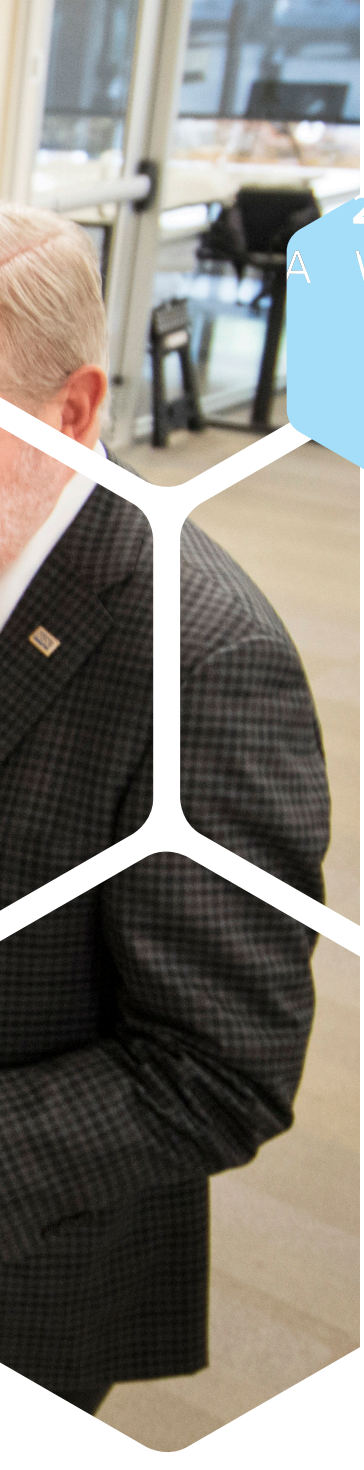
2018
AWARD

NCEES Engineering Education Award

NCEES



2018 AWARD

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Multidisciplinary and Skilled Professional Participation
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Collaboration of Faculty, Students and Local Professional Engineers

president's message

The NCEES Engineering Education Award recognizes engineering programs that encourage collaboration between students and professional engineers. The award program promotes understanding of the value of licensure and encourages partnerships between the engineering profession and education.

The 2018 competition had many firsts. NCEES introduced new project categories to encourage a greater variety of engineering disciplines to participate. Other changes included an increase in the number of awards and the monetary amounts of the awards. The jury received 97 projects for the judging in June, which was the most received to date.

When students and licensed professional engineers partner on these projects, everyone benefits. Students see first-hand how professional engineers safeguard the health, safety, and welfare of the public, and they can take lessons out of the classroom and apply them to real-world issues—both domestic and international. This allows students to expand their knowledge of engineering principles, and also to work on skills like communication, teamwork, professional ethics, and social responsibility. The licensed professional engineers benefit from working with the students and watching their capabilities and enthusiasm for the profession.

On behalf of NCEES, I thank the students, faculty, and practitioners who participated in this year's competition. I applaud your efforts to connect professional practice and education and to inspire the next generation of professional engineers. I also thank the jury members for giving their time and expertise to evaluate each project and for continuing to support this initiative.

This book celebrates the 2018 winners, and I hope that their projects will inspire other engineering programs to develop collaborative activities with licensed professional engineers.

JAMES J. PURCELL, P.E.
2018–19 NCEES PRESIDENT

about the award

The NCEES Engineering Education Award was established in 2009 to promote understanding of the value of licensure and to encourage collaboration between the engineering profession and education.

Academic programs accredited by EAC/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 12, 2018. 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 NCEES Engineering Education Award jury met in Clemson, South Carolina, on June 5, 2018, to conduct a blind judging of the 97 entries. Each submission consisted of a display board, abstract, and project description. These materials were sent electronically to the jury for review prior to the judging and were also available at the judging.

For the 2018 competition, NCEES introduced new award categories and new award amounts to encourage participation from a broad spectrum of engineering programs. Award amounts included one $25,000 grand prize and seven $10,000 prizes.

Programs entering the competition selected which category below best fit the intent and spirit of their project:

- International projects
- Community enhancement projects
- Public welfare and health services/care projects
- Energy and sustainability projects
- Device/design/prototype projects
- Freshman/sophomore design projects
- Innovation projects

The jury selected the North Carolina State University UNC/NCSU Joint Department of Biomedical Engineering to receive the $25,000 grand prize. The jury chose seven additional winners to each receive $10,000 awards.

2018 NCEES ENGINEERING EDUCATION AWARD JURY

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

Brian Robertson, P.E., *Jury Chair*
Colorado State Board of Licensure for Architects,
Professional Engineers, and Professional Land Surveyors

Nancy Gavlin, P.E., S.E.
Illinois Structural Engineering Board

Sallye Perrin, P.E.
Maryland State Board for Professional Engineers

Dennis Truax, Ph.D., P.E.
Mississippi Board of Licensure for
Professional Engineers and Surveyors

Jean Andino, Ph.D., P.E
Arizona State University

Edward Collins, Ph.D., P.E.
Clemson University

John Wagner, Ph.D., P.E.
Trine University

Brock Barry, Ph.D., P.E.
United States Military Academy

Michael Smith, D.Eng.
DiscoverE Diversity Council

Mark Golden, CAE, FASAE
National Society of Professional Engineers


9.5 mm
BRAINLAB
BRAINLAB

2018

NCEES
ENGINEERING
EDUCATION AWARD
GRAND PRIZE
WINNER

North Carolina State University

UNC/NCSU Joint Department of Biomedical Engineering

Enabling Pediatric Brain Surgery through Head Stabilization

$25,000 GRAND PRIZE

North Carolina State University

UNC/NCSU Joint Department of Biomedical Engineering

Enabling Pediatric Brain Surgery through Head Stabilization

PediaPack Devices

Enabling Pediatric Brain Surgery through Head Stabilization

Need

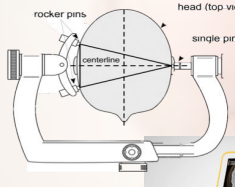
Provide complete head immobilization for pediatric patients during neurosurgery to ensure a stable surgical field compliant with stereotactic systems.

Knowledge and Skills Gained

-Design Process (Divergent/Convergent Thinking, Quick-kill)
-Clinical Immersion incl. witnessing surgery
-Networking and Stakeholder Feedback
-Communication/Presentation Skills
-Design Documentation incl. Design History File
-Market Research and Analysis
-Rapid Prototyping
-Application of Engineering and Technical Skills
-Proof of Concept Testing

Project Description

Pediatric patients offer a unique set of challenges to the field of medicine. Although they suffer from a wide variety of neurological ailments, including epilepsy, brain tumors, and hydrocephalus, treatment of these conditions through surgical intervention is complicated. Adult patients requiring neurosurgery are stabilized using a 3-pin skull clamp. This immobilization allows neurosurgeons to use neuronavigation. Neuronavigation is a highly advanced technology that combines pre-operative CT or MR images with real time feedback to assist neurosurgeons in locating targeted regions of the brain. This technology increases surgeon confidence and leads to better patient outcomes. **Due to the fragility of their skulls, pediatric patients, especially those under the age of 3 years, cannot be pinned with the traditional skull clamp;** making them ineligible for use of neuronavigation**.** As a team, we are committed to creating a device that addresses these shortcomings. PediaPack's innovative infant skull stabilization solution provides pediatric patients access to the often life-defining surgeries they require by providing surgeons the confidence they need to perform these critical intracranial procedures.



Current Adult Standard of Care

Health, Safety, and Welfare

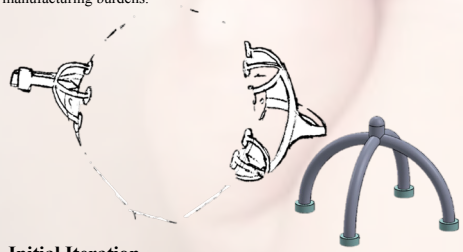
Our solution first and foremost emphasizes the safety and welfare of pediatric patients in need of neurosurgical intervention. Over 7,000 children undergo surgery each year for neurological disorders. 16-20% of these patients experience. **A major cause of pediatric postoperative complications is the inability to safely immobilize their heads**. 45 depressed skull fractures are reported each year in children undergoing craniotomies with pin fixation. Our device will significantly improve the standard of care for pediatric patients by safely and securely immobilizing infants' heads; permitting critical surgeries and reducing rates of postoperative complications.

Multidiscipline Collaboration

After narrowing to a field of focus of pediatric neurosurgery, our team of engineering students expanded our outreach to include **collaboration with medical professionals in the specific field of interest, rapid prototyping resources, and relevant engineering disciplines**. **Medical professionals** in the field of pediatric surgery highlighted a need in pediatric neurosurgery for pediatric skull stabilization and provided Quick-kill feedback. Concurrently, **prototyping, engineering professionals, and members of the Engineering Faculty** provided insight into specific engineering and manufacturing principles that needed to be considered when developing our design.

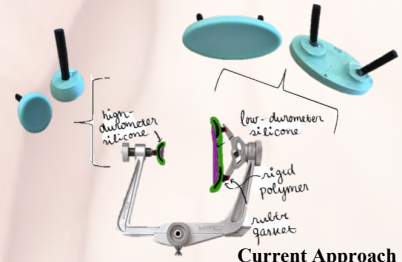
Design Progression

After **the need was identified**, the PediaPack biomedical engineering students took part in divergent thinking exercises to develop a **list of concept ideas**. These concepts were then **narrowed based on design criteria** established with the help of clinical mentors. Design criteria included stability, access to the surgical field, cost, setup time, and pressure distribution. **The first iteration** led to the development of The Octopus, disposable adaptors made with a set of pads (pictured left). Through Quick-kill ideation, this design ultimately morphed into the **current solution, the Cradle** (pictured right). Through the mentorship of professional engineers it was determined that this design would provide more stability and would decrease manufacturing burdens.



Initial Iteration

Ideation



Current Approach

Mending the Minds of Tomorrow

Participants

Students

Brian Gentry
Veronica Lavelle
Sarah Moore
Sophia Silver
Anya Trell
Zach Watkins

Faculty

Andrew DiMeo, Ph.D.
Naji Husseini, Ph.D.

Professional Engineers

Dan Fuccella, P.E.

Additional Participants

Herbert Fuchs, Ph.D., M.D.
Nandan Lad, Ph.D., M.D.
Allen Moore
Carrie Muh, M.D., M.S.
Vadim Tsvankin, M.D.

Jury Comments

"This project nicely illustrated the design process and had multiple disciplines involved."

"Great collaboration between multiple disciplines"

"Excellent device to fill a real need"

Abstract

Neurosurgery is a field marked by precision of execution. The difference between successful outcomes can come down to millimeter margins. The gold standard of stabilization for many adult, ranial-based procedures is the Mayfield 3-Pin Skull Clamp. This device allows for complete immobilization of the skull and is thus compatible with neuronavigation. Neuronavigation, also known as stereotactic systems, is technology that works with preoperative magnetic resonance and computed tomography images to allow neurosurgeons performing minimally invasive surgeries to know their exact position in the brain. This technology increases surgeon confidence and leads to better outcomes. This past year, a team of biomedical engineering students teamed up with clinicians and engineering professionals to combat inadequacies in care for pediatric neurosurgery patients.

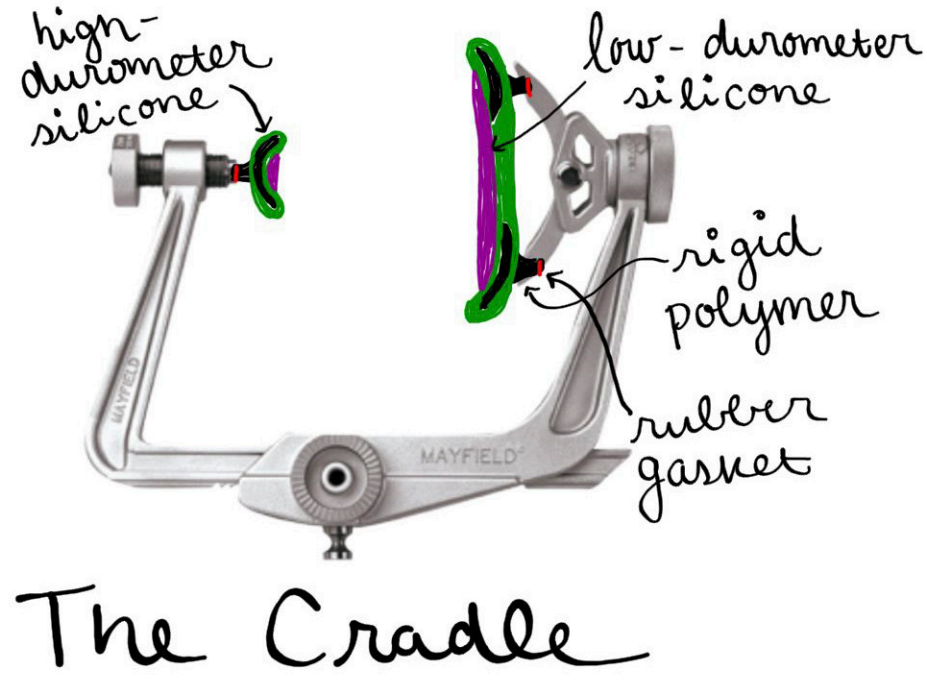
The pediatric population offers a variety of unique challenges in the field of neurosurgery. The fragility of pediatric skulls, due to fontenelles and lack of ossification of the bone, makes them especially vulnerable to skull damage. This makes pediatric patients, especially those under the age of three, ineligible for use of the skull clamp and thus neuronavigation technology. Despite this, almost 7,000 pediatric patients require surgery annually. Our device attempts to improve the head stability of pediatric patients. By enabling neurosurgeons to use neuronavigation technology, like BrainLab, on their pediatric patients, we are opening a new frontier of possibilities for treatment of pediatric neurosurgery.

Our device, affectionately called the Cradle, is a set of disposable adaptors to the current Mayfield device. Polymer attachment pieces slide seamlessly into the Mayfield setup. Replacing the metal pins with silicone pads increases the surface area contacting the head, decreasing localized pressure felt. The device is made of two different durometers (i.e., hardnesses) of silicone. The rigid exterior shell provides support and minimizes movement to less than one millimeter, the threshold for use with stereotactic systems. The pliable interior pad provides traction with the skin and decreases the risk of necrosis. Necrosis can occur when a device is in prolonged contact with the skin (more than three hours).

The immediate impact of this device is the possibility of treating and curing a child of an ailment that would otherwise go untreated. Treatment would improve cognitive function, leading to a better quality of life for the child and the ability to live and work independently. However, through market research and stakeholder interviews, our team has determined that the implications go much further than that. Reduction of the burden of disease would impact parents and caregivers who no longer are bound to a dependent child; insurance companies, including the government (i.e., Medicaid), through decreased medication costs (antiepileptic drugs, chemotherapy, etc.) and reduced hospital visits; and medical staff who save time during setup and are spared the heartache of failed procedures.

Although this device was made with the pediatric population in mind, it is also applicable for use with adult patients, as they suffer from complications due to slippage and skull fracture.

By opening a new frontier of possibilities for treatment of pediatric neurological disorders, including epilepsy, brain tumors, and hydrocephalus, our group is hoping to mend the minds of tomorrow.



$25,000 GRAND PRIZE

North Carolina State University

UNC/NCSU Joint Department of Biomedical Engineering

Enabling Pediatric Brain Surgery through Head Stabilization

Perspectives On

Protection of public health, safety, and welfare

Our solution first and foremost emphasizes the safety and welfare of pediatric patients in need of neurosurgical intervention. The most common neurological disorders affecting children are epilepsy, hydrocephalus, and brain tumors. In the United States, 470,000 children live with epilepsy, 2 out of every 1,000 children are born with hydrocephalus, and brain tumors are the leading cause of cancer deaths among pediatric patients. For each of these patients, total hospital costs range from $3,500 to $5,000 per day, and most require surgery. More than 115,000 children undergo surgery each year, and five to six percent of those cases are for neurological disorders. Out of these patients, 16–20 percent experience postoperative complications, 17.9 percent are readmitted within 90 days, and the mortality rate is 2.89 percent. A major cause for complications during these procedures is the inability to safely immobilize the heads of patients below the age of eight. While the Mayfield three-pin skull clamp is the most commonly used fixation device for adult patients, 42 depressed skull fractures are reported each year in children undergoing craniotomies with pin fixation. To ensure peace of mind for these patients and their families, neurosurgeons would be encouraged to use other methods of head fixation that would safely and securely immobilize children's heads during their operations.

Our device will significantly improve the standard of care for pediatric patients across the United States and in nations with similar established healthcare systems. In developing countries, with an even greater prevalence of conditions like hydrocephalus and treatments limited by the technology available, the low cost and adaptability of our solution will expand its scope even further. Due to its lower total area of contact than current solutions on the market, neurosurgeons will have greater access to the surgical field and potential sites of incision; however, the total contact area will remain large enough to distribute pressure and guarantee no damage to the patient's skull. For the neurosurgeon, our device will ensure less than one millimeter of movement between the skull and its points of contact. Such

precision establishes compatibility with neuronavigation, or computer-assisted technologies incorporating brain imaging, to provide the surgeon more confidence in locating specific targets and accurately positioning instruments during operations. For the patient, our solution's ease of use will reduce set-up time in the operating room, thereby decreasing the amount of time the child is kept under anesthesia. Studies have shown that the longer a patient is kept under anesthesia, the higher the risk of neurocognitive developmental delays.

During the design phase of our solution, we considered many features that would impact its feasibility, quality, and efficacy. To limit costs, we made it adaptable to three-pin skull clamps, easy to assemble with molds, and readily scalable to large-scale manufacturing. From a regulatory perspective, we worked to comply with Food and Drug Administration standards to market it as a Class I device. In terms of materials, the rigid base ensures less movement closer to the skull clamp and maintains enough compressive force, while still being flexible enough to cradle the patient's head. The softer coating material provides better conformity to the shape of the patient's skull and limits the risk of slippage due to shear forces.

Furthermore, we cooperated with the interests of clinicians, as the device does not significantly change the way they currently operate in the operating room. We continue to address challenges by using our diverse skill set, from mechanics to materials, while working with industry experts to continuously improve the quality of our product. In the future, we eagerly anticipate further collaboration and progressing our product to market.

Knowledge and skills gained

Over the course of our project, we have gained invaluable insight into the engineering design process, growing both individually and as a team along this iterative journey. Guided by many of the same foundational principles found in Stanford Biodesign, we set out to identify a pertinent need in the healthcare field. While our faculty mentor provided us with a great deal of guidance in the process of design, it was our team's responsibility to tailor this process to our specific interests and develop a project on our own from start to finish through the research and identification of a problem we observed in the healthcare setting. This fostered a great deal of independent learning and self-reliance as we took it upon ourselves to explore the many unmet needs of various areas.

While provided an abundance of potential connections and mentors, we were faced with the task of forming our own network and reaching out to clinicians and other professionals to help facilitate our project. As a result, we developed communication and networking skills that proved to be vital in our project from start to finish. Through clinical immersion and the observation of multiple surgeries, we quickly learned how to navigate the medical environment and conduct ethnographic research. By establishing meaningful relationships with healthcare providers, we were able to gain a better understanding of how patients are currently treated, along with the inadequacies of care that are in need of innovative solutions. Throughout this project, we have constantly sought input and feedback from the many people involved in every aspect of the cycle of care. From patients and caregivers to surgeons and other clinicians, we learned the value associated with analyzing the problem at hand from the perspective of all stakeholders involved.

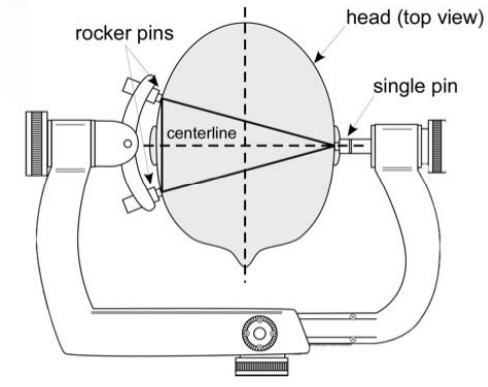
Through each phase of the design process, we became proficient at documenting our progress and thus learned the importance of maintaining proper design history files. Using a program known as Greenlight Guru, we were able to manage our deliverables and focus on our design controls. In maintaining well-documented engineering design notebooks, we were able to keep record of our progress and conveniently access our previous work in order to help facilitate reiteration throughout our design process. In the medical device industry, these skills are extremely important, since companies must maintain comprehensive design history files in order to make intellectual property claims and thus bring the product to market.

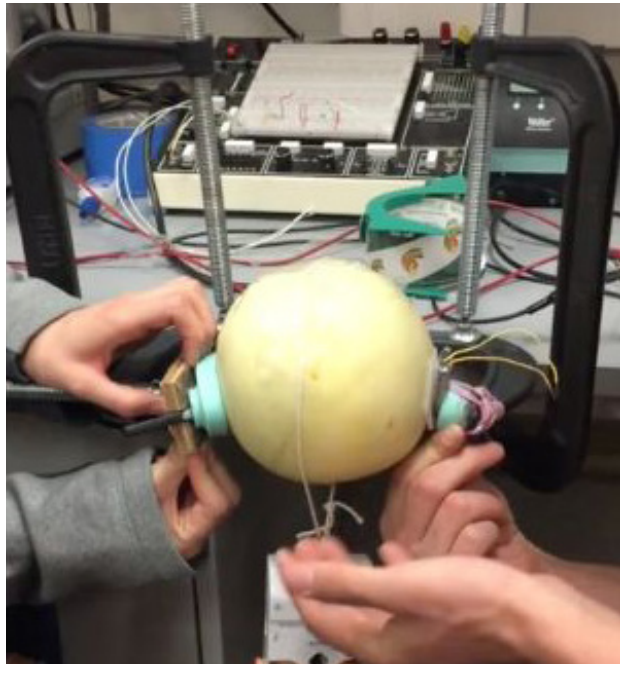
$25,000
GRAND
PRIZE

North Carolina State University

UNC/NCSU Joint Department of Biomedical Engineering

Enabling Pediatric Brain Surgery through Head Stabilization





Perspectives On

Since our project was limited to a year, we were forced to devise and analyze many different approaches to our problem in a short period of time. Through sessions of divergent and convergent thinking, we were able to envision a multitude of potential solutions and filter those potential solutions based on their practicality. Embracing the "quick kill" concept, we learned to analyze all the ways a particular solution may fail and how to avoid such failures by either altering the approach to certain solution or adopting a new solution altogether. Additionally, gaining experience in the process of rapid prototyping allowed us to go through many iterations of possible solutions and evaluate the parameters that were important to the task at hand so that they could be optimized in future designs. Through prototyping and testing, we were able to develop numerous skills important to the design process, such as 3D modeling, static/mechanical analysis, experimental design, and data collection. All of these skills are extremely important to providing proof of concept and design validation so that a particular device may be approved for its prospective use.

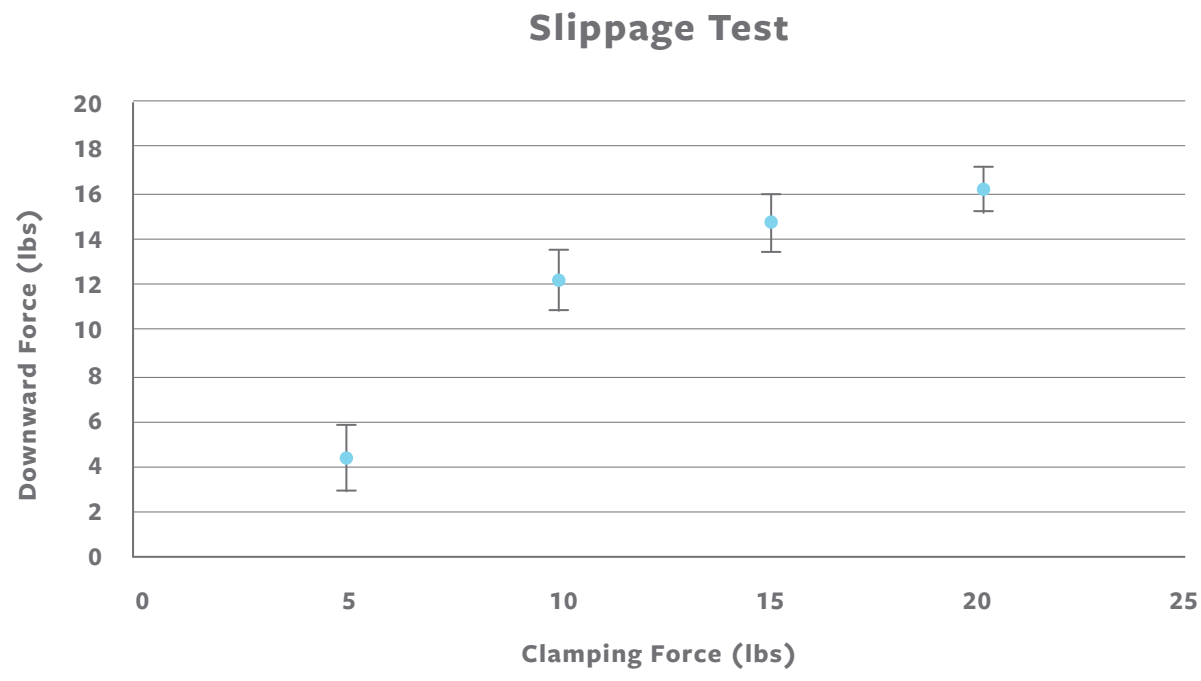
Through actively engaging ourselves in the design process and developing a project from start to finish, we have gained knowledge and skills that will prove to be indispensable in our future endeavors. Over the course of this project, we have developed both professionally and personally while striving to develop a viable solution for an unmet medical need. By pursuing innovation through enlightened empathy, we hope to make a positive impact on those affected by these disparities. Once again, we are Pediapack Devices, and by providing pediatric patients the opportunity for neurological surgery through proper head stabilization, we hope to help mend the minds of tomorrow.

Multidiscipline or allied profession participation

Throughout the completion of our design, it was necessary to consult with stakeholders and other professionals from various disciplines. Our team set our focus on pediatric neurosurgery, and once our focus was established, it was necessary to expand from our small group of engineers and consult with medical professionals to truly understand the needs within the field of pediatric neurosurgery. We consulted with both pediatric and non-specialized neurosurgeons, ranging from chief residents to attending physicians with over 30 years of experience in the field. These physicians gave us unique insight into the needs of this area of healthcare practice. After shadowing, observing cranial surgeries, and interviewing several physicians, we concluded that head stabilization in pediatric patients was an area of focus requiring vast amounts of improvement. Additionally, our team collaborated with the founder and chief executive officer of a well-respected industrial design firm to gain insight on how to manufacture a prototype of our device once we had established its primary design.

Interdisciplinary efforts between engineering fields were also required due to wide-ranging design criteria that needed to be understood in developing the head stabilization device. Materials science engineers were vital to ascertaining which materials were best suited for our purposes. After we established that we wanted to use both a rigid and softer material to create the pads, we were able to determine that silicones of different durometers, or hardnesses, would be best for our design. Mechanical engineers were also essential to our design process as they provided information on the applied forces and pressures that would be necessary for correct function of the device and the most effective ways in which we could test our device to obtain a proof of concept. Ultimately, biomedical engineers were necessary to understand the interaction of the head stabilization device with the pediatric patient during various neurosurgical procedures. Biomedical engineers were able to apply the engineering principles previously established within the realms of the cranial anatomy and various surgical procedures that would require head stabilization due to their understanding of anatomy and medical practices.

Furthermore, within biomedical engineering, several branches contributed to the success of our design, including biomechanics, bioinstrumentation, and biomaterials. Our team was comprised of members that have concentrated their undergraduate studies in each of these three disciplines.



$25,000
GRAND PRIZE

North Carolina State University

UNC/NCSU Joint Department of Biomedical Engineering
Enabling Pediatric Brain Surgery through Head Stabilization

Points of View

Andrew DiMeo, Ph.D.
Faculty advisor

What value does a real-world project bring to the students?
The complexities of real-world projects include not just the fundamentals of engineering; they additionally include aspects such as business, regulatory, economic, and intellectual property position. After graduation, students will be working on multidisciplinary teams solving open-ended problems. Simulating this environment in the classroom better prepares students to work in context to meet real unmet needs with diverse teams. An upside value is when the students take the simulation and own it as "real-world-in-the-classroom." This has resulted in projects that started with students and ultimately led to real products improving the health and economy of our community.

How do you decide which projects to work on?
In short, the students decide through a diligent process. I set up relationships between the students and a service line at a hospital or clinical site. In this case, that was

neurosurgery at Duke University Medical Center. The students interview, shadow, and collaborate with caregivers while doing a strategic focus exercise to determine diligence and decision criteria. The project is a complex process of uncovering unmet medical needs and vetting them through their strategic focus.

How did this project prepare students for professional practice?
For this project, the professional preparation and biggest challenge were related. It especially involved making a business case for a small market, quite literally. Not only are children small in size with unique anatomy, an engineering challenge in itself, but the financial attractiveness of the market for the disease state they took on was also small. That was not to be misinterpreted as unimportant. The students learned a lot about how to make a business case without losing sight of the very important population they were serving.

What advice do you have for other programs wanting to add similar collaborative projects to their curriculum?
This program relies on collaboration between caregivers and engineering students. When it goes wrong, it is students looking for caregivers to give them a problem to solve, or vice versa, a caregiver looking to the students to solve their problem. Best practice is when caregivers and engineering students work together to identify an unmet medical need for a patient and then collaborate on defining the problem and realizing innovative solutions that have been vetted through a diligent multidisciplinary collaboration including engineering professionals.

Veronica Lavelle
Student

What did you like best about participating in this project?
For me the best part of the project was working with medical professionals on identifying a medical need. This included shadowing a variety of pediatric neurosurgical procedures and conducting interviews with various medical professionals. It was really incredible to witness the ways that the different individuals worked together to deliver care.

What did you learn?
This whole project was about growth and learning, both in technical knowledge and industry experience. I would say the thing we learned the most about was our disease state, including the procedures and technology used to treat it. In order to develop and pitch our product, we had to know this like the back of our hands.

How did the participation of professional engineers improve the experience?
Our engineering curriculum taught us a lot about the technical aspects of the project, and although this is incredibly valuable, there is no substitute for experience. Professional engineers gave us a glimpse into the way that industry works and shared advice on a variety of topics. Specifically, our professional engineering mentor was very knowledgeable about which materials would work best and how we would actually manufacture our final product.

What do you think the engineers learned from working with students on this project?
I definitely think that the engineers learned a lot about our disease state and the health care sector. Our biomedical coursework, as well as the fact than many of us are interested in pursuing careers in medicine, helped us to better understand concepts and terminology that our physician mentors used.

Daniel Fuccella, P.E.
Practitioner

Why did you get involved with North Carolina State University's project?
For the past several years I have had the good fortune to be invited to assist teams participating in N.C. State's biomedical engineering senior design course under the direction of Dr. DiMeo. It has been truly gratifying to be asked to assist these talented and committed students as they work their way through the well-structured processes of pursuing solutions to identified medical needs. The PediaPack team exemplified all the virtues of the course, from the identification of a significant need through to demonstration of a real-life solution.

How did you assist the students in the project?
By making the team aware of resources that might be useful, my role throughout the phases of the program was to use my product design and materials development experience to help the team bridge the gap between proposed design concepts and effective and practical solutions to the technical challenges presented by those concepts. My role was not one of proposing solutions, but rather one of suggesting paths that might facilitate achievement of the team's goals. In this particular project, the team was able to build on my knowledge of polymeric elastomers and prototyping contacts to tackle the challenging issues associated with the development and demonstration of a practical design for the head support.

What did you learn from working with the students?
The team members were a never-ending source of education for me. In addition to updating me on medical trends and technologies specific to this project, the students were a continuous source of optimism in the will and creativeness of our young men and women to identify issues, propose solutions, and tackle the challenges inherent in fulfilling identified needs.

What did you want students to take away from working with you?
Aside from enduring my seemingly endless stories of life in the '60s, the primary message that it is hoped that the students take away from our time together is the importance of developing a portfolio of resources to enrich both their professional careers and personal lives. Take advantage of opportunities to expand your experiences. One never knows when it will come in handy.

2018

NCEES ENGINEERING EDUCATION AWARD

$10,000 WINNERS

Miami University
Department of Chemical, Paper, and Biomedical Engineering
Design and Implementation of a Community-Driven Water System in a Rural African Village

Seattle University
Department of Civil and Environmental Engineering
Load Rating and Repair Options for Bridge Connecting Dam and Intake Structure

Seattle University
Department of Civil and Environmental Engineering
Replacement Design of a Culvert to Allow for Fish Passage

University of Minnesota Twin Cities
Department of Civil, Environmental, and Geo-Engineering
Multistage Drip Irrigation System in Ethiopia

University of Nebraska–Lincoln
Charles W. Durham School of Architectural Engineering and Construction
Children's Hospital and Medical Care Expansion

University of Wisconsin–Madison
Department of Civil and Environmental Engineering
Interlake Lock and Boat Transfer

University of Wisconsin–Madison
Department of Civil and Environmental Engineering
Law Park Revitalization

$10,000 AWARD

Miami University

Department of Chemical, Paper, and Biomedical Engineering

Design and Implementation of a Community-Driven Water System in a Rural African Village

Participants

Students

Lexie Adams
Prasidh Arora
Benjamin Daniels
Sophia Fisher
Maggie Jones
Jarred Karikas
Becca Kheiry
Bryce Linkous
Audrey Maguire
Michaela Mitchell
Chantal Monnier
Anne Poindexter
Julia Poth
Brent Reichert
Lucy Rukstales
Nathan Soundappan
Nikki Sundrup
Matt Vito

Faculty

Catherine Almquist, Ph.D., P.E.
Vincent Hand, Ph.D.

Professional Engineers

Mike Brunner, P.E.
Chuck Dragga, P.E.
Gordon Miller, P.E.

Additional Participants

Dallas (Buzz) Auvil, M.D.
Melissa Auvil
John Baginski
Bill Lennard
Jim Maher, M.D.

Jury Comments

"Strong written narrative that shows student engagement and aligns to student learning"

"Great use of the design approach to look at alternatives and devise a final solution"

"Interesting multidiscipline solution to common water-supply issue"

Abstract

This project seeks to provide year-round potable water to a rural African community of around 3,000. The project is part of a partnership between the community, a non-governmental organization (NGO) medical mission group, a professional engineering group, and a student engineering group. The project's assessment, source development, and small-scale pilot treatment phases have been completed, and the full-scale design phase is currently underway. The full design includes solar-powered distribution to a hilltop storage facility; gravity-fed distribution through a physical treatment plant and then to key points in the community, such as the health clinic, schools, and sub-village centers; and sustainable storage throughout.

A project of this type requires collaboration between the student engineering group and their faculty mentors, members of the professional engineering group, members of the NGO, a local hydrogeologist in Africa, and the community leaders, university students, a construction manager, and other members of the partner community. These groups and individuals working together have already resulted in improved water availability for community members located at and around the local secondary school, and with the full design, the entire community will be provided with the same.

The improved water quantity and quality that this design seeks to provide will positively affect the welfare of the community by reducing waterborne illness, dehydration, and other health issues related to lack of water and low-quality water. The clean water will particularly benefit the local health clinic, which will help the village health workers provide better care to community members.

People from a variety of backgrounds have been key in bringing the project to this point. Some of the vital disciplines involved include civil, electrical, chemical, and structural engineering, as well as hydrogeology, construction, and plumbing. A variety of project management skills are also instrumental to the continued success of the project. Because many aspects of the design involve multiple disciplines, those working on the project become familiar with how to work closely with team members from different backgrounds.

Due to how interrelated each discipline is in the design, student engineers working on this project have absorbed knowledge and skills associated with each one of the aforementioned disciplines. This means they can now use their own knowledge of these topics to further this project, in addition to consulting the professionals from each background.

Such a large-scale, multifaceted project allows members of the student engineering group many opportunities: to learn about intercultural and interdisciplinary collaboration, to find solutions to problems facing a community very different from their own, to work with people from a variety of technical and nontechnical fields, and to learn professional, technical, and soft skills that are not often taught in their engineering curriculum. All of these opportunities provide life experiences that will benefit the student engineers throughout their careers.

$10,000 AWARD

Miami University

Department of Chemical, Paper, and Biomedical Engineering

Design and Implementation of a Community-Driven Water System in a Rural African Village

Perspectives On

Collaboration of faculty, students, and licensed professional engineers

The design and implementation of the water collection, distribution, and filtration system would not have been possible without thorough collaboration between students, faculty, and professional engineers. The students managing the project worked closely with professional engineers from several different backgrounds, in addition to faculty mentors from the university. The student engineering group worked primarily with five mentors from the professional engineering group, three of whom traveled with members of the student engineering group to provide onsite engineering expertise and oversight.

Professional engineers met with students from the student engineering group on a weekly basis to guide the design process and provide feedback and comments on drawings and reports. For each implementation, the final system design must be approved by a professional engineer, who certifies that the design, specifications, and calculations are of sufficient quality for professional approval.

The continuous feedback from the professional engineering group mentors ensured that the students were producing high-quality work that would pass inspection by professional engineering reviewers when each project report was submitted.

From their collaboration with professional engineers and faculty mentors, students learned how to interact in a professional environment and gained technical skills from attendance at technical conferences led by professional engineers. Additionally, multiple professional engineers and faculty mentors held technical workshops teaching the fundamentals of EPANET, AutoCAD, and solar-powered systems, which allowed students from any discipline to learn the skills needed to design and model a water collection, distribution, and filtration system. The technical skills gained through these workshops are not explicitly taught within the classroom, which makes the experiences of the students from the student engineering group at these workshops unique and irreplaceable. Faculty mentors also led workshops focusing on skills such as project management and successful communication, and have met with some of the student engineering group leaders to discuss these and related topics in-depth.

In addition to the involvement of professional engineers during the design process, the student engineering group worked closely with engineering students of the partnered community in Africa. This allowed the engineering group students to benefit from the involvement of both professional engineers and fellow engineering students from vastly different backgrounds. The understanding of the local engineering students of the system design was an important aspect of ensuring the sustainability of the water collection, distribution, and filtration system over time.

While in the partner community, members of the engineering group also had the opportunity to work with a variety of other professionals, including a hydrogeologist, construction manager, and members of the community with agricultural and plumbing certifications. The plethora of different skills and accreditations that the collaborating professionals brought to the project were vital to the quality of the finished design as well as the educational experience of the students involved.

Knowledge and skills gained

Students from the student engineering group gained invaluable skills from this project. They learned the benefits of working with professional engineering mentors, faculty mentors, students of different disciplines, and community members of different backgrounds. These skills allowed the students to enhance their knowledge related to working on an engineering project with an international community partner.

The students learned to explore concepts with, teach skills to, and learn from local engineering students in the partner community, which included overcoming some language and cultural barriers. This collaborative work with the community's students and other members, who possessed different abilities and ideas from themselves, led to the students' ability to better understand their own skills and limitations and to assist in creating a community-driven, sustainable project. This partnership allows for continuous learning opportunities that can increase the students' intercultural understanding and collaboration.

Students also learned to search for sustainable solutions in resourceful ways. The university students learned to hone their innovative skills when thinking of solutions that would be viable for the community in the long term. For example, with limited resources, buying supplies requiring specialized equipment may not be an option, so instead students learned optimization processes to maximize their design with the materials available locally. They then relayed this information to the community leaders to assess the community's agreement with and investment in the proposed solution. A project of this type cannot be sustainable and impactful in the long term without the ongoing support and approval of the community, as once the partnership between the engineering groups and the community ends, the community will be responsible for all future upkeep of the system. Overall, students learned how to adapt to changes and utilize community resources to facilitate a sustainable solution.

The engineering students also learned about health initiatives and waterborne illnesses common in a rural African community. From their discussions with workers at the local health clinic and other community members, the students have a better idea of the health concerns facing many African communities, particularly issues that arise from poor access to water. This deepened the students' understanding of how much this project stands to impact in the lives of those living in the partner community.

Furthermore, many skills gained from working on this project could directly translate into the students' professional careers. The students learned how to use surveying equipment to determine elevation differentials for digital models used in hydraulic design programs. Using tools such as EPANET and AutoCAD under the mentorship of professionals expands their knowledge beyond what they might have learned in a class. Additionally, the students worked with the professional engineers on a regular basis to learn the proper procedure and methods for a large-scale project. The knowledge and connections the students gained from working with professional mentors allow for them to improve their skills in working and communicating in a professional environment. The professional engineering group mentors worked tirelessly with the students to help them understand proper design methods, technology, and thought processes to find the most economical solutions to the problems they were facing. Understanding the design process and the other skills the mentors passed on will help the students become leading candidates in their chosen industry.

Students learned leadership skills by holding positions within the student engineering group and from their experiences with their mentors, peers, and members of the partner community. Students had the opportunity to learn about team management and efficiency from a certified project manager. They were taught how to handle a large organization of students that works with people from many different disciplines and how to bridge different viewpoints and ideas to develop an inclusive solution. Additionally, several students on the project learned how to construct and follow a budget and to schedule construction tasks in tandem with other project tasks such as surveying, water data collection, and meetings with community members. The project also involved working closely with the community leaders while following a partnership contract detailing each group's responsibilities. All of this contributed to the students' knowledge of important aspects of project management and collaboration both within teams and between teams and communities. This has allowed for them to gain an understanding of the importance of professional communication and solid agreement between all parties.

Overall, the project has taught the university students that they have the ability to work closely with communities and each other to facilitate collaborative and sustainable solutions to a pressing problem, and it has brought them the ability to extrapolate that which they have learned to many aspects of their life. The knowledge with which their mentors and partner community contacts endowed them will enrich the students' professional journeys for years to come, both in technical aspects and in soft skills. The students had to learn how to work as a part of a team of professionals, peers, and international community members, and what they have gained from these interactions are some of the most valuable skills and knowledge they will ever have.

$10,000 AWARD

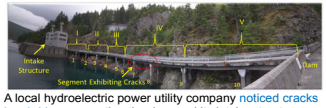
Seattle University

Department of Civil and Environmental Engineering

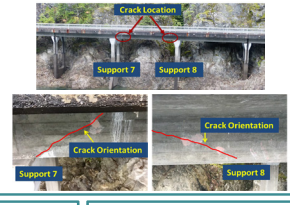
Load Rating and Repair Options for Bridge Connecting Dam and Intake Structure

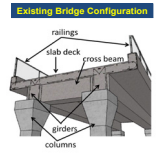
Load Rating and Repair Options for Bridge Connecting Dam and Intake Structure

Introduction



A local hydroelectric power utility company noticed cracks in a bridge connecting the dam and its intake structure. The company requested one of our civil engineering capstone teams to perform load rating of the bridge, and recommend retrofit options to control further cracking enabling safe use of the bridge by maintenance vehicles.





Site and Project Constraints

- Site located within a national park; thus strict environmental regulations apply.
- Facility on registry of historic sites; therefore the original appearance of the structure must be preserved.
- Remote location of site poses challenge transporting any construction materials.
- Due to load limitations on the bridge, no cranes to be used in the retrofit; any construction should be done from barges on lake.

Engineering Analysis

Field Reconnaissance

Team visited site, talked to utility maintenance crew to understand operational practices, and measured accessible parts of the bridge.

Document Review

Team reviewed engineering drawings in various formats (microfiche, as built plans, AutoCAD reproductions), and bridge inspection reports.

Findings

- Used field measurements to confirm accuracy of as-built drawings.
- Obtained steel and concrete properties used in construction from drawings and literature review.
- Compiled list of three trucks to use in analysis based on discussion with maintenance crew, site constraints and AASHTO recommended generic vehicle specifications.

Load Rating Analysis

- Team computed demand and capacity of bridge in shear, tensile flexure, and compression flexure for the three design vehicles.

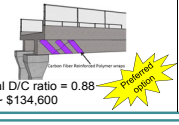
	Demand to Capacity Ratio (D/C)		
	HL-93 Truck	HL-93 Tandem	RT750-XL Crane
Shear (kips)	1.20	1.12	1.31
Tensile Flexure (kip-ft)	0.76	0.83	0.86
Compressive Flexure (kip-ft)	0.68	0.66	0.73

D/C < 1 for safe performance

- Bridge has insufficient shear capacity; therefore team considered retrofit options to increase shear capacity.

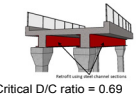
Retrofit Options Considered to Increase Shear Capacity

Option 1: Carbon Fiber Reinforced Polymer (CFRP) Wraps



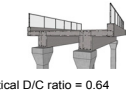
Critical D/C ratio = 0.88
Cost ~ $134,600

Option 2: Attaching steel channels to girders



Critical D/C ratio = 0.69
Cost ~ $1.5 Million

Option 3: Replacement of slab and girder

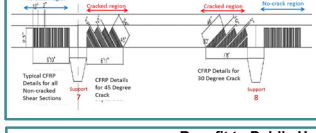


Critical D/C ratio = 0.64
Cost ~ $3.5 Million

Design Details of CFRP Wrap, the Preferred Option

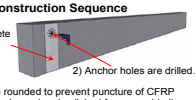
Design of CFRP Wrap Placement

Team compared shear capacity to demand along span where cracks were observed and determined the distance from either support where demand exceeded capacity. In the cracked zones, CFRP wraps will be applied perpendicular to the crack preventing further crack propagation. In the uncracked regions, CFRP wraps will be applied vertically.



Construction Sequence

1) A layer of concrete is removed from girder.



2) Anchor holes are drilled.

3) Sharp edges are rounded to prevent puncture of CFRP wraps; surface is cleaned and polished for proper binding. Then epoxy is injected into anchor holes.

4) Anchor dowel end and anchor slot are saturated with primer. Then anchor dowel is impregnated into anchor hole and anchor fan fanned out.

5) Epoxy is applied to the girder and CFRP is installed. Finally another coat of epoxy is applied.

Multi-Professional and Multi-Disciplinary Collaboration

- Two licensed faculty members advised the team.
- A licensed engineer from the utility company served as a client liaison and mentor to the team.
- Department advisory committee consisting of a dozen professional engineers provided feed back on the presentations.
- At a local ASCE presentation competition a panel of five professional engineers served as judges and chose this project to be presented at the monthly ASCE section meeting.
- Utility crew personnel educated the team on the usage of the bridge and provided insight on retrofit option.
- Team consulted with a CFRP manufacturer to learn the technology and the installation technique.
- A drafter from the utility company assisted the team to develop a professional quality project.
- A historian helped the team to understand the historical significance of the project site and design criteria to abide by.
- Team presented its final recommendations to project managers and staff members at the utility company.

Benefit to Public Health, Safety Welfare

- Health and safety of the utility company maintenance crew was the impetus for the project.
- Safety of construction crew was taken into account in design.
- Interruption of power supply would adversely impact the welfare and quality of life for consumers.
- Experience dealing with nation's aging infrastructure issues.

Knowledge and Skills Gained

Engineering & Technical Skills

Use of Design Documents: 2014 AASHTO LRFD Bridge Design Specifications, ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures, American Concrete Institute Guide for the Design of Construction of Externally Bonded Fiber Reinforced Polymer Systems for Strengthening Concrete Structures

Use of Software: SAP 2000 software, MS Excel, Trimble Sketchup, AutoCAD

Experience in construction sequence, cost estimation

Professional Skills

Oral presentations to peers, Professional Engineers on department advisory committee, utility company personnel, and to local ASCE and Structural Engineering societies

Developed technical writing skills through proposal, final report, and professional emails

Interacted with engineers and non engineers

Project management and leadership: ran meetings with agenda, tracked action items, managed schedules and budgets, worked as a team

Participants

Students

Christopher Belson, E.I.T.
James Esteban
Delton Oki, E.I.T.
Yashar Zafari, E.I.T.

Faculty

Nirmala Gnanapragasam, Ph.D., P.E.
Josh Pugh, Ph.D., P.E.

Professional Engineers

(Late) Dan O'Sullivan, P.E.
David Rowan, P.E.

Additional Participants

Kevin Vaughn (Sika Corporation)

Jury Comments

"Tackled a real-world problem close to home"

"Detailed and comprehensive project that was clearly student-led"

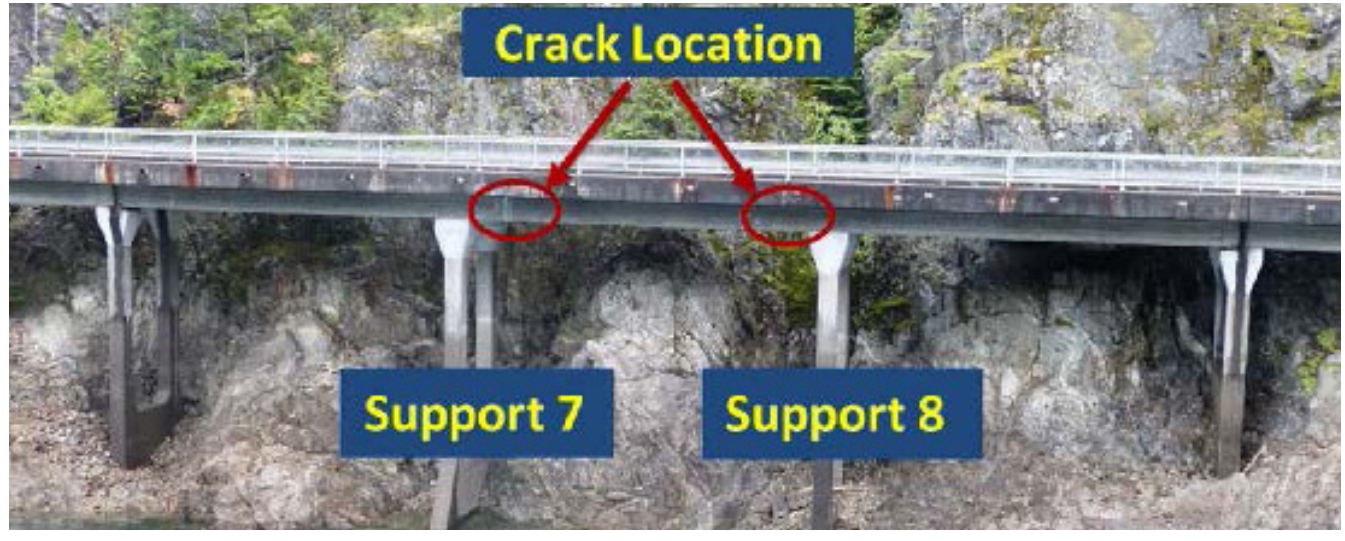
"Good to see alternatives were evaluated to define a best approach"

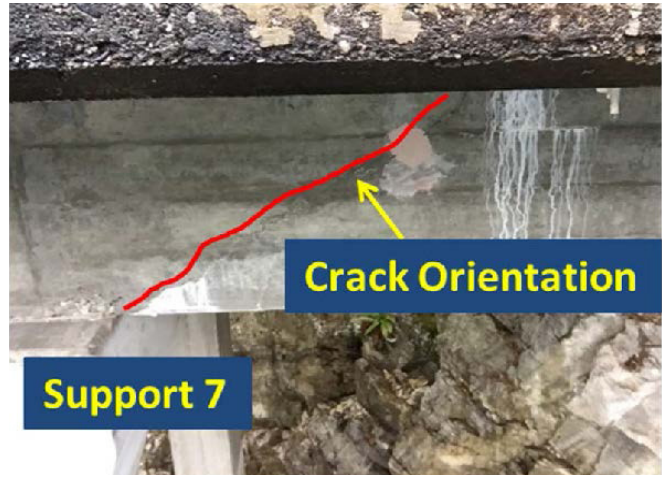
Abstract

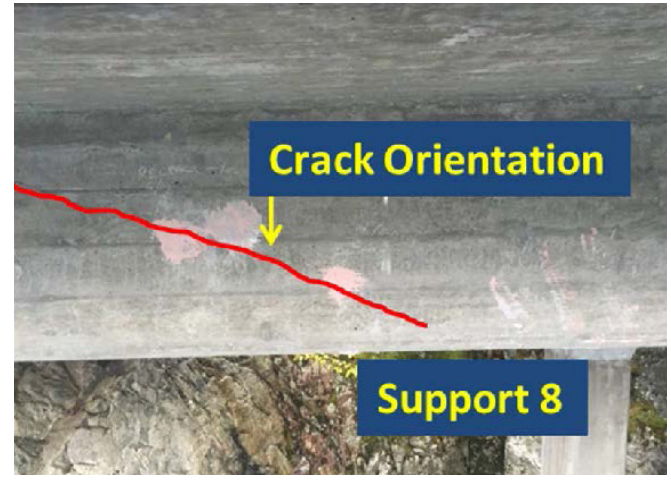
A local hydroelectric power utility company found diagonal cracks in a concrete bridge connecting the dam to its intake structure. The utility company requested our senior capstone team to perform a load rating of the bridge and recommend retrofit options to ensure safe operation of the maintenance vehicles using the bridge.

The bridge, built in the 1930s, is in a remote area within a national park and is on the National Registry of Historic Sites. Using measurements collected during the site visit and as-built drawings, the team computed the demand and the capacity of the bridge for various vehicular loadings. From this analysis, the team concluded that the bridge had insufficient shear capacity, leading to cracking.

The team proposed three retrofit options: i) wrapping the girders with carbon fiber reinforced polymer (CFRP) wraps, ii) attaching steel channels to the girders, or iii) replacing the slab deck and the girder. Based on the cost, ease of installation, and reduced environmental impact, with input from the company, the team selected CFRP as the preferred alternative. The team took the CFRP option to 60 percent design.





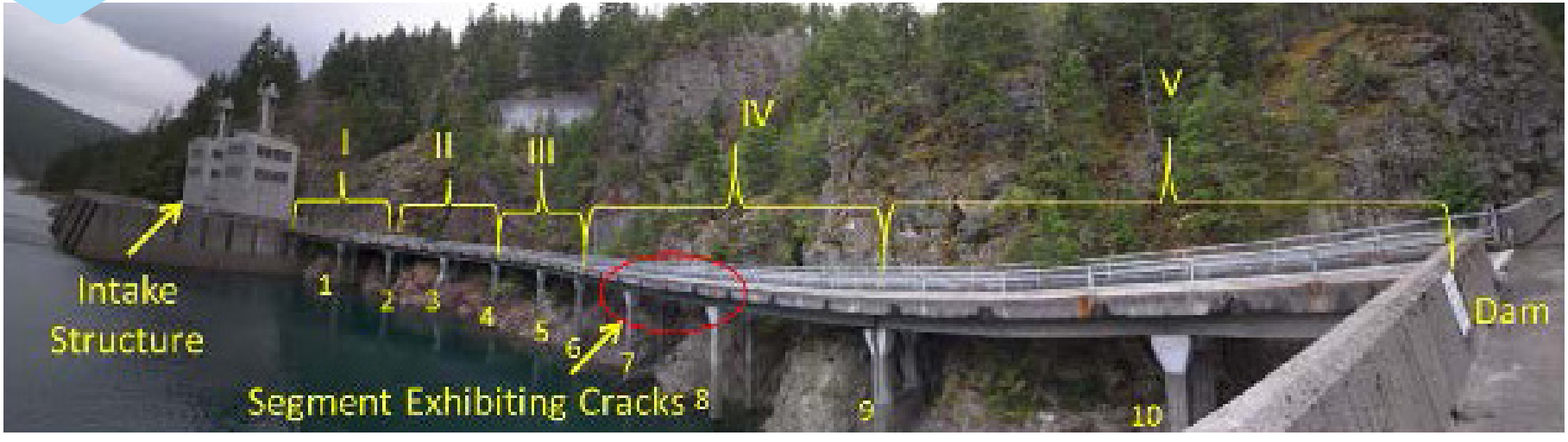


$10,000 AWARD

Seattle University

Department of Civil and Environmental Engineering

Load Rating and Repair Options for Bridge Connecting Dam and Intake Structure



Perspectives On

Collaboration of faculty, students, and licensed professional engineers

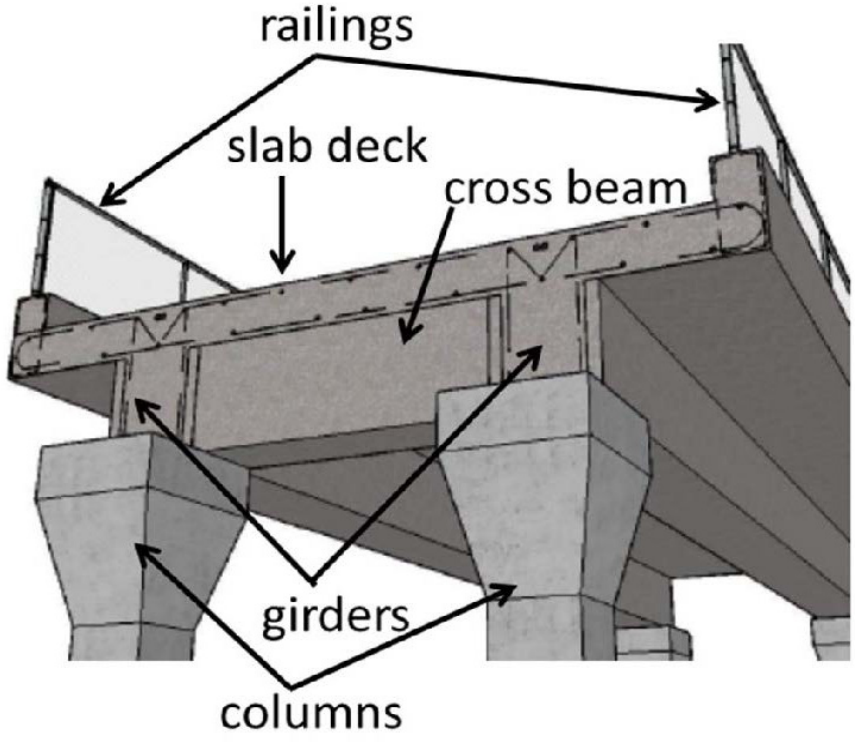
Students in our engineering program complete a year-long, industrially-sponsored, real-life capstone project. A team of four students worked on this project under the supervision of a liaison engineer from the client and a structural engineering faculty member from the university, both licensed professional engineers. The senior design course is taught by a faculty member who is also a licensed professional engineer. The students met with the faculty advisor weekly and with the client liaison biweekly. The faculty members provided feedback on the proposal and report throughout the academic year.

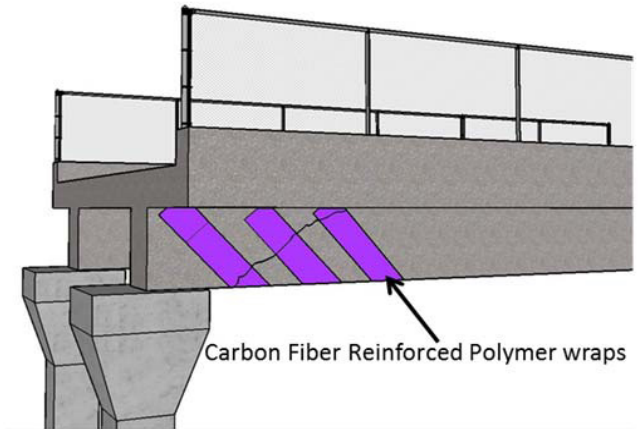
In fall and spring quarters, the team presented their work to the client. Diverse groups of professionals attended these presentations. Although the students found these presentations to be quite challenging due to the extensive knowledge and experience of the audience and the questions asked, they believed it provided an opportunity for professional growth.

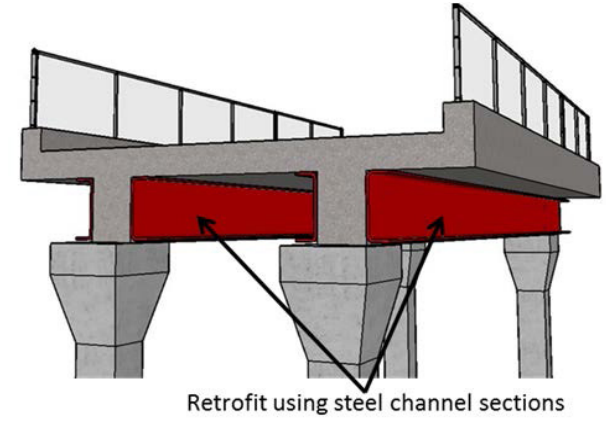
The team made an oral presentation to the department's advisory committee —consisting of a dozen local licensed practitioners—in early winter quarter, describing their project scope and plan of action. Members of the advisory committee also attended the end of the academic year presentation at a university event. In addition, the team presented its proposed plan in early winter quarter to the local Structural Engineers Association.

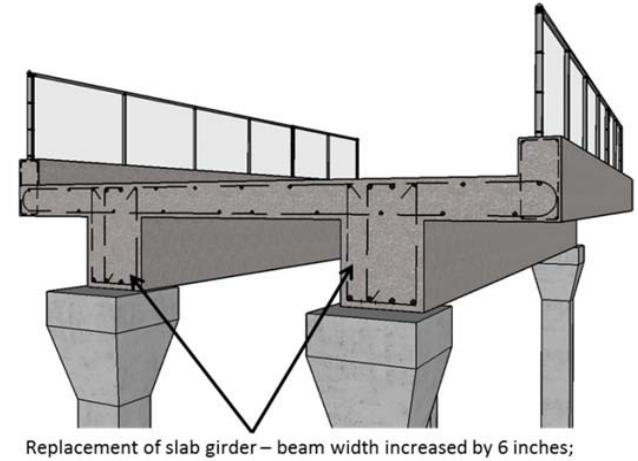
Protection of public health, safety, and welfare

The health and safety of the utility company maintenance crew who uses the bridge was of paramount importance. The project, when completed, enables the maintenance crew to perform their work in a safe environment. The team also considered the safety of the construction crew when repairing the bridge. The









dam is a major hydroelectric power generator for the region. Any interruption of power production could adversely affect the quality of life of the consumers.

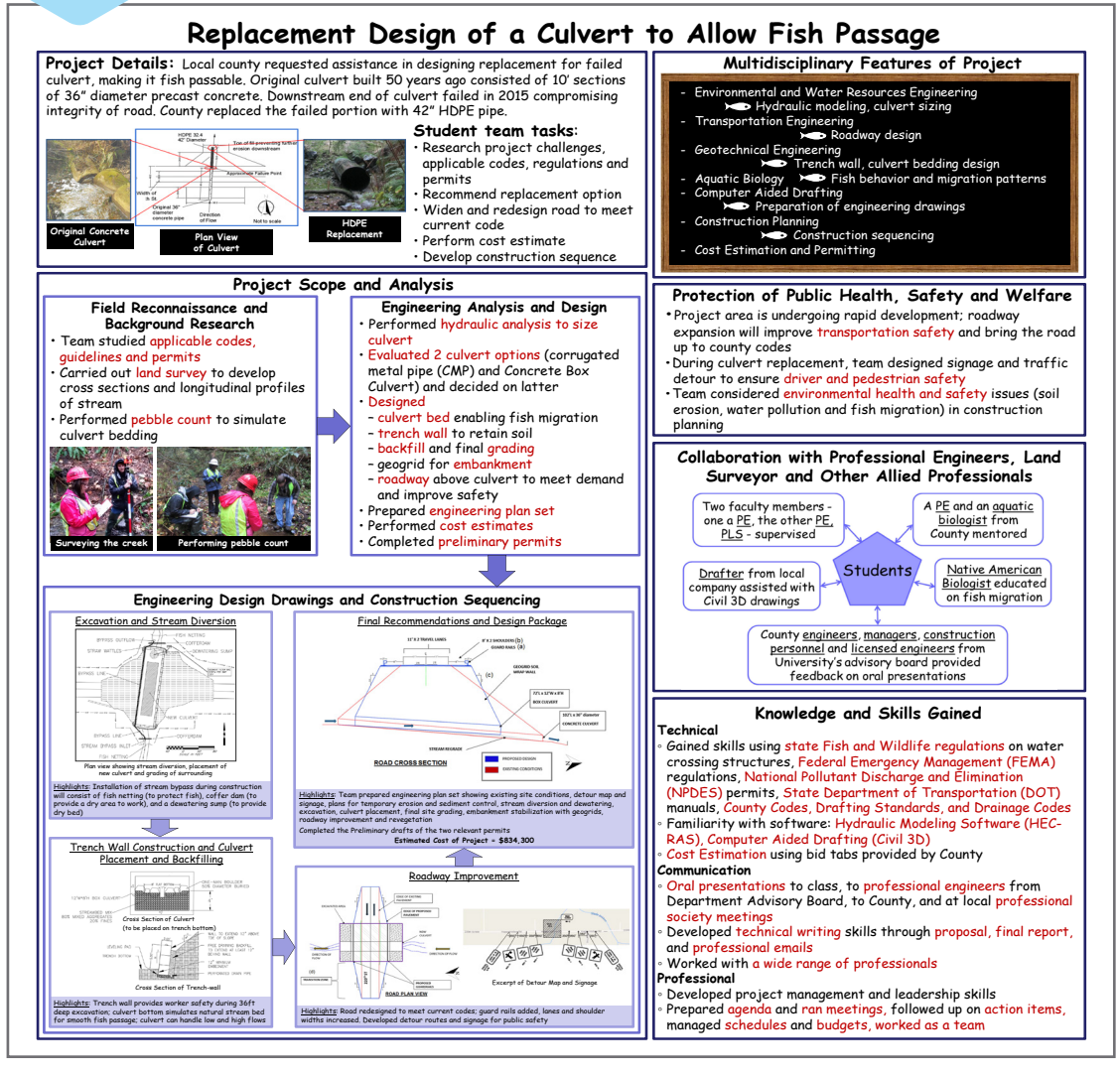
Our nation's aging infrastructure is currently of major concern. The skills the students developed through this project are valuable for the health, safety, and welfare of the public in the long run.

$10,000 AWARD

Seattle University

Department of Civil and Environmental Engineering

Replacement Design of a Culvert to Allow for Fish Passage



Participants

Students

Paul Caswell, E.I.T.
John Faille, E.I.T.
Mireille Fogang
Dorothea Hannah, E.I.T.

Faculty

Nirmala Gnanapragasam, Ph.D., P.E.
Mark Siegenthaler, P.E., P.L.S.

Professional Engineers

Nova Heaton, P.E.
Mike Randall, P.E.

Additional Participants

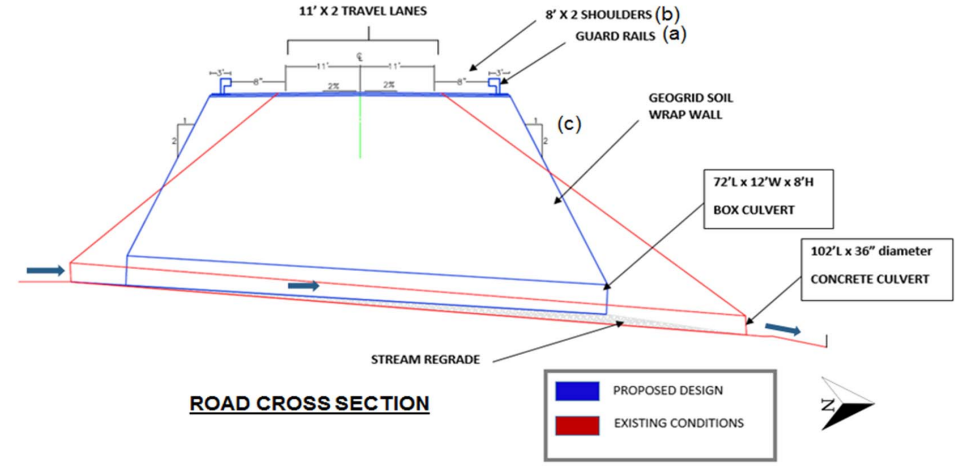
L. Ted Parker
Scott Rockwell
Lara Turnidge

Jury Comments

"Good multidisciplinary project that also involved associated sciences and community leadership"

"Applied creative engineering to best serve everyone involved"

"Good student-driven solution to resolve a real-world issue"



Abstract

A local county requested our university's assistance to design a culvert that had failed underneath a county road. The culvert was also considered a fish barrier. The original culvert was designed and built more than 50 years ago, prior to regulations governing fish passage. Furthermore, because of the rapid growth in the region, the road above the culvert was not meeting local codes. The county requested that the team develop two culvert options that were fish passable, evaluate them, and recommend a preferred option. Following that, the team had to finalize the preferred option with the roadway above the culvert widened to meet current codes, develop a construction sequence for replacement of the culvert, estimate the cost of the project, identify relevant permits, and complete preliminary drafts of these permits.

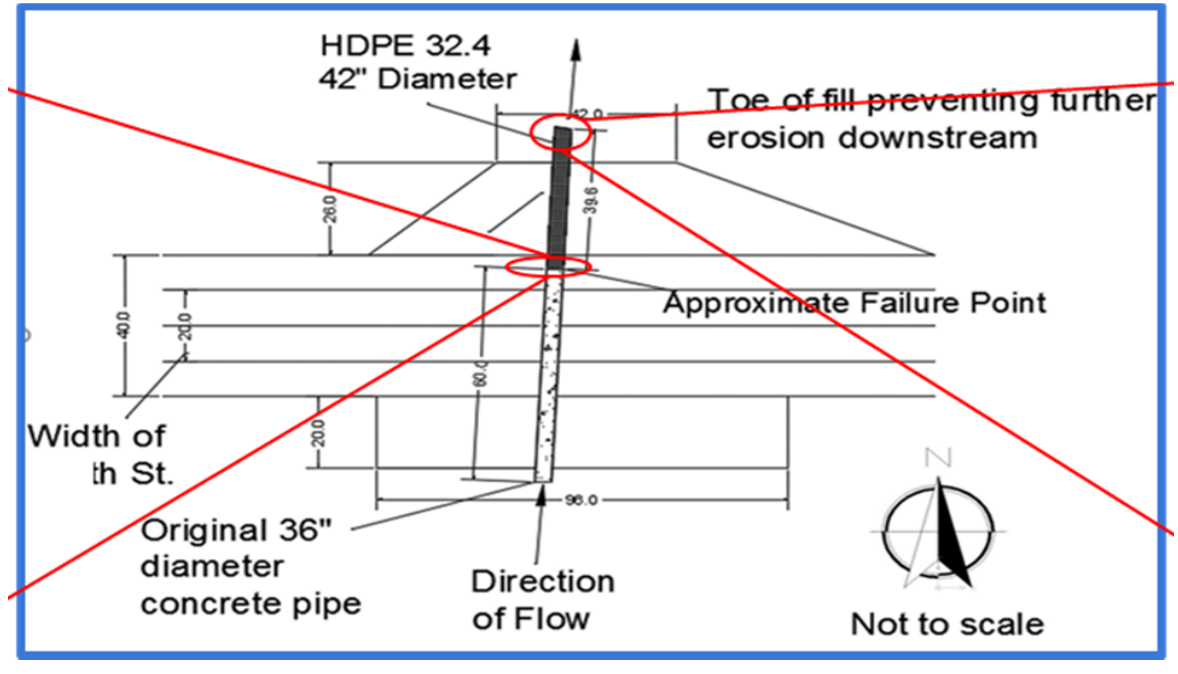
The project encompassed multiple disciplines: environmental and water resources engineering for stream flow simulation and culvert sizing; geotechnical engineering for trench wall design and for selection of culvert base material so that it matches the stream bed, making it fish friendly; transportation engineering for roadway design; aquatic biology to understand fish behavior and migration patterns; drafting to develop professional-quality engineering drawings; and knowledge of applicable permits, cost estimation, and construction methods.

$10,000 AWARD

Seattle University

Department of Civil and Environmental Engineering

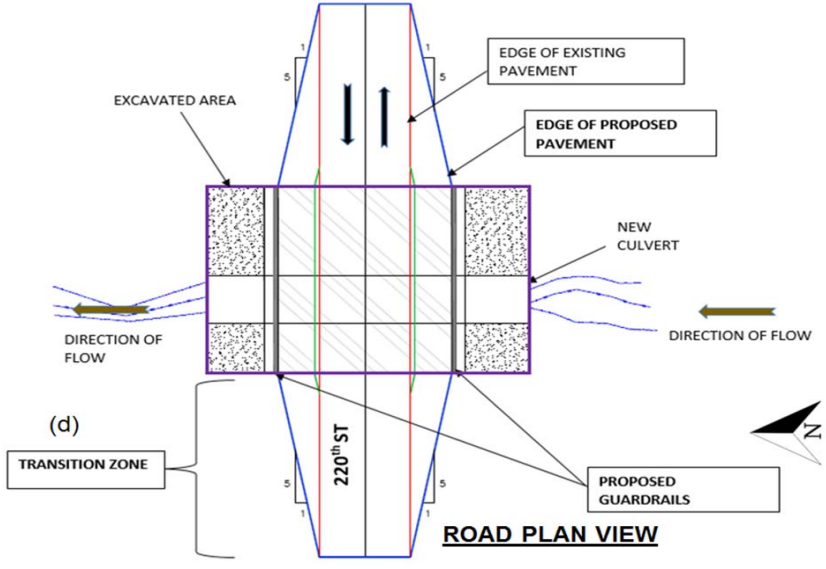
Replacement Design of a Culvert to Allow for Fish Passage

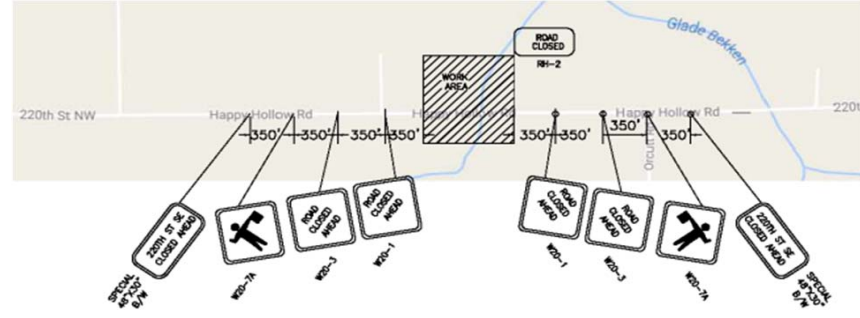


Perspectives On

Multidiscipline or allied profession participation

This project required knowledge of various sub-disciplines within civil engineering: environmental and water resources engineering for stream flow simulation and sizing the culvert, geotechnical engineering for simulating the culvert base to match the stream bed and for trench wall design, and transportation engineering for roadway design. Furthermore, an aquatic biologist from the county and a biologist from a Native American tribe advised the team on issues related to fish migration. The university hired a drafter from a consulting company to serve as a resource to the team in preparing professional-quality civil 3D engineering drawing. When the team presented their work to the county, engineers, managers, and construction managers attended the presentations, asked questions, and provided valuable feedback to the team.





Protection of public health, safety, and welfare

The project area has experienced rapid development in recent years. Bringing the road up to current code would alleviate traffic congestion, which is a public welfare issue. The team planned signage and traffic detours because of the 36-foot-deep excavation, which could affect driver and passenger safety. The students considered soil erosion and water pollution issues when considering stream diversion options during construction.

Collaboration of faculty, students, and licensed professional engineers

At our institution, all engineering students work on a real-world project during their senior year under the mentorship of a sponsoring agency or company. A diverse group of four students worked on this project and were mentored by a liaison engineer from the county and two faculty members from the university, all licensed professional engineers. One of the faculty members is also a licensed land surveyor.

Our department has an active advisory board consisting of local civil engineering licensed practitioners. It meets twice a year to provide feedback on curriculum, future growth, internship/job opportunities for students, and other industry-academic issues. The team presented the project to the board members twice. The first presentation early in the year covered their understanding of the project scope and how they planned to accomplish the work. The second presentation at the end of the year covered the work accomplished, conclusions, and recommendations. In addition, an advisory board member reviewed the final drafts of the proposal and report. The team addressed the reviewer's comments before finalizing the documents.

$10,000 AWARD

University of Minnesota Twin Cities

Department of Civil, Environmental, and Geo-Engineering

Multistage Drip Irrigation System in Ethiopia

Participants

Students

Colin Bain
Maxwell Fite
Nathan Heyer
Lily Hock
Andrew Kanewske
Mitchell O'Brian
Allan Ouyang
Cole Theobald

Faculty

Paul Capel
Matt Simcik

Professional Engineers

Gerritt Bangma, P.E.
Walter Eshenaur, P.E.
Doug Fullen, P.E.

Additional Participants

Nebiyu Eguale
Tim McCarron
Jeff Weiss
Shannon Wolkerstorfer
Mehrete Kirstos Monastery

Jury Comments

"A project with real-world impact and public benefit"

"Multidisciplined team and approach strengthened the project"

"Innovative approach to a significant human health issue"

Abstract

Ethiopia is facing an ongoing drought since 2015 that has led to 5.6 million people needing emergency food assistance. During much of the year, the community of Filakit Geragera in the Amhara region of Ethiopia has insufficient irrigation capacity to utilize all of their fields. The community hopes to improve their economic standing and the nutrition of all residents, especially children. In addition, the local government is threatening to repossess these lands if the situation remains unchanged. The student-led project team has partnered with the people of Filakit Geragera to address these problems by designing an irrigation system that would make use of limited water supply during the dry season.

In order to make sure that all of the village's needs are met, the team holds regular community calls and works with an NGO partner, a local monastery. The monastery is a foundational organization within the community and acts as both a funding partner and a community-based partner. One of the biggest problems the village faces to this day is utilizing all of their tillable land and supplying enough food to meet the demands of the community's growing population. During the rainy season, water is plentiful, but a combination of wasteful irrigation practices, far-off water sources, and inefficient water distribution systems makes the dry season difficult for the people who live there.

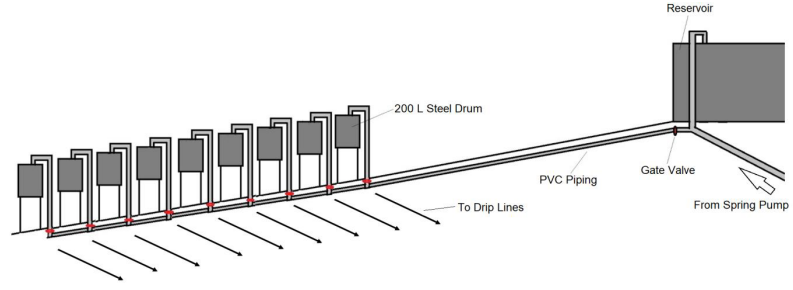
The four-student design team determined that a drip irrigation system would minimize water loss from evapotranspiration while still meeting the field's water demands. However, the terrain of the area is very mountainous. The upper field has a slope of about 5 degrees, while the lower field has a slope of about 8 degrees. This makes traditional irrigation methods and a normal gravity-fed drip irrigation system impractical. Another major challenge is the lack of power in the region and the community's distance from major markets. A sustainable solution that does not rely on modern power and piping infrastructure is required. To overcome these challenges, students designed and are implementing a gravity drip irrigation system that utilizes a set of towers, each feeding a set of drip lines that run perpendicular to the slope of the field. This multi-tower system allowed for effective use in an inclined situation without relying on a pressurized water pipe system. Human-oriented design and sustainability were major focuses of this innovative engineering and construction project.

$10,000 AWARD

University of Minnesota Twin Cities

Department of Civil, Environmental, and Geo-Engineering

Multistage Drip Irrigation System in Ethiopia



Perspectives On

Collaboration of faculty, students, and licensed professional engineers

The Ethiopia project involved multiple mentors with professional engineering experience. While the student group is completely student-led, these mentors assisted the various sub-groups within the project, including with the drip irrigation sub-group. One of the professional engineers, whose background is in construction and public works, provided design advice and also held a "build day" to teach team members vital construction skills, such as laying pipes, using concrete, and constructing the tower bases. Another mentor recommended coating the below-ground parts of the tower in used motor oil to prevent corrosion in the wood. The build day was also used to create a prototype of one of the water storage towers. A project manager of an architecture and engineering firm is the design team's primary mentor. One principal engineer who works for a medical device company also mentors the drip irrigation group, giving input on creating a budget, setting deadlines, and design decisions. A group of students, who will implement the project in May 2018, will also be accompanied by two professional engineers. Mentors make sure construction goes smoothly and help solve any problems that may arise in-country. One of the mentors acts as a translator, as he can speak Amharic. Finally, the professional engineers who volunteer as project mentors help students make connections with local companies and set up presentations at their workplaces to inform associates about the impact of students' work.

Besides the professional engineers and architects who work with the project team, students also have direct support from staff within the college and department. Two professors meet with the student group leaders in regular meetings every two weeks to discuss administrative decisions and long-term goals and to provide technical support. They also are advocates for the student group when it comes to reaching out to local companies and supporters within the university. The staff from the university department and college help maintain continuity with financial accounting and benefactor relations. Each advisor

helps students learn soft skills, such as communication and group decision making, while helping the students retain knowledge and connections as new members take over leadership roles in the group and outgoing members transition out of school and into the industry.

The student project team members are also pursuing many different degrees and career paths, which makes the project process truly a multidisciplinary endeavor. Members of the design team are currently pursuing degrees in civil engineering, mechanical engineering, chemical engineering, and mathematics. This synthesis of ideas and backgrounds allows for a variety of approaches from across disciplines that further provides development as engineers and student leaders.

Protection of public health, safety, and welfare

One way to ensure project sustainability and community welfare is to involve the community members in many aspects of the project-planning and decision-making process. This entails regular community calls and working with the monastery NGO partner. As the monastery is led by two main priests who live within and lead the community, they are the clear points of communication from which the project team can receive reliable information about the community and ask for input on the project design. They are invaluable resources for determining the needs of the community. Furthermore, they are leaders in the community and know how to introduce new ideas or spread information to the residents. This helps ensure that project plans are understood and well received by community members and local officials. Beyond the NGO partner and the community leaders, project leads communicate with the local government council, the Woreda, to ensure the project best meets the community's needs. The assistant director of the Woreda has also introduced the project team to local engineers who will be valuable resources with knowledge on aspects of engineering specific to the area. Another important person in ensuring successful communication between the community members and the project team is an Ethiopian university student who will help translate. She also has a background in public health. These collaborators, along with the project team, all have an important role in the project's success, which will ultimately improve the lives and health of community members.

It is imperative for project sustainability that community members understand and are engaged in the system's implementation. Informative discussions along with operation and maintenance manuals will supplement community members' hands-on understanding. That way, they will be able to operate the system properly and to its full potential. In the case of a system malfunction, a select group of trained community members will be able to pinpoint where a failure is and make the proper fixes. To foster this understanding, students will give a detailed and thorough explanation of how the system works and the reasoning behind the design choices made. This will make repairs easier and also build trust and further communication between the community and our team. Beyond emergency repairs, establishing a regular maintenance program will make problems less frequent and easier to address. The student group has calculated the financial cost estimates for maintaining the system, which assures community members the system will be financially feasible for them in the future. One important point students emphasize with the community leadership is that the irrigation system water is not intended to be used for drinking. Other portions of the larger project with the community of Filakit Geragera are simultaneously being implemented in the community and are intended to provide access to treated water for household use.

System safety and proper construction practices will also be applied to this irrigation project. Tower stability is a crucial aspect of the design in order to allow for safe use. While operating the system, it is imperative that each tower can withstand the load of a full tank as well as unexpected horizontal loads. In order to prevent failure, a stress analysis was performed on the tower design to make sure that it can support the weight of the water. Each tower also has outer dimensions of 2.5 by 2.5 feet, and each of the legs will be dug and anchored into the ground to improve stability. The pipeline feeding into the system took into consideration other safety effects to prevent pressure buildup and backflow in the system. The tanks themselves are open to the atmosphere to prevent pressure buildup and subsequent damage to the drip lines. Since this system uses gravity to feed water to the field, there is no risk of pressure building up in the system after it leaves the tower. The total hydrostatic pressure in the drip line is only about 5 feet of head or 2.2 pounds per square inch. The flag emitters used in the system have a low flow rate of one gallon per hour. Drip systems inherently avoid erosion of the community's fields and overwatering of the crops. Emergency shutoff valves will also be installed in case of malfunction.

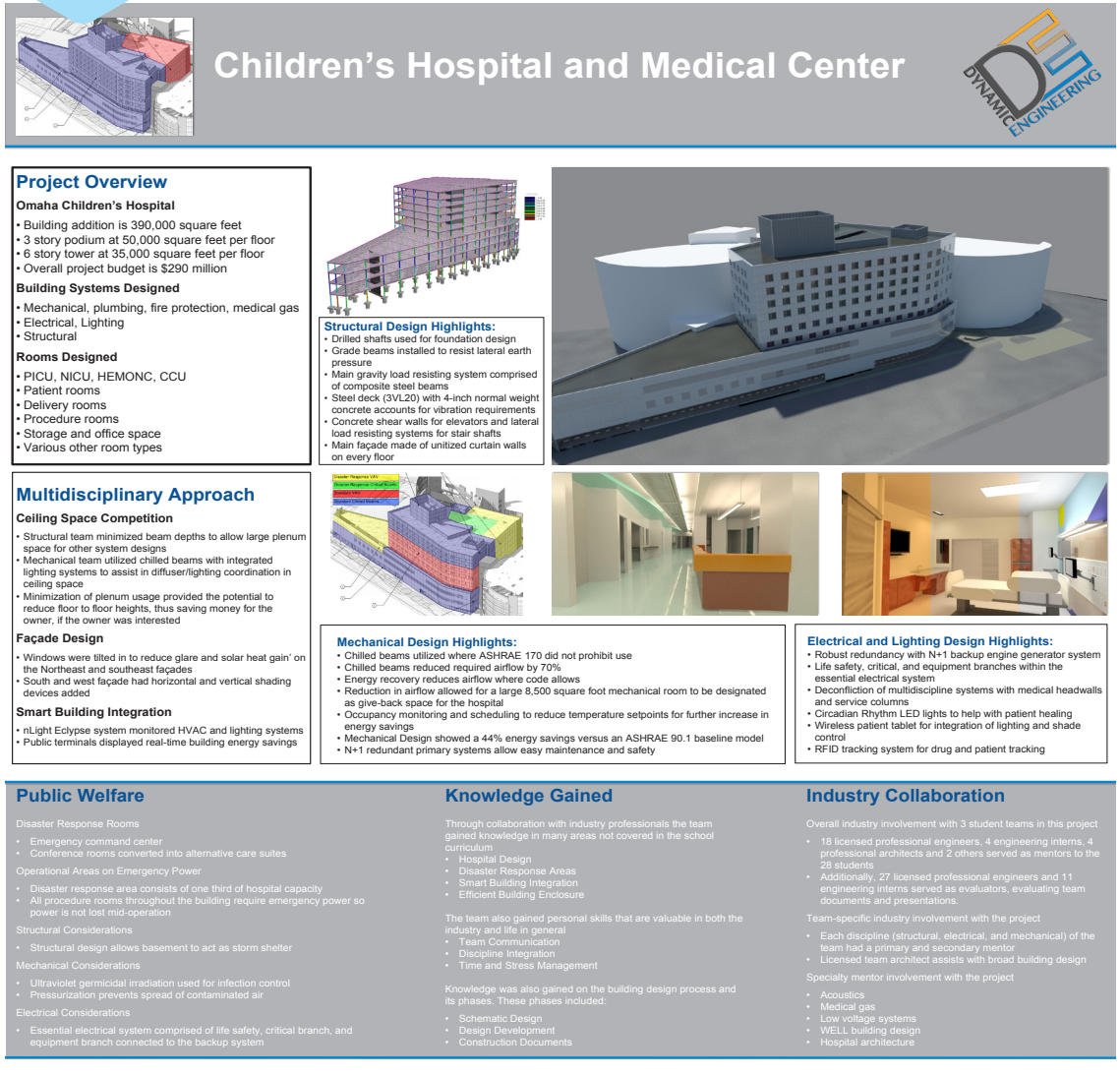
The multi-towered drip irrigation system will ultimately increase community crop production. Utilizing this improved irrigation technique along with a double-cropping system that they employ in their other fields, the community will be able to maximize the project's impact. These changes will lead to improved harvests that will directly benefit the community by giving them improved nutrition and more economic opportunity and by reducing the chance of regional government repossession of their farmland.

$10,000 AWARD

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction

Children's Hospital and Medical Center Expansion



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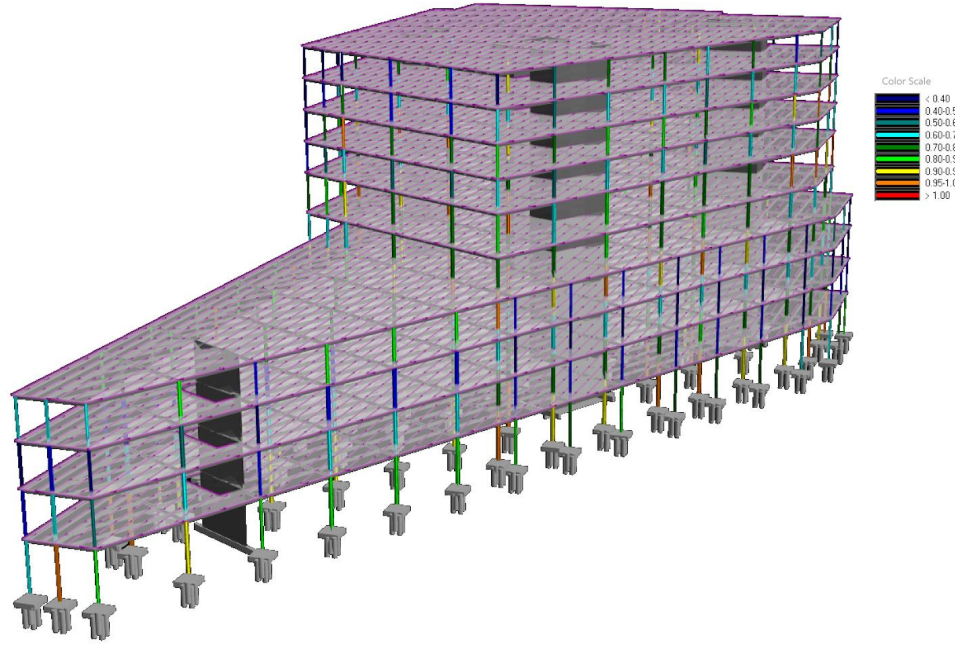

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Jury Comments

"Uniquely innovative project for student learning"

"Great collaboration between students and P.E.s"

"A large, complex project that brought together many disciplines"

Abstract

With great pride, engineering student teams have undergone the task of designing the new addition to the children's hospital and medical center in a city. For this project, careful attention was given to design solutions for the owner's three specific design challenges: a high-performance building enclosure, smart building integration, and disaster response planning. Student design teams placed an emphasis on the development and integration of innovative design solutions, while engaging in robust collaboration and peer review. Students gained experience working in a manner similar to typical building design and construction industry professionals. Teams consistently worked together to integrate innovative design solutions. Through this close collaboration with not only team members but also a large pool of industry mentors and evaluators, the students gained an unprecedented amount of knowledge in a single academic year. Through this experience, the students gained confidence in their complex designs that pushed the boundaries of what was expected. Owner challenges were met with an excitement to create unique solutions, all while adhering to the budget provided. This project had a strong impact on all members of the design course that will prove beneficial as they soon begin their careers in the architectural engineering industry.

Teams addressed the overall building systems via written submissions communicating the design intent and showing proof of concept, complete with supporting calculations within the outlined scope. All designs complied with code and zoning requirements. The following sections describe some of the key systems integrated across design disciplines as well as lessons learned from deeply engaged professional engineers and faculty.

$10,000 AWARD

University of Nebraska–Lincoln

Charles W. Durham School of Architectural Engineering and Construction

Children's Hospital and Medical Center Expansion

Perspectives On

Protection of public health, safety, and welfare

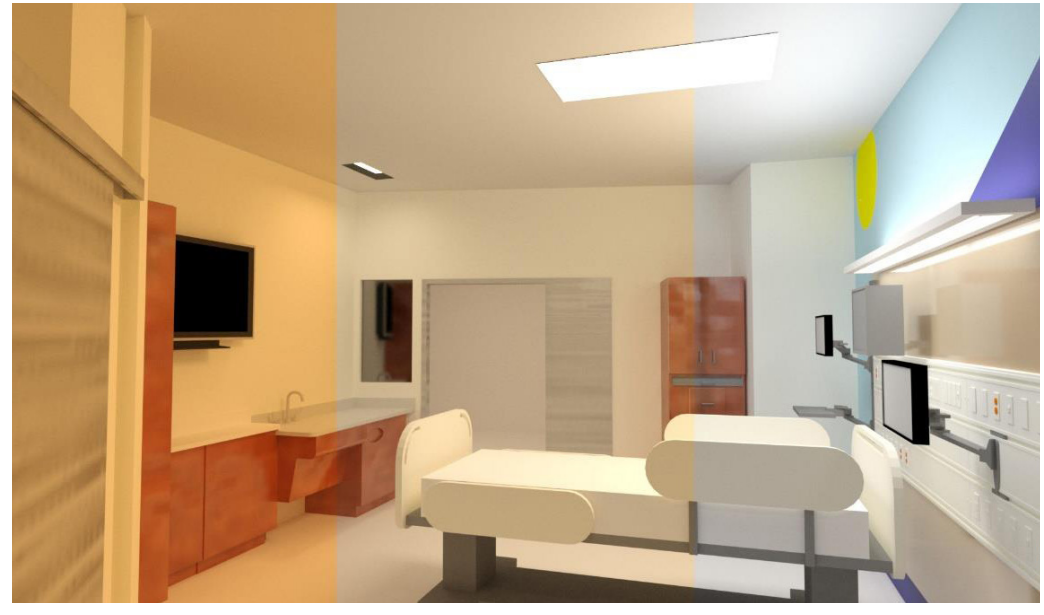
Portions of the building were designed to serve as an emergency command center in the event of a natural disaster. Structural teams designed the alternative care site to withstand an Enhanced Fujita scale 4 tornado. Mechanical teams provided additional cooling and heating capacity to the emergency command center to address the increased loads caused by the increase in occupancy during emergencies. In addition to structural challenges, the electrical and mechanical teams provided a plan to operate the building for a minimum of 96 hours on emergency power, meeting the basic requirements of National Fire Protection Association 110, Federal Emergency Management Agency 543, and Facility Guidelines Institute guidelines.

Day-to-day safety of the patients, staff, and general public is protected by multiple systems within the hospital. Legionella prevention followed American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard, 188 and in addition, faucet aerators were selected that prevent the water from being retained within the aerator and acting as a potential legionella breeding environment. Emergency lighting systems maintain the lighting levels for safe navigation of the hospital in the event of emergency power loss.

Patient isolation rooms and operating suites were designed to maintain a negative pressure relative to the surrounding spaces. All air handling units serving the hospital spaces utilize a minimum of minimum efficiency reporting value 13 filters to prevent the circulation of contaminants and utilize ultraviolet lamps to kill mold and bacteria within the airstream.

Knowledge and skills gained

With their broad basis of experience, industry mentors



provided a rich well of knowledge for students to draw upon and learn from. Through collaboration with these professionals, teams were able to experience professional-level practices about facets of the field not covered in coursework. This project also provided a unique opportunity for students to learn about the codes and standards typically used for hospital design. Allowing teams to learn about advances in healthcare, focus was placed upon designing a facility that placed patient needs and comfort at the forefront of the decision-making process.

The project provided each team with the opportunity to work in a multidisciplinary collaboration for possibly the first time. To ensure proper team and resource management, the teams used weekly meetings and predetermined worktimes to collaborate. This resulted in learning how to properly manage a project from start to finish, with a construction document level submittal due at the end of the project.

Being an effective influencer is imperative when competing against other firms for allocation of a project. This practice was similarly applied to this course and project. It was essential for teams to effectively communicate their design intent to the client and perspective audience.

To understand a facility of this caliber, past project research was crucial to learn about healthcare facility design trends. This research led to selection of equipment and systems that are competitive in the healthcare environment. In addition, codes and standards drive design choices, so developing a deep understanding of the codes and standards related to healthcare design was critical to understanding the choices to be made.

$10,000 AWARD

University of Wisconsin–Madison

Department of Civil and Environmental Engineering

Interlake Lock and Boat Transfer

Interlake Lock and Boat Transfer Station

Enhancing Navigation While Preventing Invasive Aquatic Species

Community Enhancement and Environmental Protection

Project Description

The Interlake Lock on River A links Lake Michigan to a large nearby lake (Lake B) in Wisconsin, USA. The lock was closed in 1988 to prevent the spread of aquatic invasive species (AIS) such as sea lamprey and spiny water flea. Movement of AIS from the downstream Lake Michigan side to the upstream Lake B side warranted a permanent barrier, but closure of the lock halted both upstream and downstream passage of recreational and commercial vessels.

Without the lock, community members are trusted to thoroughly clean their aquatic craft to remove AIS when transporting between bodies of water. The new Interlake Lock and Boat Transfer will give a means to regulate treatment and is expected to reduce the risk of AIS contamination into Lake B. While the current lock acts as an effective barrier in halting the spread of AIS, full navigation of River A is desired. A new lock will have the ability to transfer boats, while preventing the spread of AIS, and will benefit the local community and economy.

The project drew the engineering student team together with professional engineers and architects, community members, and the navigational authority. The students considered design alternatives, handled ethics and business questions, and prepared designs.

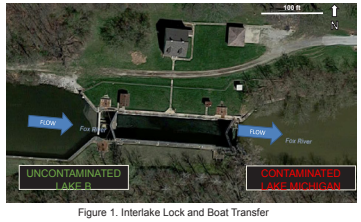


Figure 1. Interlake Lock and Boat Transfer

Student, Faculty and Professional Collaboration

Fields: Structural, Geotechnical, Environmental, Hydrological and Construction Engineering; estimating, scheduling, client and community interaction.

Design Team: Five Civil and Environmental engineering students; two volunteer registered engineers as mentors from the local engineering community; faculty and adjunct faculty members.

Professional Support: Structural, geotechnical, and environmental PEs, architect, project review by a board of multidisciplinary PEs.

Treating Aquatic Invasive Species

The new design must prevent Aquatic Invasive Species (AIS) such as the Sea Lamprey, Gobi fish, Spiny Waterflea, and Zebra Mussel from spreading through the lock to Lake B. Currently, the State Department of Natural Resources supports the use of pressure washers and flush muff to treat aquatic craft and avoid transmission of AIS. The final design utilizes multiple measures to avoid transmission of AIS during the following treatment process. Watercraft will first enter the contaminated bay and be lifted out of the water on a universal boat stand. Trained employees will use heated pressure washers to treat the hull while flush muffs will cleanse the engine intake. Once treated a marine travel lift will complete the transfer process by lifting the craft from the contaminated to the uncontaminated bay.

Figure 2. Gobi Fish

Figure 3. Spiny Waterflea

Figure 4. Existing Lock

Knowledge and Skills Gained

The students applied their engineering curriculum to a real-world problem. They used their knowledge of civil engineering to evaluate alternatives, considered risks and benefits, and created a viable final design, while meeting the time and budget constraints of their client and internal organization. Their interaction with mentors and other members of the engineering profession taught them valuable communication skills, and gave them insights into questions about ethics, professional responsibilities, and the logistics of taking a design project to completion.

Design Options

The student team developed three design options: Basic Re-Use; Bay and Lift; and Elevated Rail with Hot Wash. The Basic Re-Use design utilized much of the existing lock to create a cleansing station. The Bay and Lift design included a wall to create two bays, with a boat lift on top of the lock for transfer and cleaning. The Elevated Rail with Hot Wash design integrated an elevated rail system for lifting watercraft into a hot water bath.

Final Design

After analyses, evaluation through a decision matrix, and consultation with the navigation authority, the Bay and Lift design was selected for final design.

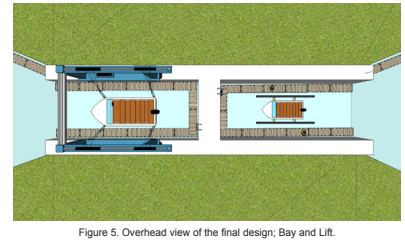


Figure 5. Overhead view of the final design; Bay and Lift.

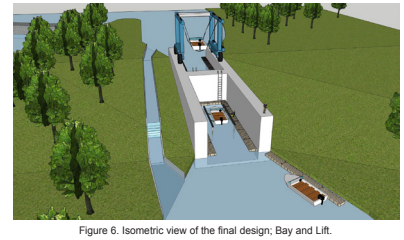


Figure 6. Isometric view of the final design; Bay and Lift.

Participants

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Faculty

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Charles Quagliana

Professional Engineers

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Jury Comments

"Comprehensive example of the value of licensure and the partnership between disciplines"

"Extensive collaboration between engineers and biologists"

"Great student use of the design process to address a problem of increasing importance"

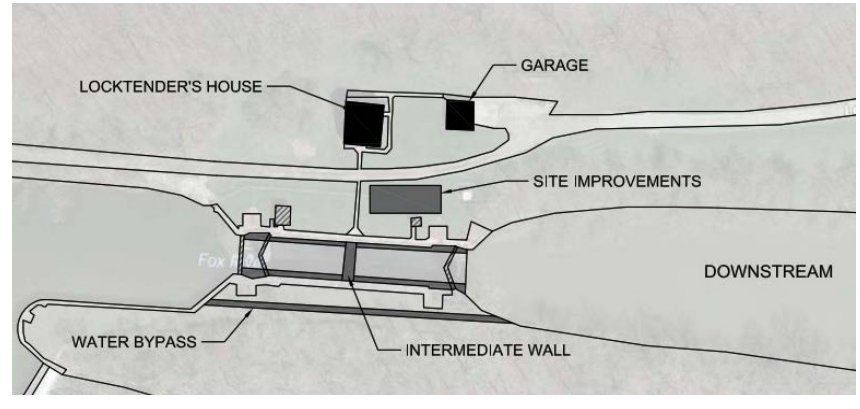
Abstract

The Interlake Lock formerly linked Lake Michigan to a large nearby lake (Lake B) in Wisconsin. In collaboration with the local navigational authority, a team of five undergraduate civil and environmental engineering students worked with two P.E.s, an architect, and other consultants to design a new lock and boat transfer that would allow passage of vessels while preventing the spread of aquatic invasive species (AIS), such as sea lamprey and spiny water flea. The former lock was constructed in 1851 and renovated in the 1930s but was closed in 1988 to prevent the movement of AIS from the downstream Lake Michigan side to the upstream Lake B side. Closure of the lock halted both upstream and downstream passage of recreational and commercial vessels. Without the lock, community members are trusted to thoroughly clean their aquatic craft to remove AIS when transporting between bodies of water.

The student team was challenged to design an interlake transfer facility that provided a means to regulate treatment to reduce the risk of AIS contamination into Lake B while providing full navigation of River A, thereby benefitting the environment, the local community, and the area economy. The existing lock is listed on the National Register of Historic Places, and preserving historical integrity was an important factor in the design.

The students developed three design alternatives, preparing a concept design for each. Then, having achieved an understanding of the engineering, environmental, and public constraints, they prepared an evaluation matrix in which weighted decision criteria were applied to each concept design. The team made a recommendation to proceed with a bay and lift design, in which parts of the existing lock are preserved and a new wall added to separate the lock into two zones.

In the downstream zone, vessels will have been exposed to AIS. When traveling upstream, vessels will enter the lower portion of the lock via the existing doors, the doors will close, and the water level will drop within the lock. The vessel will lower onto a universal stand where it will be prepared for treatment. Using pressure washers, the boat will be sprayed down with water heated to 200 degrees Fahrenheit. Flush muffs will be attached to engine intakes on the treated vessel and the engine will be started, running hot water through the intake to provide comprehensive treatment. Hot water spray treatment will kill and deactivate spiny water fleas and zebra mussels. All water used in treatment will only be in contact with this exposed zone, reducing the risk for cross contamination upstream. Upon completion of treatment, a sling crane will hoist the craft out of the exposed zone and into the clean zone located in the upstream side of the lock. The vessel will be lowered into clean upstream water to complete the boat transfer.

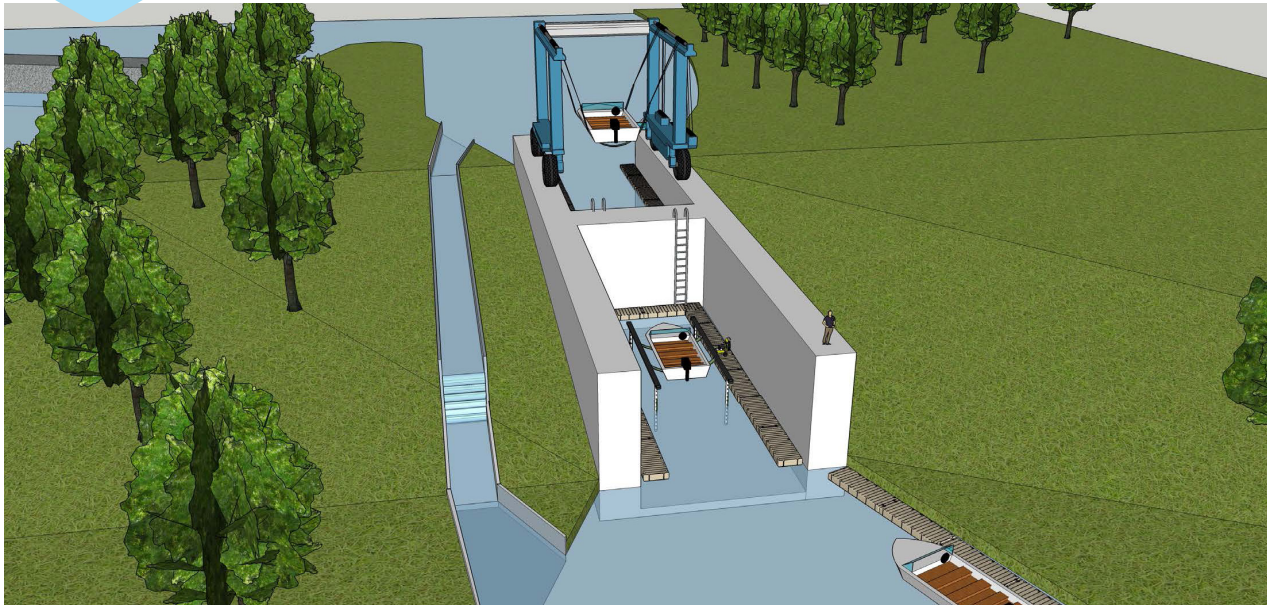


$10,000 AWARD

University of Wisconsin–Madison

Department of Civil and Environmental Engineering

Interlake Lock and Boat Transfer



Perspectives On

Protection of public health, safety, and welfare

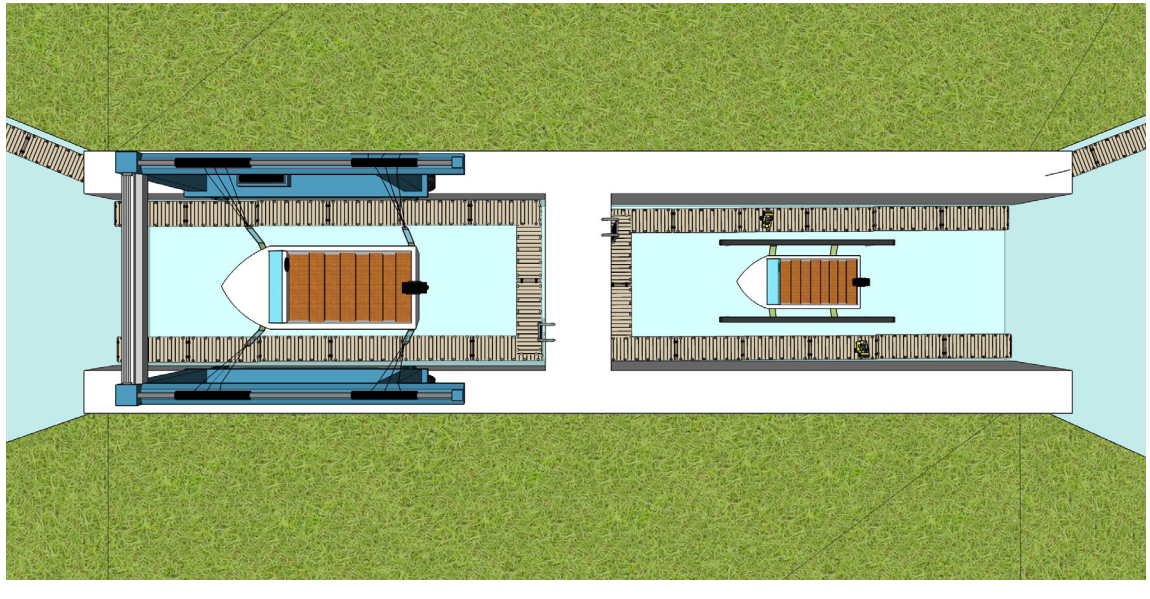
The student team was challenged to design an interlake transfer facility that provided a means for regulated treatment to reduce the risk of AIS contamination into Lake B while providing full navigation of the river, thereby benefitting the environment and the local community. The existing lock was old, in poor condition, and unsafe to use from an environmental standpoint due to the probability of AIS contamination. Any members of the public who desired to navigate up-river from Lake Michigan were required to use trailer transport for their vessels, and they were relied upon to properly cleanse their trailers and vessels prior to launching into the river or Lake B. Although a number of species are considered AIS for the area, the goby fish and spiny water flea are especially dangerous to the Lake B system. The design submitted by the student team implemented measures for preventing the spread of these and other species by cleansing the vessel's hull, wells, bilge, and motors; removing plants attached to the vessel; and prohibiting bait to pass through the lock.

Knowledge and skills gained

The students applied their engineering curriculum to a real-world problem. They used their knowledge of civil engineering to evaluate alternatives, considered risks and benefits, and created a viable final design, while managing themselves to meet the time and budget constraints of their client and internal organization.

Their interaction with mentors and other members of the engineering profession taught them valuable communication skills and gave them insights into questions about ethics, professional responsibilities, and the logistics of taking a design project to completion.

This unique project incorporated the requirements of several stakeholders, including the navigation authority, the public, the State Historic Preservation Office, and regulatory agencies. The students identified applicable codes and standards, prepared contract documents (contract, technical specification, plans), and answered requests for information. They learned to communicate effectively with other team members, as well as with the project stakeholders.



$10,000 AWARD

University of Wisconsin–Madison

Department of Civil and Environmental Engineering

Law Park Revitalization

Law Park Revitalization

A Cross Disciplinary Engineering Design Project with Multiple Constraints

Project Background and Objectives

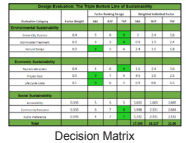
Law Park is located in a downtown area of a city in Wisconsin, USA, and shares its borders with a U.S. highway and the city's second largest lake.

Law Park is currently home to a variety of different activities. The park offers easy access to the lake for kayaks, canoes, and swimmers. The space is also used as a staging and viewing area for a number of more structured events, such as annual triathlons, a popular July 4th celebration, and area ski team shows. However, Law Park is not without its limitations. Given its location, the park has limited space and a significant portion of that space is consumed by a parking lot. The park also has outdated facilities that includes a boat launch in need of repair.

The project drew the engineering student team together with professional engineers and community members to design a new Law Park that will revitalize the park as a community resource and visitor destination, expand downtown connections and universal accessibility to the park for pedestrians and bicyclists, improve water quality, and strengthen the city's "green city" reputation.

The Triple Bottom Line

Existing Conditions of Law Park

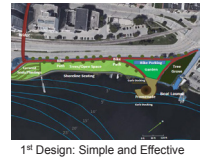


Decision Matrix

Design Options and Methodology

The student team developed three holistic designs that varied in size and cost. The first design was the smallest and most cost effective, utilizing simple and effective concepts to address the Triple Bottom Line. The second design proposed filling a portion of the lake and creating a larger park, yet still maintaining the original shoreline as best as possible and only providing enough space for room to play. Finally, the third design proposed the most amount of fill and is the most ambitious and expensive design, resulting in a space that architecturally dominates the local area as a signature park. In analyzing each design, the team utilized a decision matrix to evaluate how well the design satisfied the Triple Bottom Line.

Law Park (Existing)



1st Design: Simple and Effective

2nd Design: Room to Play

3rd Design: The Signature Park

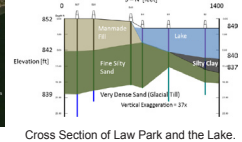
The Signature Park

While the Signature Park design is the most ambitious and expensive of the three designs, the increased space allows the park to include a man-made wetland, boater's beach, and larger seating and open space area. This design provides enough space for a dynamic park that satisfies the Triple Bottom Line by promoting social good, encouraging economic consideration, and fostering environmental stewardship.

Design Constraints

During the soils investigation of Law Park, a substantial amount of man-made fill below the surface was discovered. Thus, the geotechnical considerations of the proposed park was a significant design constraint, and further analysis concluded that man-made fill would not have sufficient bearing strength for shallow foundations. As such, cast-in-place steel pipe piles were required for the foundation of the FLW Boathouse and bridge abutments. Other design constraints included significant traffic congestion in an extremely compact park as well as major environmental regulations and permitting associated with the park's close proximity to the lake.

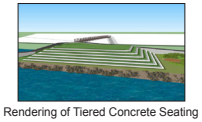
Law Park Subsurface Soils



Cross Section of Law Park and the Lake.

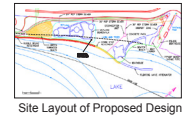
Outcomes

After using several different engineering disciplines to analyze each of the designs, the design team finalized and modeled The Signature Park. The model shows distinct features that sets this park apart from any other, and defines the city the same way Millennium Park defines the city of Chicago.



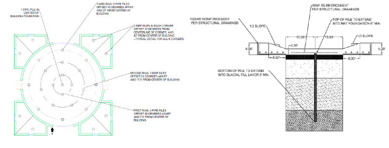
Rendering of Tiered Concrete Seating

Rendering of Wetland



Site Layout of Proposed Design

Rendering of Boathouse/Shoreline



FLW Boathouse Foundation – Plan View (left) and Section Cut (right)

Knowledge and Skills Gained

The students applied their engineering curriculum to a real-world problem. They used their knowledge of civil engineering to evaluate alternatives, considered risks and benefits, and created a viable final design, while meeting the time and budget constraints of their client and internal organization. Their interaction with mentors and other members of the engineering profession taught them valuable communication skills, and gave them insights into questions about ethics, professional responsibilities, and the logistics of taking a design project to completion.

Cross Discipline Collaboration

Fields: Structural, Geotechnical, Environmental, Transportation, and Construction Engineering; estimating, scheduling, client and community interaction. Design Team: Four civil and environmental engineering students; two volunteer registered engineers as mentors from the local engineering community; faculty and adjunct faculty members, community representatives, project review by a multidisciplinary panel of experts.

Participants

Students

Muhammad Alqahtani
Erik Silvis
Miles Tryon-Petith
Kyle Williams

Faculty

Greg Harrington
Mark Oleinik
Charles Quagliana

Professional Engineers

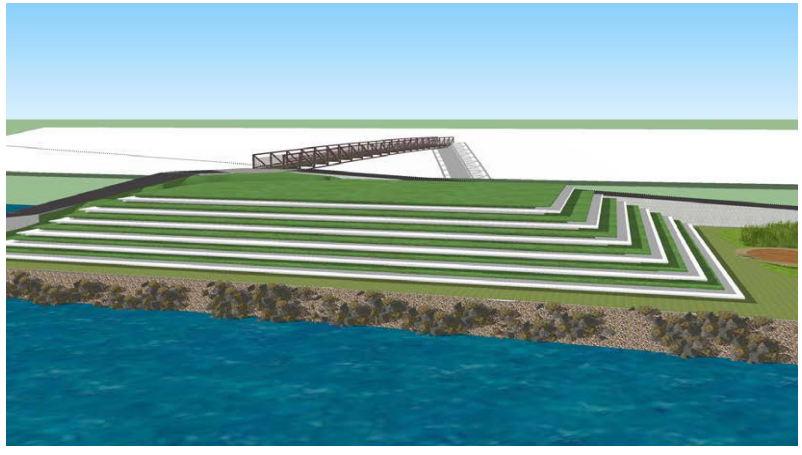
Fred Klancnik, P.E.
Mark Oleinik, P.E.
Bill Wuellner, P.E.

Jury Comments

"Well-defined project focus with strong P.E. engagement"

"Well thought out and presented"

"Good comparison of alternative solutions and stakeholder feedback"



Abstract

Law Park, located in a downtown area of a city in Wisconsin, occupies a small strip of land situated between the city's second largest lake and a U.S. highway. The park offers easy lake access for kayaks, canoes, swimmers, and other activities and is also used as a staging and viewing area for several annual triathlons, a popular Fourth of July celebration, and area ski team shows, amounting to more than 100,000 visitors per year. The park also serves as a home for the county sheriff's marine and trail enforcement watercraft. However, Law Park is not without its limitations. Given its location, the park has limited space, and a significant portion of that space is consumed by a parking lot. The park also has outdated facilities, including a boat launch in need of repair.

In collaboration with three P.E.s, city officials, and the community Clean Lakes organization, a team of four undergraduate civil and environmental engineering students worked to develop a design for a new Law Park that will revitalize the park as a community resource and visitor destination, expand downtown connections and universal accessibility to the park for pedestrians and bicyclists, improve water quality, and continue to strengthen the city's growing green city reputation.

The students developed three design alternatives, preparing a concept design for each. Then, having achieved an understanding of the engineering, environmental, and public constraints, they prepared an evaluation matrix in which weighted decision criteria were applied to each concept design. Based on input from their collaborators and an expert panel, the team made a recommendation to proceed with the Signature Park design, the most ambitious and expensive option that incorporates a man-made wetland area as a natural way to treat runoff along with more greenspace and a second grade.

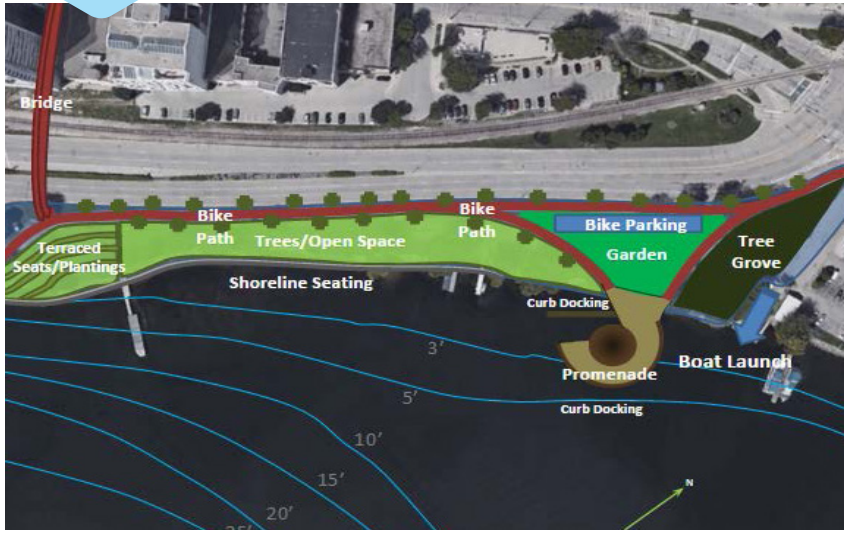
During the soils investigation of Law Park, a substantial amount of man-made fill below the surface was discovered. Thus, the geotechnical considerations of the proposed park were a significant design constraint, and further analysis concluded that man-made fill would not be sufficient for shallow foundations. As such, cast-in-place steel pipe piles were proposed for the foundation of the boathouse and bridge abutments.

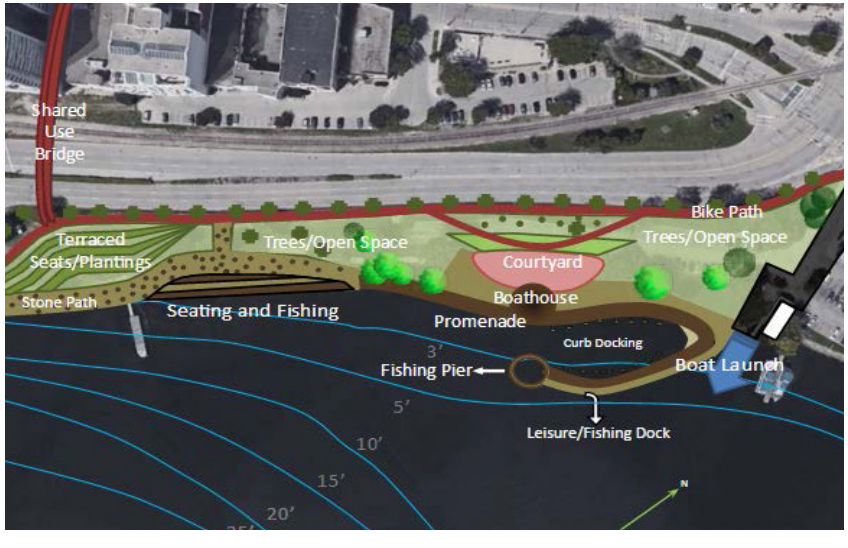
$10,000 AWARD

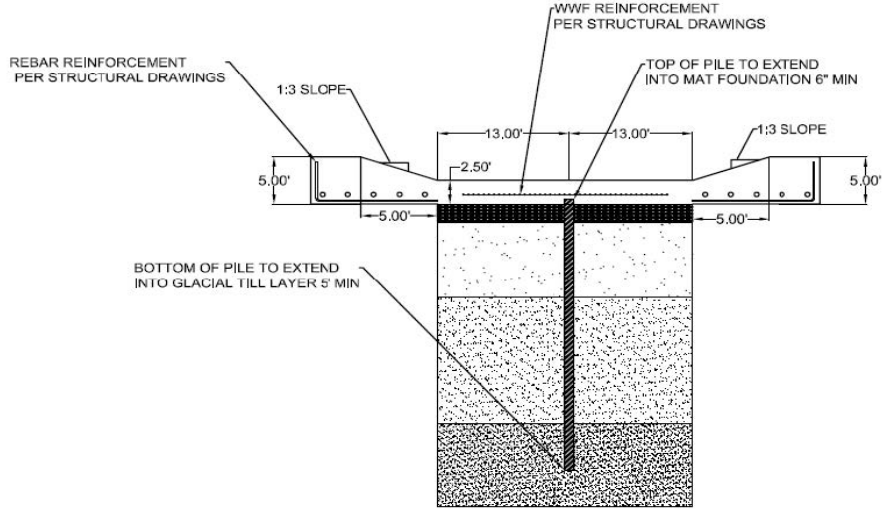
University of Wisconsin–Madison

Department of Civil and Environmental Engineering

Law Park Revitalization





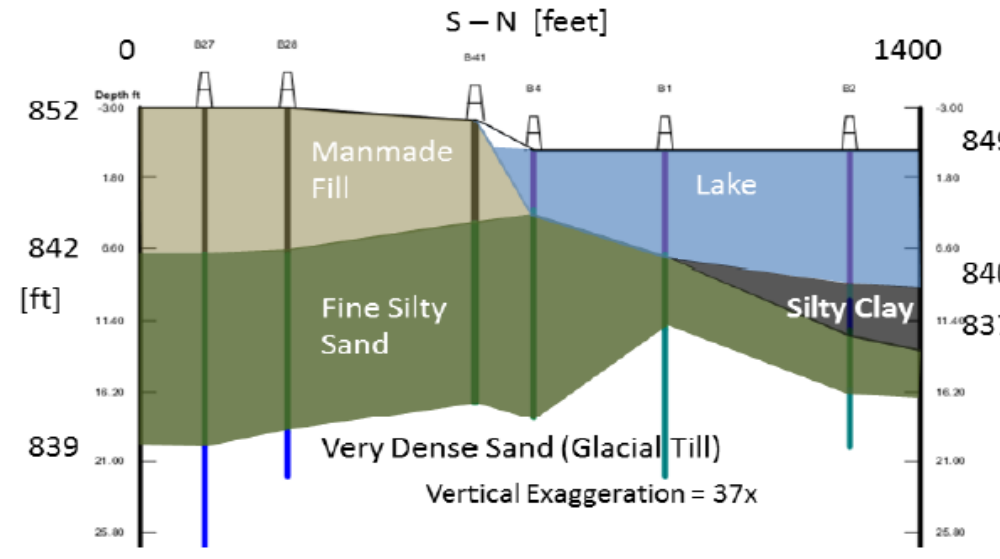


Perspectives On

Protection of public health, safety, and welfare

The student team was challenged to evaluate the three design alternatives based on the triple bottom line of environmental, economic, and social sustainability. Water treatment, ecological restoration, tourism, community strengthening, and financial costs and benefits were considered in determining the recommended alternative, with respect for the input of the community Clean Lakes organization, city officials, experts, and the public.

Based on the Triple Bottom Line criteria, as quantified in the project decision matrix, the student team recommended the Signature Park design for the Law Park Revitalization Project. As noted in their final design summary, the design stewards the environment at a higher level than the other alternatives considered. This design exudes green city essence and functions as one—wetlands and repurposed parking restore water quality and encourage wildlife ecology while generating an increased social magnetism. Social equity is further enhanced



with larger land space facilitating events and bringing communities together. Accessible to all and more attractive than ever, the Signature Park draws visitors to the water, increasing tourism to the park and the city. The Signature Park asks a higher price—larger project and life-cycle costs—than the other designs; this cost is met with benefits to people, place, and the planet that cascade off one another more effectively than either other design. The selected design serves as an accessible community resource, connecting visitors to each other through the park and the lake. It balances costs and benefits—long and short term, direct and indirect—most effectively and proposes the strongest environmental ethic.

An important change from the preliminary to final design was the rearrangement of the shoreline, which was configured to better facilitate lake flow from the prevailing current at the site, or littoral drift, and what it carries (like algae) while still providing fishing and boating amenities.

Knowledge and skills gained

The students applied their engineering curriculum to a real-world problem. They used their knowledge of civil engineering to evaluate alternatives, considered risks and benefits, and created a viable final design, while managing themselves to meet the time and budget constraints of their client and internal organization.

Their interaction with mentors and other members of the engineering profession taught them valuable communication skills and gave them insights into questions about ethics, professional responsibilities, and the logistics of taking a design project to completion.

During the soils investigation of Law Park, a substantial amount of man-made fill below the surface was discovered. Thus, the geotechnical considerations of the proposed park were a significant design constraint, and further analysis concluded that man-made fill would not have sufficient bearing strength for shallow foundations. As such, the student team proposed cast-in-place steel pipe piles for the foundation of the boathouse and bridge abutments.

Other design constraints included significant traffic congestion in an extremely compact park as well as major environmental regulations and permitting associated with the park's proximity to the lake.

PREVIOUS WINNERS

2017

Grand Prize

Dordt College
Engineering Department
Liberia Farm Bridge

Additional Awards

George Mason University
Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering
Design and Construction of a Reliable Drinking Water System for an Orphanage in Central America

Marquette University
Department of Civil, Construction, and Environmental Engineering
El Bosque Pedestrian Bridge

North Carolina State University
UNC/NCSU Joint Department of Biomedical Engineering
Belltower Medical—Urinary Catheter Solutions

Seattle University
Department of Civil and Environmental Engineering
Design of a Care Facility for Young Mothers in Uganda

Seattle University
Department of Civil and Environmental Engineering
Restoration and Replacement Options for Utility Company Bridge

2016

Grand Prize

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

Additional Awards

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 Civil and Environmental Engineering
Solar Microgrid in Rural Zambia with Real-Time Cloud-Based Monitoring

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 at 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

PREVIOUS WINNERS

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 Multidisciplinary, 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

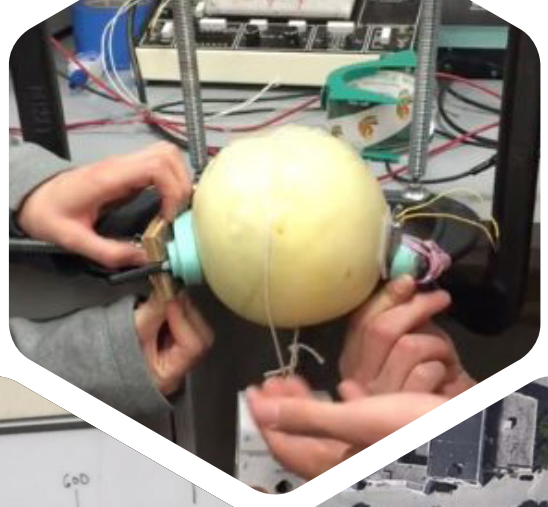
University of Tennessee at Chattanooga
Department of Civil Engineering
Intermodal Transit Center

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

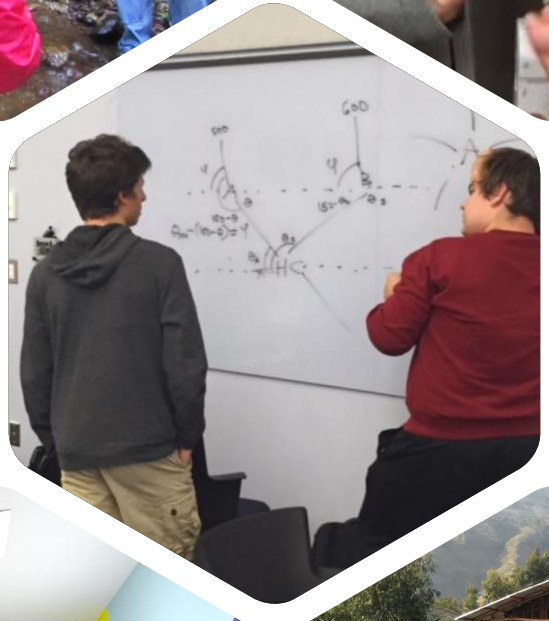
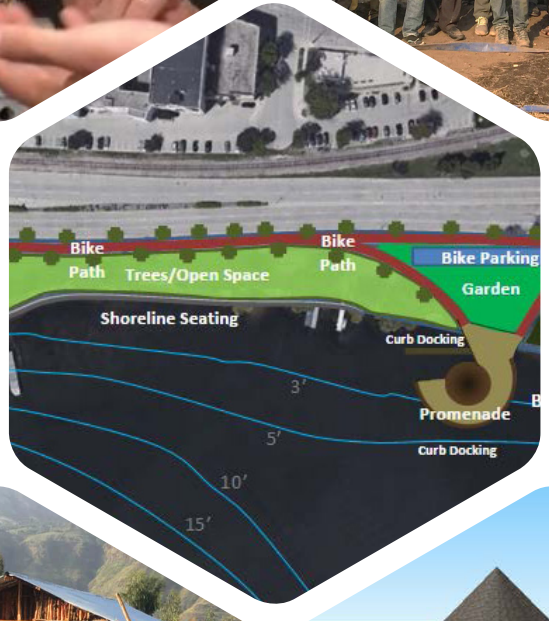
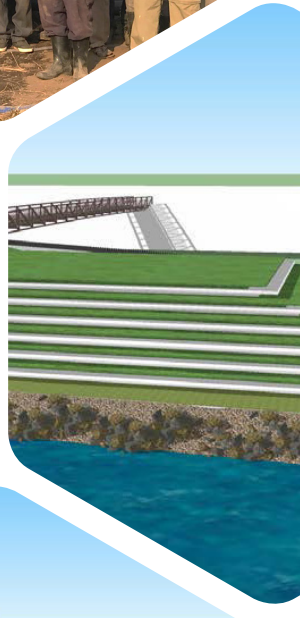
Honorable mention

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






Lawn
Promenade



Bike Path
Trees/Open Space
Bike Path
Bike Parking
Garden
Shoreline Seating
Curb Docking
Promenade
Curb Docking
3′
5′
10′
15′


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