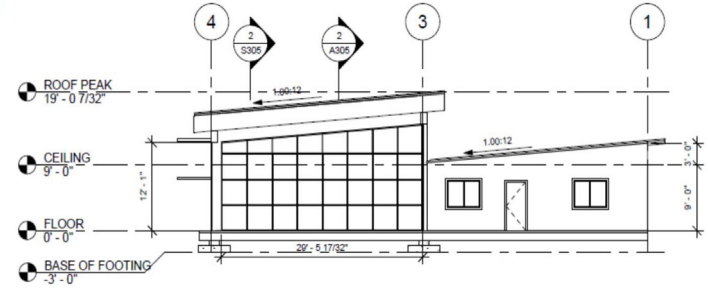
The NPO and the students mutually benefitted from the project. The NPO used the deliverables for lobbying and fundraising. If successful, it plans to implement this model across the state. The students became aware of their social and ethical responsibility towards a marginalized community critical to the American economy.

$7,500 Award Winner

Seattle University

Department of Civil and Environmental Engineering

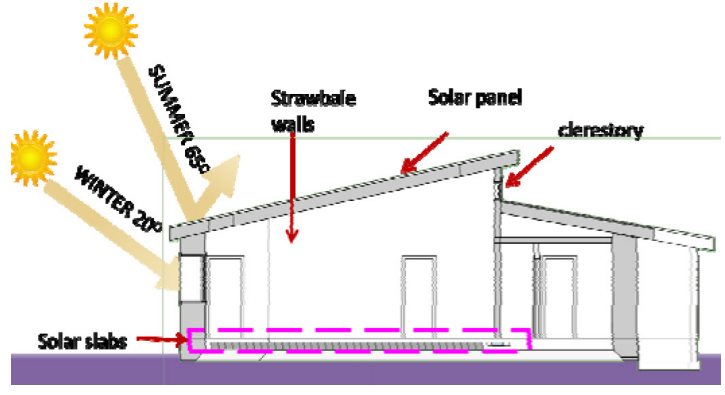
Design Development of a Cultural Village for Migrant Workers



Perspectives On

Multidiscipline or allied profession participation

The team worked with a multitude of allied professionals on this project. The summer prior to the beginning of the academic year, a licensed land surveyor who teaches surveying at a local institution surveyed the property as a student project. They provided the topographic map of the site for the engineering student team to work on. Two architects, one of them licensed, met with the team to discuss the architectural issues and help the team with cost estimates. The team worked with a legal advocacy group to learn the details and deficiencies of the code governing migrant housing. A local community action group and a food bank facilitated the students to work in the field picking produce and at the food bank for a few days in the summer prior to the school year and again in the fall. These experiences helped the team to recognize the struggles of migrant workers and gave them an opportunity to work in a food bank serving the migrants and to hear their concerns of the farmer-provided housing. The team contacted a straw-bale contractor to learn their construction practices. The team attended a legislative session in the state capital where migrant worker housing issues were discussed. This was an enlightening experience for the students to see how legislature plays a role in the implementation of policies and about the complexity of these types of issues due to the myriad of stakeholders involved.



Protection of public health, safety, and welfare

Migrant farm workers are the backbone of the U.S. agricultural economy; however, the wellbeing of this population is largely overlooked and the community stigmatized by political rhetoric. On the other hand, migrant workers continue to come to the U.S. every year because they believe, despite the hardships they endure, that the U.S. provides a better opportunity that is unavailable in their own country. This project helped the team to be aware of migrant worker issues and how an engineer's skills could be put to good use in improving the lives of this community. The migrant worker's health, safety, and welfare were the foci throughout the project.

$7,500 Award Winner

Seattle University

Department of Civil and Environmental Engineering

Design of Habitat-Sensitive Erosion Hazard Mitigation Near a Bridge

Participants

Students

Kaitlyn Hammond
Calika Kaley
Mark Lovrin
Nicole Nagao
John Polka
Ross Starkey
Matthew Thomas
Valerie Wu
Brian Yee

Faculty

J. Wesley Lauer, Ph.D., P.E.
Nirmala Gnanapragasam, Ph.D., P.E.

Professional Engineers

Mary Lear, P.E.
Clint Loper, P.E.
Mark Ruebel, P.E.

Additional Participants

Lica Dulan
Phyllis Meyers
Richelle Rose

Jury Comments

"The project helped to stabilize an ongoing erosion problem and improve the habitat for fish and game."

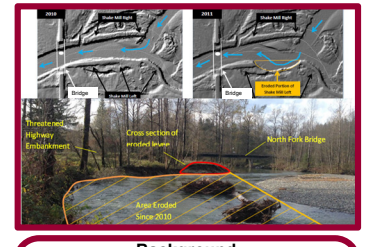
"Dealing with the effects of stream migration is incredibly important to the sustainability of our infrastructure."

"The students learned important lessons not normally covered in the classroom from the licensed engineers and county liaisons."

Design of Habitat-Sensitive Erosion Hazard Mitigation near a Bridge

Introduction

Large floods in 2011 caused bank erosion to threaten a bridge in a rural part of our county. Designing a solution to this problem that addressed erosion hazards, ecological needs, and community safety was the focus of a multi-year student project. Work involved two civil engineering senior capstone teams, two non-engineering students (biology and environmental studies), regular supervision by three engineers and several ecologists and planners at the county, input from engineers and drafters at a local consulting firm with experience in the regional river management, and a faculty advisor.

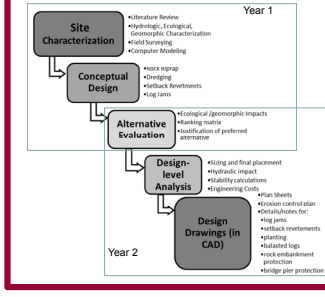


Background

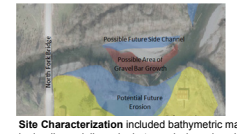
Erosion in 2010/2011 led to scour on the north abutment of the bridge. Further erosion of the bend would likely lead to change in flow direction through the bridge, potentially causing damaging scour near the bridge piers and could threaten the entire roadway embankment along the south bridge approach. Long-term sustainability and ecological impact are heavily-weighted considerations for the county flood management division and were emphasized on this project.

Scope of Work and Deliverables

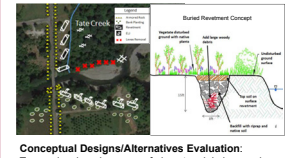
- Written Proposals (submitted in Dec '13 and Dec '14)
- Final Design Reports (submitted in June '14 and June '15). Year 1 and 2 tasks and deliverables were:



Key Elements of Project



Site Characterization included bathymetric mapping, hydraulic modeling, air photo analysis and ecological assessment. Flood and erosion hazards were used to map overall risk to infrastructure.

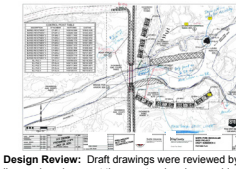


Conceptual Designs/Alternatives Evaluation: Teams developed a range of plans to minimize erosion using setback revetments, engineered log jams, rock embankment protection, and excavation, and evaluated with respect to effectiveness, cost, and ecological appropriateness.

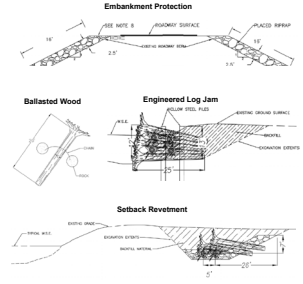
Engineered Log Jam

Calculation	Result Value	Units	Design Use	Equation	Source	Calc. Reference
Tower	11.4	ft		Leopold & Maddock (1953)	USDA (1991)	J01
Drag Force (Horizontal)	49.7	kips	File Handling		Large Wood Manual	J02
Passive Force (Horizontal)	275	kips	File Handling		Foundation Engineering	J03
Active Soil Pressure (Horizontal)	35	kips	File Handling		Foundation Engineering	J04

Design-level Analysis: Teams worked with county engineering liaisons to identify design standards and perform stability calculations. The chart illustrates some computations performed on a single project element.



Design Review: Draft drawings were reviewed by three licensed engineers at the county who also provided training on review protocol.



Drawings: Both teams developed CAD drawings. In year 1, these focused on conceptual design. In year 2, drawings were taken to a typical 30% design level that can be used for initial review by regulatory agencies.

Major Design Challenges

- Developing hydraulic model for simulating velocities and shear stresses for use in design
- Designing for ecological appropriateness, which emphasized allowing for geomorphic change and required input from non-engineering team members.
- Developing system for evaluating the wide range of conceptual alternatives. This required the input from county planners and ecologists.
- Evaluating continued change that occurred at the site between year 1 and year 2.
- Identifying design standards for the relatively new low-impact technologies employed on the project.

Student Skills Developed

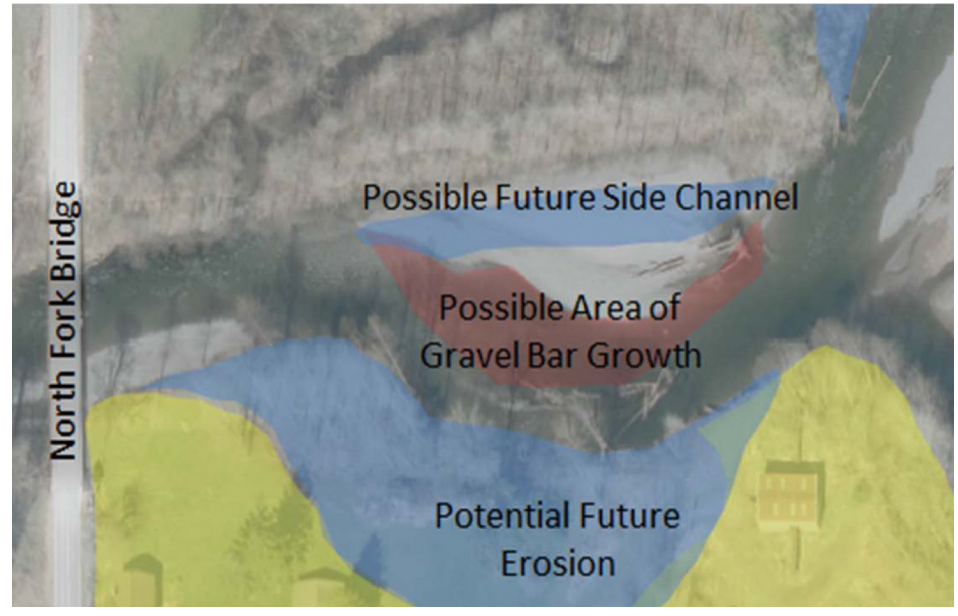
- **Technical skills**
  - Developing working knowledge of HEC-RAS, design manuals, AutoCAD, and GIS.
- **Communication skills**
  - Oral presentation and technical writing skills, developing client interaction
- **Project management and leadership skills**
  - Learning team dynamics, duties and responsibilities of a Project Manager; Setting up and running team meetings, preparing meeting agenda, following up with action items, keeping track of schedules, value of file organization and project archiving.
- **Collaboration with allied professions**
  - Ability to incorporate multidisciplinary criteria regarding ecology, transportation, hazard management in decision making

Abstract

Our university regularly supports teams of three to five students on year-long capstone design projects. Recently, we supported two teams of civil engineering students who worked in collaboration with a local county flood management division to design erosion mitigation for a bridge. In addition to a host of traditional engineering analyses related to river hydraulics, slope stability, erosion protection, grading, and cost, the project required detailed assessment of geomorphic and ecological conditions. This would not have been possible in a single year, so the project was organized in two phases. The first occurred during the 2013–14 academic year and focused on background analysis and conceptual design. The second occurred during 2014–15 and focused on detailed design analysis and design drawings. Continuity between project phases was maintained by a) working with the same team of engineers and scientists at the county both years, b) having a single faculty advisor supervise the project for its duration, and c) including a single biology/environmental studies student as a biological consultant during both years.

The project was motived by progressive erosion of a river bend that threatened an important bridge in a rural part of the county. The site is located in a natural area, much of which is designated county parkland. Simply rebuilding the failing banks and lining with rock riprap was not a preferred alternative due to potentially significant impact on habitat and ongoing maintenance costs. Maintaining habitat quality for resident populations of trout and for terrestrial mammals such as elk was a priority for the county. The county was also interested in developing projects for which acquisition of environmental permits would be straightforward.

The project required regular (i.e., at least monthly) interaction between multiple departments at the county, as well as input from a consulting firm with experience in the area. Several members of the sponsoring team are licensed as professional engineers, and others have advanced training in ecology and environmental planning. Because of the rather specialized nature of the work, students from both teams (as well as non-engineering students) attended regional and national conferences on river restoration or water management where they interacted with professional engineers and restoration scientists. The team developing the design drawings regularly met with design engineers and drafters at county and at the consulting firm that had studied the reach.



The main tasks performed in 2013–14 included background analyses related to hydrology, geomorphology, habitat, and hazards; hydraulic modeling; and conceptual design. The design alternatives included traditional rock riprap based bank protection, construction of engineered log structures to divert flow away from the eroding bank, and buried rock/log structures that would be set back from the existing bank but that would stop erosion once it progressed into these structures. The 2014–15 team performed additional hydraulic modeling necessary for developing design velocities and depths and detailed development of the preferred alternative, which included buried rock/log structures, construction of an engineered log structure in the channel, and rock armoring of the roadway embankment. Calculations were performed to assess performance of these project elements in range of failure modes. Design drawings were produced in AutoCAD representing project plan, cross-section, and profile; project details; and a full temporary erosion and sediment control plan for use during project construction.

$7,500
Award
Winner

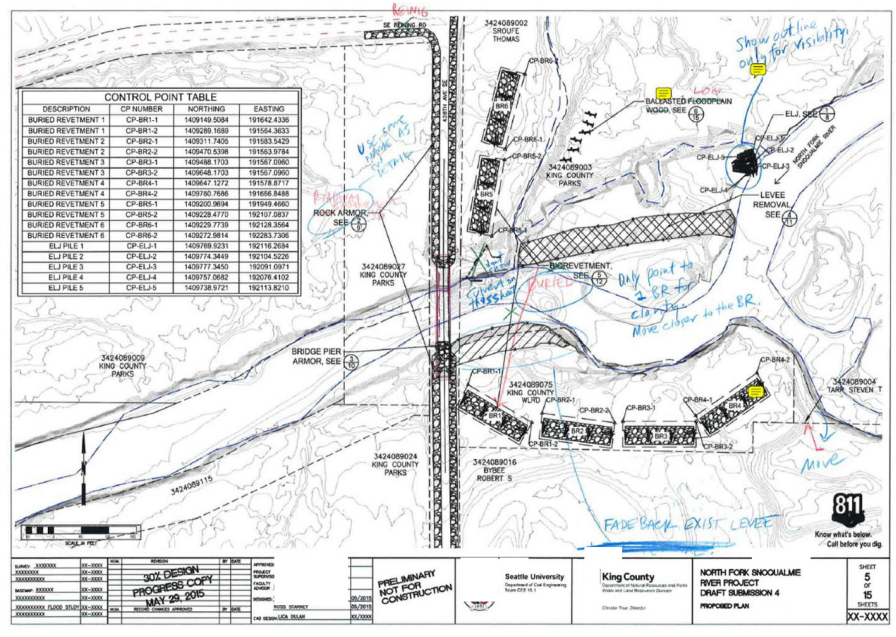
Seattle University

Department of Civil and Environmental Engineering
Design of Habitat-Sensitive Erosion Hazard Mitigation Near a Bridge

Perspectives On

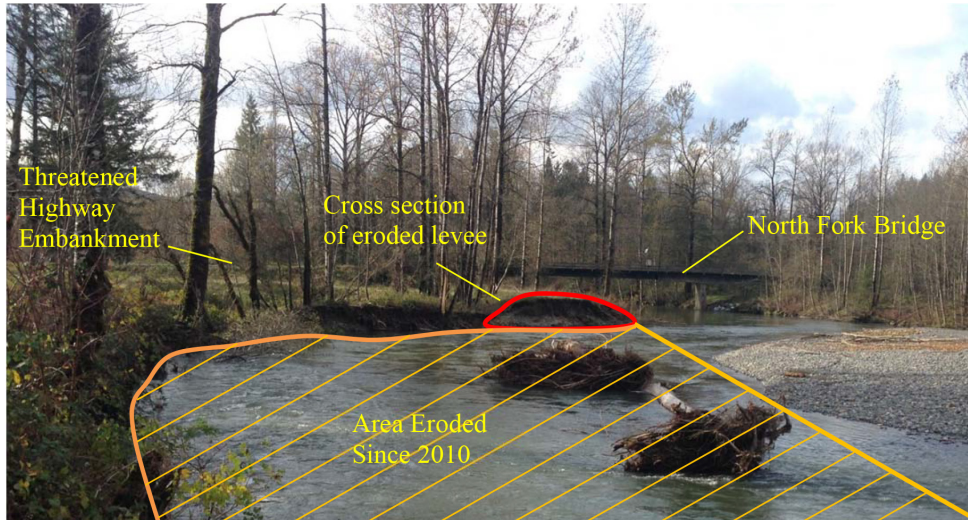
Collaboration of faculty, students, and licensed professional engineers

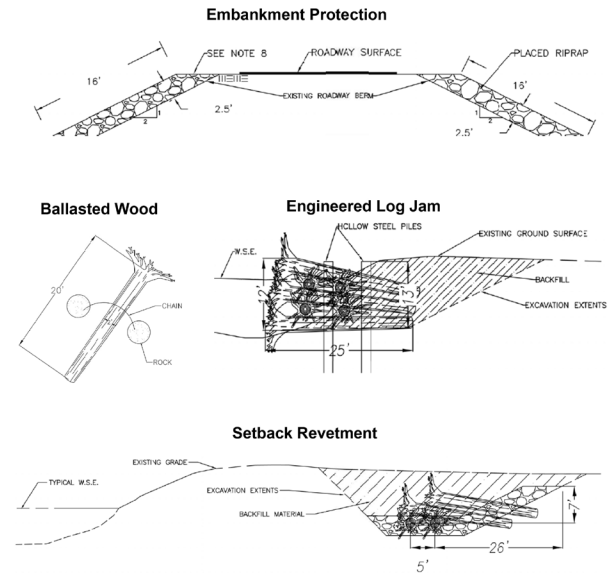
During their senior year, students at our program are divided into teams of four or five students and assigned a project that is supported by an external organization such as an engineering consulting firm or municipal engineering agency. Teams prepare a written proposal during fall and a final report at the end of the academic year for the client. Teams are advised by a faculty member and are supervised by a faculty instructor who organizes capstone project milestones and provides day-to-day continuity for the entire capstone class. In this project, both faculty members were licensed professional engineers. The design team was supported by two liaison organizations—the county flood management division and an engineering consulting firm that had developed management plans near the study reach. Three of the county liaisons, who met regularly with the team, are licensed engineers, and others on the county team have advanced degrees in ecology and land use planning bringing a unique interdisciplinary element to the project. Meetings with the county occurred regularly during both years (i.e., at least once/month).



Multidiscipline or allied profession participation

Students in both years collaborated with multiple departments at the county. These included county roads crews, who installed emergency rock protection at one of the bridge abutments during the first year; county transportation engineers, who attended student presentations and clarified transportation department priorities; county surveying crews, who the teams directed regarding locations for cross-section surveys and identification of benchmarks; county drafters, who provided the teams with site topography and helped set up AutoCAD templates in standard County format; and with





county ecologists and planners, who worked closely with the non-engineering team members on their site assessment work.

Students also benefitted from input from a range of professionals outside the county. In the fall quarter of both years, several practicing engineers from multiple engineering disciplines provided lectures and workshops to the class on project planning, project scheduling, project management, team work, and making effective presentations. In the spring quarter, project reports were reviewed by several external engineering reviewers.

A local consulting firm that had developed reach-scale management plans for the river system also met with team members and provided advice regarding drawings and engineered log jam design.

We encourage our students to enter their projects in regional and national student design competitions. Consequently, the year two team entered their project in a national undergraduate design competition sponsored by a water resources engineering organization and was selected to attend the associated conference to present their project.

They won the competition, and by competing, benefitted from feedback from nationally recognized engineers. The biology/environmental studies student, who served the role of "consulting" ecologist, presented her work at a regional professional meeting on river restoration. Three of the year two team members also attended this conference, where they received specialized training on river morphology. The regional conference draws professionals with engineering and ecological backgrounds and thus also supported the interdisciplinary nature of the project.

$7,500 Award Winner

Seattle University

Department of Electrical and Computer Engineering

Solar Microgrid in Rural Zambia with Real-Time Cloud-Based Monitoring

Participants

Students

George Goldsmith
Sergey Russo
Alexandra Keiko Schleicher
Natalie Swope

Faculty

Steve Szablya, P.E.

Professional Engineers

Patrick Cummings, P.E. (USA)
Henry Louie, Ph.D., P.E. (Zambia)
Matt Salmon, P.E. (USA)

Additional Participants

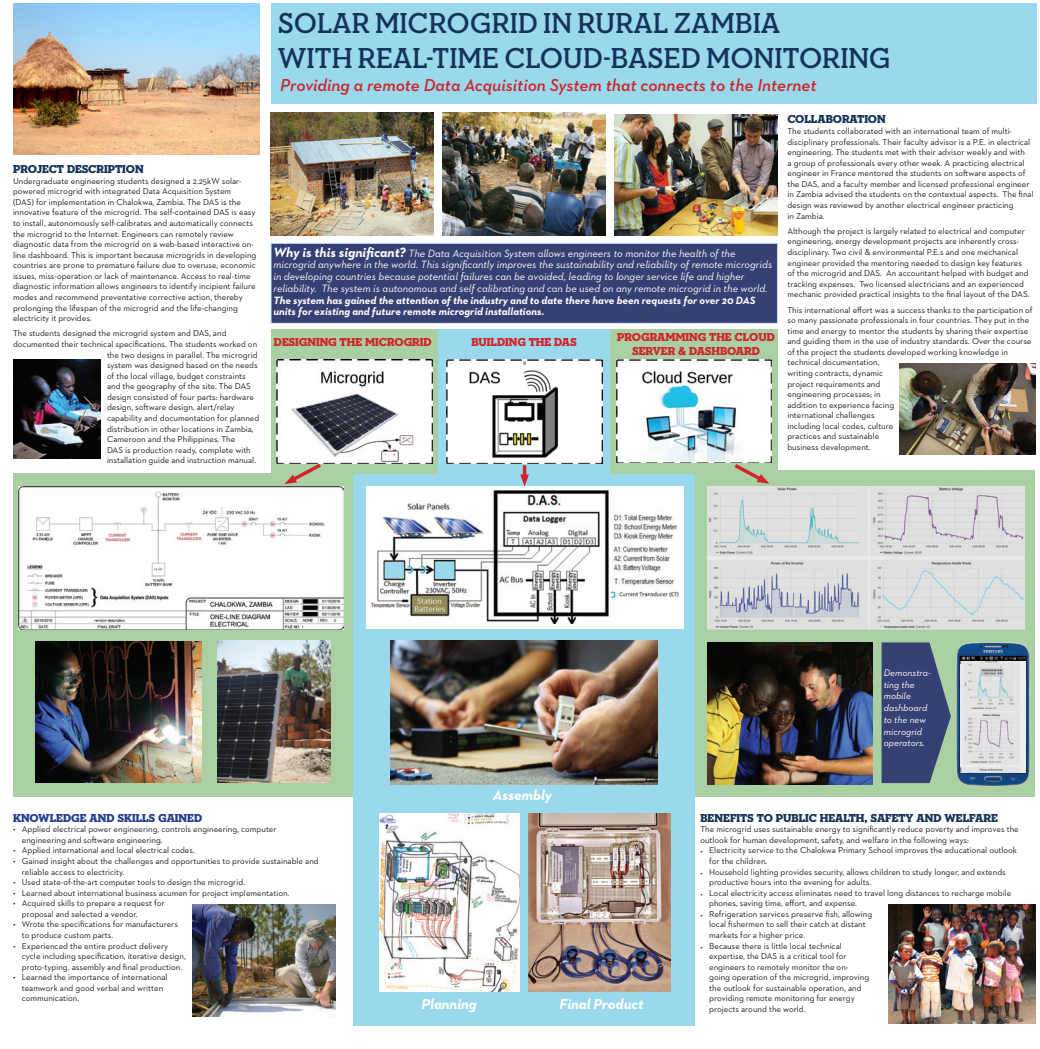
Matthieu Bach
Michael Dauenhauer
Peter Dauenhauer
Antoine Desclos le Peley
Jay Heitman
Jenna Isakson
Byron Lynch
Likonge Makai
Reynard Pieterse
Michael Swope

Jury Comments

"The project fills a need in a remote area of the world for an isolated rural village."

"Innovative project that allows for continued monitoring of the problem addressed in the project"

"Electricity is vital to improve society. When it is too expensive to provide through normal means, engineers find a solution."



Abstract

Undergraduate engineering students designed a 2.25kW solar-powered microgrid with integrated data acquisition system (DAS) for implementation in Chalokwa, Zambia. The DAS is the innovative feature of the microgrid. The self-contained DAS is easy to install, autonomously self-calibrates, and automatically connects the microgrid to the Internet through a cloud server. Engineers can remotely review diagnostic data from the microgrid on a web-based interactive online dashboard. This is important because microgrids in developing countries are prone to premature failure due to overuse, economic issues, misoperation, or lack of maintenance. Access to real-time diagnostic information allows engineers to identify incipient failure modes and recommend preventative corrective action, thereby prolonging the lifespan of the microgrid and the life-changing electricity it provides.

The students designed the microgrid system and DAS and documented their technical specifications. The students worked on the two designs in parallel. The microgrid system was designed based on the needs of the local village, budget constraints, and the geography of the site. The DAS design consisted of four parts: hardware design, software design, alert/relay capability, and documentation for planned distribution in other locations in Zambia, Cameroon, and the Philippines. The DAS is production ready, complete with installation guide and instruction manual. The DAS has gained the attention of the industry. To date, requests have been made for over 20 units for existing and future microgrid installations.

Presently, the people of Chalokwa, Zambia, have no access to the electrical grid. The microgrid improves the outlook for human development, safety, and welfare in several ways. A primary school will have electricity service for the first time, improving the educational outlook for the children. Indoor household lighting allows children to study longer and adults to extend productive hours into later in the evening. Outdoor lighting improves security and reduces encounters with dangerous wildlife. Villagers will no longer be forced to travel several kilometers to the nearest electrified town to recharge their mobile phones, saving time, effort, and expense. Refrigeration services powered from the microgrid will let the local fishermen preserve their catch, allowing them to be sold at distant markets for a higher price. Because there is little local technical expertise, the DAS is critical in monitoring the ongoing operation of the microgrid, improving the outlook for its sustainable operation. In short, this project benefits public safety, welfare, and the developmental outlook for the entire Chalokwa community.

The project was led by four electrical engineering undergraduate students under the mentorship of a university faculty member and dedicated liaison engineers in France and Zambia. The large scope of this project and complex nature of development projects in general made it necessary to have an international, multidisciplinary, and collaborative team. The broader team consisted of engineers from various disciplines, licensed professional engineers (P.E.s) in the United States and Zambia, allied professionals (licensed electricians, machinists, and carpenters), and an accountant.

The knowledge gained by the students reflected the multidisciplinary nature of the project. The students learned how to design off-grid solar-powered systems. They designed the innovative DAS hardware and software. They gained insights on the influence that social, economic, and geographic factors can have on the sustainability of microgrid projects in developing countries. More specifically, the knowledge gained included designing to meet international and local codes, collaborating with technical and business experts, planning for longterm sustainability, and learning the importance of community involvement and education. The students also learned how to collect and analyze site information from community surveys. The students participated in field testing, construction, and deployment. The DAS has been field tested and is operational, yielding the expected results.

$7,500
Award
Winner

Seattle University

Department of Electrical and Computer Engineering
Solar Microgrid in Rural Zambia with Real-Time Cloud-Based Monitoring

Perspectives On

Collaboration of faculty, students, and licensed professional engineers

The students collaborated with an international team of multidisciplinary professionals. Their faculty advisor is a P.E. in electrical engineering. The students met with their advisor weekly and with a group of professionals every other week. A practicing electrical engineer in France mentored the students on software aspects of the DAS. A faculty member who has a Ph.D. in electrical engineering and is a licensed professional engineer in Zambia advised the students on the contextual aspects.

Although the project is largely related to electrical and computer engineering, energy development projects are inherently cross-disciplinary. Two civil and environmental P.E.s and one mechanical engineer assisted with the design of the microgrid and DAS. An accountant helped with the budget and tracking expenses. Two licensed electricians and an experienced mechanic provided practical insights to the final layout of the DAS.

This international effort was a success thanks to the participation of so many passionate professionals in three countries. They put in the time and energy to mentor the students by sharing their expertise and guiding them in the use of industry standards. Over the course of the project,

the students developed working knowledge in technical documentation, writing contracts, dynamic project requirements, and engineering processes. They also experienced international challenges, including local codes, culture practices, and sustainable business development.

Knowledge and skills gained

The knowledge students gained was broad. Students gained appreciation for the diverse skills that energy development projects require. The students learned and applied elements of electrical power engineering, computer engineering, and software engineering. They experienced the design process from specification through iterative design, prototype construction, and final production.

The four students learned the importance of team work and good oral and written communication, as they interacted with professionals across the globe. They were exposed to the interaction between engineers and the public they serve—in this case the community of Chalokwa.

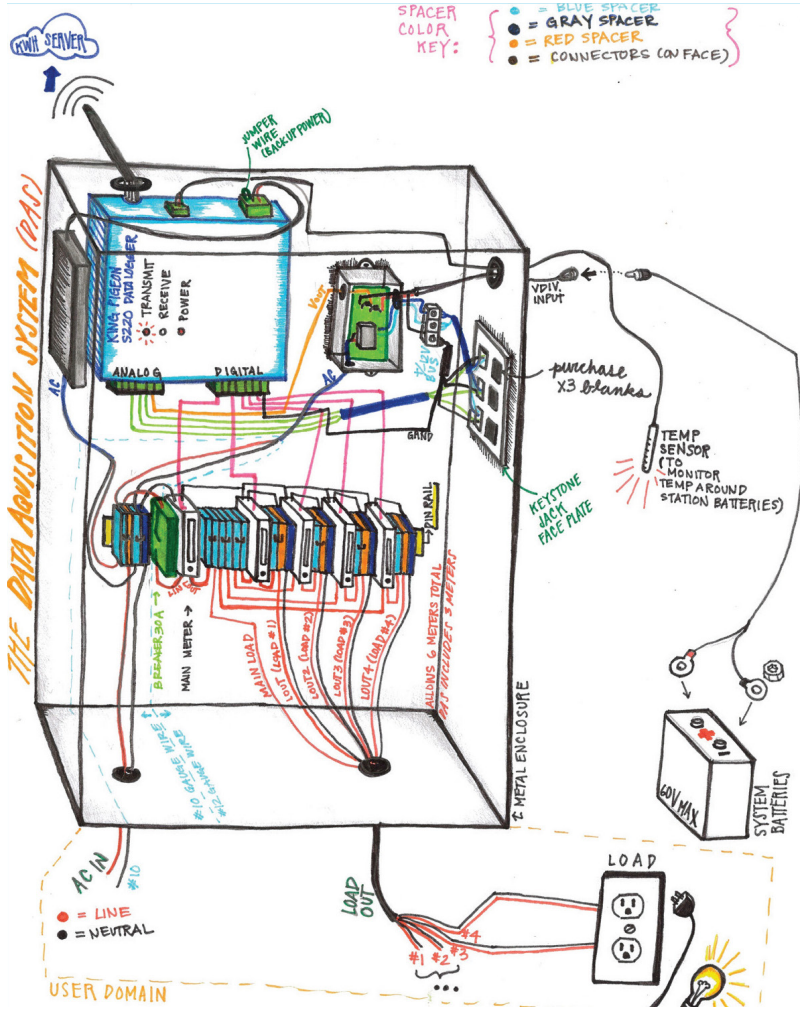
This project was not just a technical or academic problem. There were

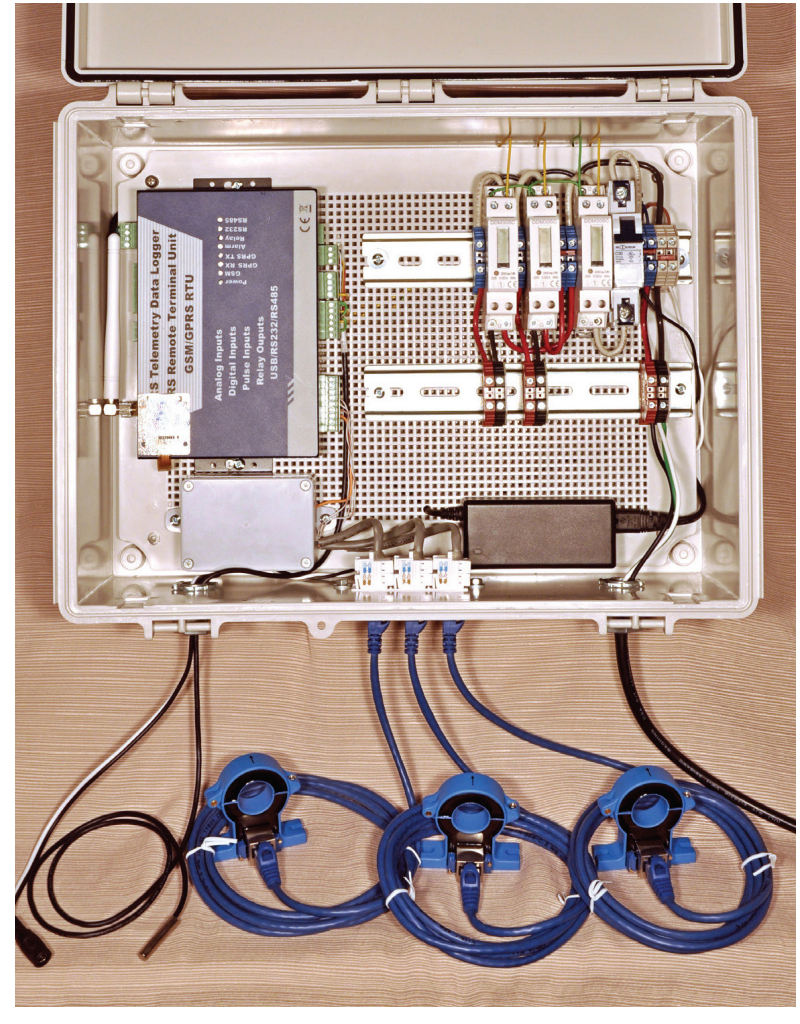
$7,500 Award Winner

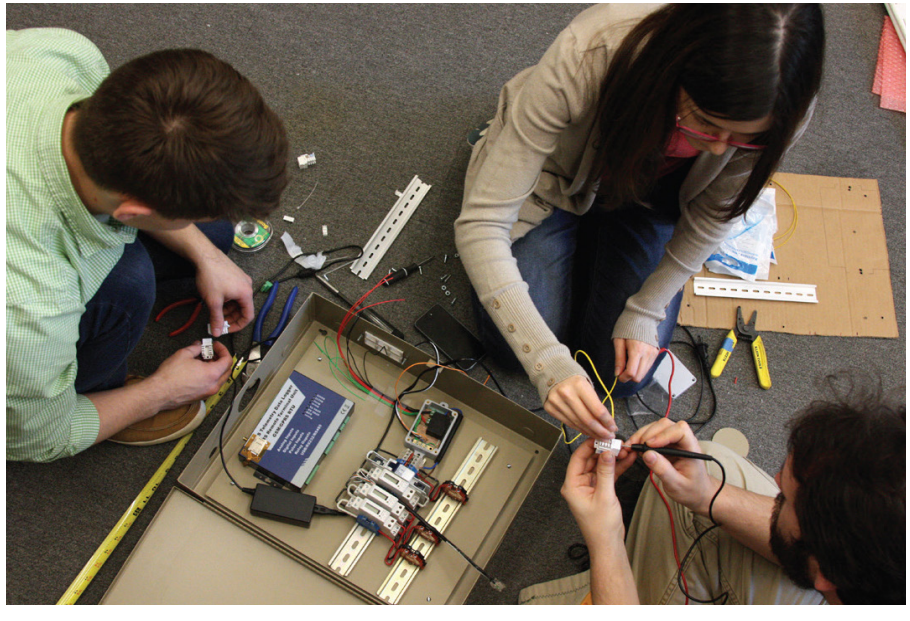
Seattle University

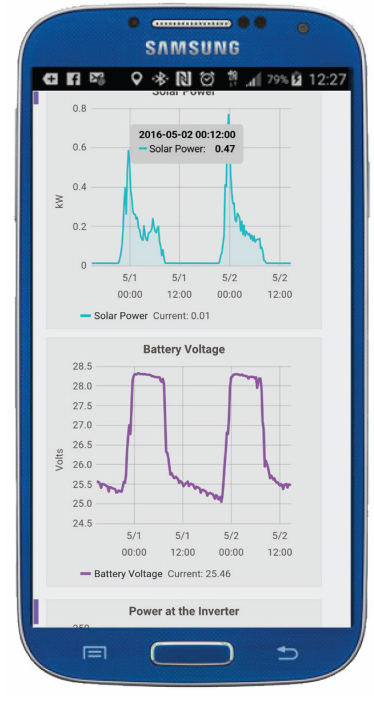
Department of Electrical and Computer Engineering

Solar Microgrid in Rural Zambia with Real-Time Cloud-Based Monitoring









aspects of the Chalokwa community and culture that needed to be captured and incorporated into its design. This required patience and active listening. It required students to value the needs and real desires of the locals. The context of this project challenged the students to step away from their lives and experience what life is like without access to electricity.

The students learned that post-implementation plans are just as important as pre-implementation design. The data collected from the DAS will be monitored to improve the technical outlook of the kiosk for years to come.

Clean energy solutions are the future of humanity. The knowledge gained from this project will allow students to apply their sustainable design approaches into their own communities. The world is a global village and in order to satisfy its energy demands, without depleting the environment of its natural resources, renewable energy approaches need to be adopted.

2016 Participants

George Mason University
Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering
New Drinking Water and Sewer System for an Elementary School for Orphans—Bilwi, Nicaragua

George Mason University
Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering
Water and Sanitation Project—Children's Feeding Center—Puerto Cabezas, Nicaragua

Mississippi State University
Department of Industrial and Systems Engineering
Piston Assembly Simulation

Old Dominion University
Department of Civil and Environmental Engineering
Engineering Systems and Research Building Addition

Polytechnic University of Puerto Rico
Electrical and Computer Engineering and Computer Science Department
Thermal Energy Reduction

Portland State University
Department of Civil and Environmental Engineering
Landscaping Yard Stormwater Treatment Design

Portland State University
Department of Civil and Environmental Engineering
Living Cully Plaza Ecoroof

Rose-Hulman Institute of Technology
Department of Civil Engineering
Infrastructure Improvements for Two Communities in the Dominican Republic

Seattle University
Department of Civil and Environmental Engineering
Design Development of a Cultural Village for Migrant Workers

Seattle University
Department of Civil and Environmental Engineering
Design of Habitat-Sensitive Erosion Hazard Mitigation Near a Bridge

Seattle University
Department of Civil and Environmental Engineering
Liquefaction Mitigation Design Options for a Utility Service Center

Seattle University
Department of Civil and Environmental Engineering
Seismic Retrofit Design of a Historic Utility Powerhouse

Seattle University
Department of Electrical and Computer Engineering
Solar Microgrid in Rural Zambia with Real-Time Cloud-Based Monitoring

State University of New York
Department of Environmental Resources Engineering
Setting Pole Dam Evaluation, Tupper Lake, New York

University of Arkansas at Little Rock
Department of Construction Management and Civil and Construction Engineering
Three-Story Medical Office Building—Multidisciplinary Study

University at Buffalo
Department of Civil, Structural, and Environmental Engineering
Changing the World One Engineer at a Time

University of California, San Diego
Department of Electrical and Computer Engineering
Global TIES—Baja del Sol

University of Evansville
Department of Mechanical and Civil Engineering
MCDC Green Infrastructure Project

University of Kansas
Department of Civil, Environmental, and Architectural Engineering
Design-Build Suspension Footbridge

University of Nebraska–Lincoln
Charles W. Durham School of Architectural Engineering and Construction
888 Boylston Street—Interdisciplinary Team Design

Virginia Military Institute
Department of Civil and Environmental Engineering
Implementation of Sustainable Drinking Water Infrastructure and "Pipe-In-Bottle" Solar Showers/Eco-Latrines in Pampoyo, Bolivia

Previous **Winners**

2015

Grand Prize

Marquette University
Department of Civil, Construction, and Environmental Engineering
Sechum Vehicle Bridge

Additional Awards

The Citadel
Department of Civil and Environmental Engineering
Multidisciplinary Evaluation and Rehabilitation Design of Sacred Heart Catholic Church

George Mason University
Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering
Water Supply, Distribution and Storage Sabana Grande, Nicaragua

Seattle University
Department of Civil and Environmental Engineering
Seismic Analysis and Retrofit Design of a Historic Substation Control Building

University of Arkansas at Little Rock
Department of Construction Management and Civil and Construction Engineering
American Red Cross of Greater Arkansas Seismic Retrofit Feasibility Study

University of Nebraska–Lincoln
Charles W. Durham School of Architectural Engineering and Construction
Multidisciplinary Vertical Farm Design

2014

Grand Prize

Seattle University
Department of Electrical and Computer Engineering
Microgrid System for a Wind and Solar Farm Located in Rural Kenya

Additional Awards

The Citadel
Department of Civil and Environmental Engineering
Wave Dissipation System

North Carolina State University
UNC/NCSU Joint Department of Biomedical Engineering
Creating a Better Way to Locate Vasculature for Intravenous Therapy

Seattle University
Department of Civil and Environmental Engineering
Historic Landmark Incline Lift Structural Evaluation and Retrofit

University of Evansville
College of Engineering and Computer Science
Fairfield Reservoir and Dam

University of Notre Dame
Department of Civil and Environmental Engineering and Earth Sciences
Innovative Housing Solutions for Post-Quake Haiti

2013

Grand Prize

Cleveland State University
Civil and Environmental Engineering Department
Design, Funding, and Construction of the August Pine Ridge School/Hurricane Shelter in Belize

Additional Awards

Northern Arizona University
Department of Civil Engineering, Construction Management, and Environmental Engineering
Paper Pulp Sludge Characteristics and Applications

Seattle University
Department of Civil and Environmental Engineering
Design Options for a Creek Crossing for a Utility Company

Seattle University
Department of Civil and Environmental Engineering
Structural Evaluation and Retrofit of a Warehouse

University of Nevada, Reno
Department of Civil and Environmental Engineering
Capstone Design Project—SouthEast Connector

University of Texas at El Paso
Department of Civil Engineering
Multidisciplinary Design of a Sustainable, Environmentally Friendly, and Affordable House

2012

Grand Prize

Florida Atlantic University
Department of Civil, Environmental, and Geomatics Engineering
Dania Beach Nanofiltration Plant Expansion

Additional Awards

Oklahoma State University
School of Civil and Environmental Engineering
Roadway and Water Feature Design at the Botanic Garden

Seattle University
Department of Civil and Environmental Engineering
Design of an Orphanage, Learning and Community Center in Ethiopia

Seattle University
Department of Civil and Environmental Engineering
Historic Dam Guard Rail and Vehicle Barrier Retrofit for Public Safety

University of Texas at El Paso
Department of Civil Engineering
Multidisciplinary SMART Design of Fire Station 513

Valparaiso University
College of Engineering
Maji for Masaera—Rehabilitation of a Man-Made Irrigation Canal

Previous **Winners**

2011

Grand Prize

University of New Mexico
Department of Civil Engineering
Integrated Infrastructure Improvements for a Youth Scout Ranch

Additional Awards

California State University, Los Angeles
Department of Civil Engineering
Connecting Professional Practice and Education through a Civil Engineering Capstone Project: Mud Flow Barrier

Lawrence Technological University
Department of Civil Engineering
Civil Engineering Capstone Project Recovery Park

Seattle University
Department of Civil and Environmental Engineering
Flood Control Channel Design for a River in Northwest Haiti

Seattle University
Department of Civil and Environmental Engineering
Structural Design of Dam Sluice Gate Walkway Slabs: Retrofit and Replacement Options

University of Texas at El Paso
Department of Civil Engineering
Development of a Sustainable Infrastructure Management System for a City

2010

Grand Prize

University of Delaware
Department of Civil and Environmental Engineering
Pomeroy Trail East Annex

Additional Awards

California Polytechnic State University, San Luis Obispo
Civil and Environmental Engineering Department
Bridging the Gap between Theory and Practice through Capstone Design

California State University, Los Angeles
Department of Civil Engineering
Connecting Practice with Education through Civil Engineering Capstone Experience: Puddingstone Reservoir Operations Level Study

Clemson University
Holcombe Department of Electrical and Computer Engineering
Engineering Haptic Virtual Manipulatives to Enhance K–12 Math and Science Education

University of Maryland
Department of Civil and Environmental Engineering
Engineers Without Borders: Solar Recharge Project in Burkina Faso, Africa

University of New Mexico
Department of Civil Engineering
Integration of Civil Engineering and Construction Management Education: A Multi-disciplinary, Mentor-led Capstone Experience

2009

Grand Prize

Florida A&M University–Florida State University
Department of Civil and Environmental Engineering
Senior Design Capstone Course: Collection of Projects with Featured Everglades Restoration Project

Additional Awards

Seattle University
Department of Civil and Environmental Engineering
Structural Design Package for the Replacement of a County Bridge

University of Arizona
Department of Civil Engineering and Engineering Mechanics
Practitioner-Led Engineering Experiences

University of Missouri–Kansas City
Department of Civil and Mechanical Engineering
Redcone Civil Design Group: A Practitioner-Centric Capstone Experience

University of Tennessee at Chattanooga
Department of Civil Engineering
Intermodal Transit Center

Virginia Polytechnic Institute and State University
Charles E. Via Jr. Department of Civil and Environmental Engineering
Land Development Design Initiative

2009

Honorable Mention

University of Iowa
Department of Civil and Environmental Engineering
Pilot Program for Expanding Connections between Professional Practice and Education

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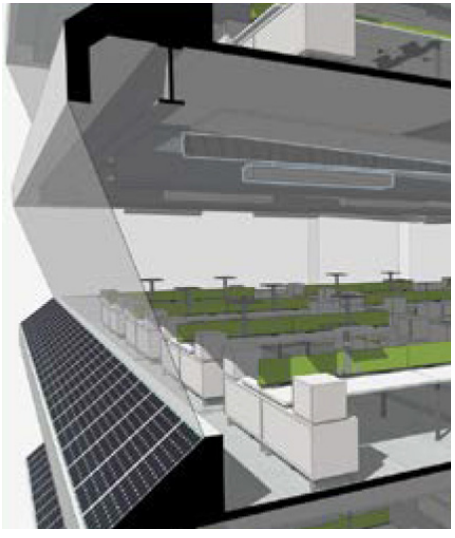

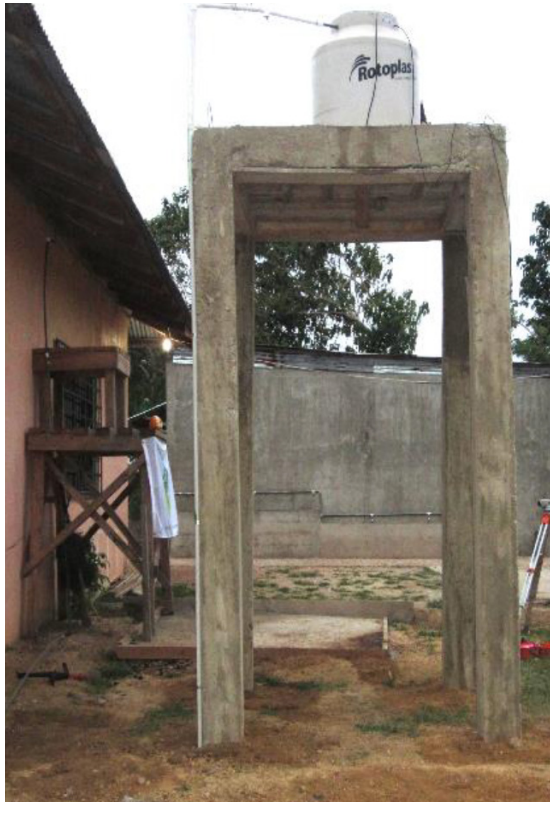
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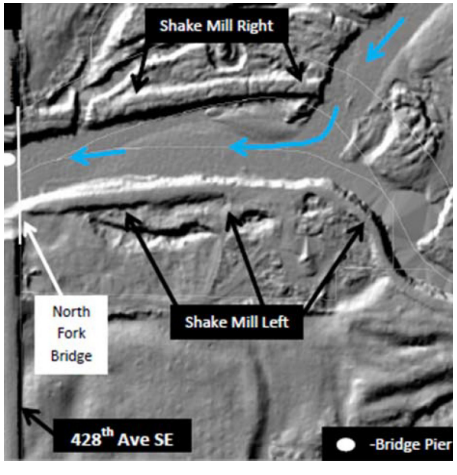
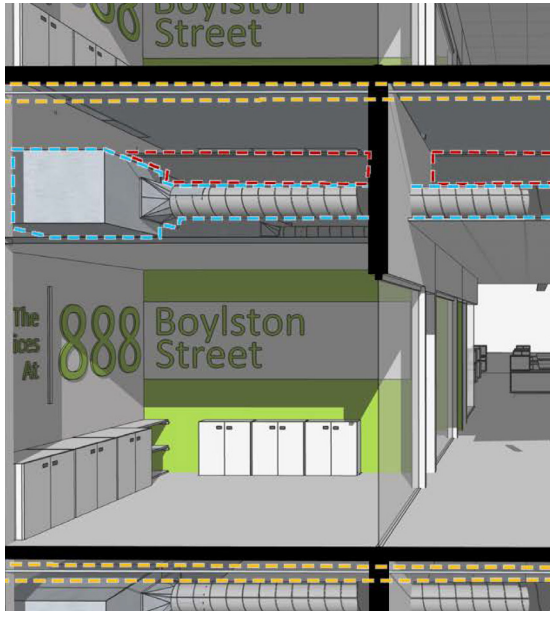

Shake Mill Right
North Fork Bridge
Shake Mill Left
428th Ave SE
-Bridge Pier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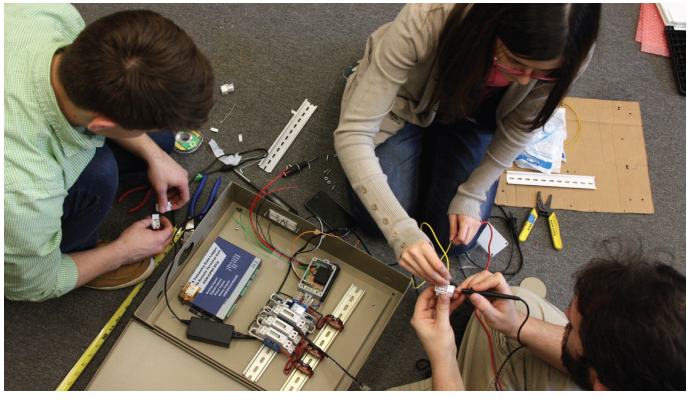
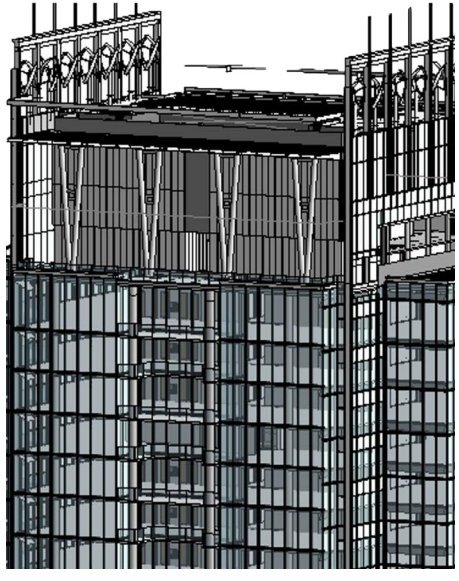
888 Boylston Street



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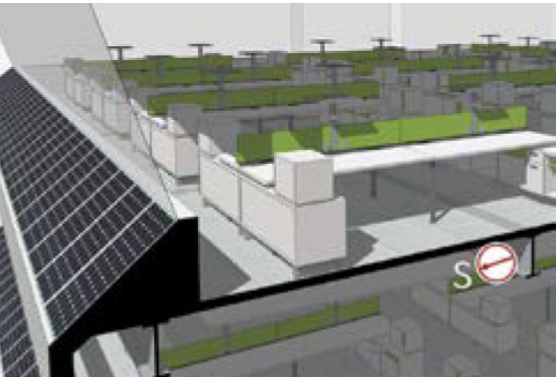

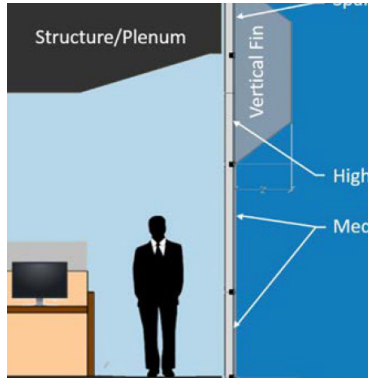

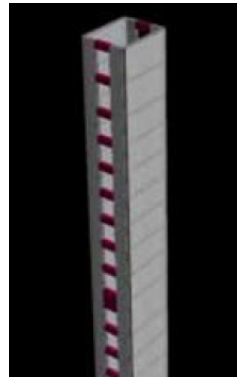

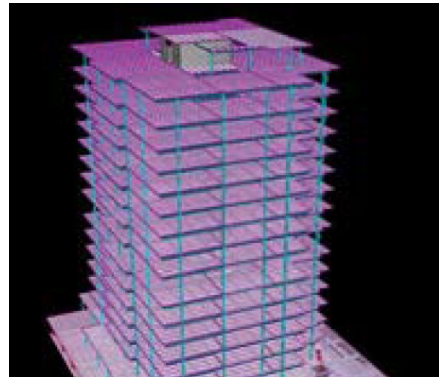

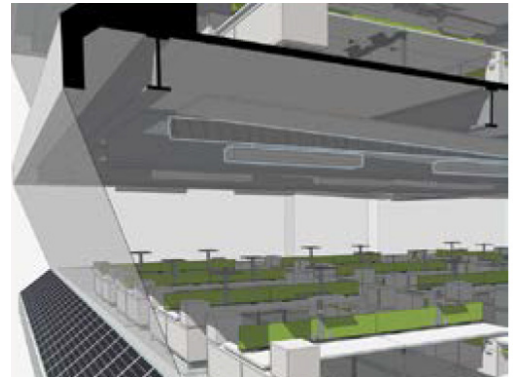

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