

Abstract

The Civil Engineering program (the Program) at the University has a two-semester design and project management capstone experience. The capstone represents the culmination of the students' undergraduate education, providing them an opportunity to integrate and apply various educational components in preparation for their careers as civil engineers. Students are mentored by professional engineers and industry practitioners throughout the sequence while interacting with community organizations.

Students form teams and develop projects of their choice. Their scope of work, based on at least four of the civil engineering subdisciplines, entails generating a conceptual design and project management plan. Deliverables for the capstone include written technical and progress reports, and oral progress and poster presentations.

A major pedagogical aspect of the capstone is the mentor initiative, where the students meet with professional engineers and other construction and design practitioners at various points in the project cycle. For example, teams meet with engineers and design-builders to review the scope and overall viability of their projects. Students participated in subdiscipline-specific sessions where they receive feedback from practitioners on their design and project management approaches. Also, professional engineers evaluated and provided significant feedback to teams in poster presentation sessions.

For the 2010-2011 academic year two of the projects are especially notable for their collaboration with the nonprofit corporation Self Help Addiction Rehabilitation (SHAR; pronounced "share"), located in Detroit, MI. Along with administering programs for recovering addicts, SHAR is involved with the development of blighted and depressed property in Detroit now known as Recovery Park. Recovery Park is a major initiative for the revitalization of Detroit. One student capstone team chose an abandoned market to conceptualize an equestrian center for the stabling, training, caring for, and displaying of horses affiliated with the Detroit Police Department. Another team utilized an abandoned Detroit Public School to conceptualize a vocational school for teaching residents urban farming and sustainable living skills. Both student design projects served the Recovery Park community and were utilized by SHAR as part of their fundraising efforts.

This competition submittal will discuss the students' choice of project locations; their interaction with professional engineers, industry practitioners, and community organizers who manage the Recovery Park Master Plan; how their project benefitted public health, safety, and welfare; and finally, the knowledge and lifelong skills student gained.

I. *Project Description*

This section describes the Civil Engineering capstone design experience at the University and two design teams from the 2010-2011 academic year who particularly embraced the ideals of the NCEES Engineering Award.

The Civil Engineering program at the University requires students to complete a two-course design and project management capstone experience. The first course of the sequence, ECE4021 CE Design Project 1 (CE Project 1), is offered in the fall, and the second course, ECE4033 CE Design Project 2 (CE Project 2), is offered in the spring. The capstone represents the culmination of the students' undergraduate education, providing them an opportunity to integrate and apply various educational components in preparation for their careers as civil engineers. In a typical year approximately eight teams of three to five members participate in the capstone. Each team member is required to cover a civil engineering subdiscipline and each team having a minimum of four civil engineering subdisciplines including construction engineering.

The overall goals of CE Project 1 are initiation and planning, which comprises such tasks as identifying and evaluating potential projects, analyzing relevant background data and potential constraints, and developing a scope of work. The goals of CE Project 2 are a continuation of planning and, in a conceptual sense, execution of the project. Neither course has an instructor in the traditional definition. Rather, a faculty member coordinates the course by dissemination of the syllabi, managing deliverable dates, communicating with practitioner mentors, and processing grades. Each team is assigned a faculty member to serve as team advisor. Faculty members, based on their area of expertise, also act as subdiscipline advisors for individual team members. Figure 1 depicts the relationships among the capstone participants, including practitioner mentors (discussed below).

Deliverables for both CE Project 1 and 2 include individual subdiscipline written technical reports, team progress written reports, and team progress oral and technical poster presentations. Figures 2 and 3 provide a timeline of primary deliverables (identified as triangles) along with industry mentor participation noted above.

The capstone design sequence allows students to identify and undertake unique projects of their choosing. Two groups of students (*Plan E Design Build, Inc.* and *Earth Preservation & Recovery, Inc.*) located their conceptual designs within the boundaries of Recovery Park with the SHAR Foundation as their "client." Recovery Park (www.recoverypark.org) is a planned community redevelopment project for the city of Detroit that will include urban farming, education, commercial and housing development. The projected 10-year, multi-million dollar project that will help the city and its residents recover through personal and economic empowerment. Recovery Park plans to demonstrate how urban farming impacts the local

economy through job creation from farming operations and in downstream activities such as food processing, packaging and logistics.

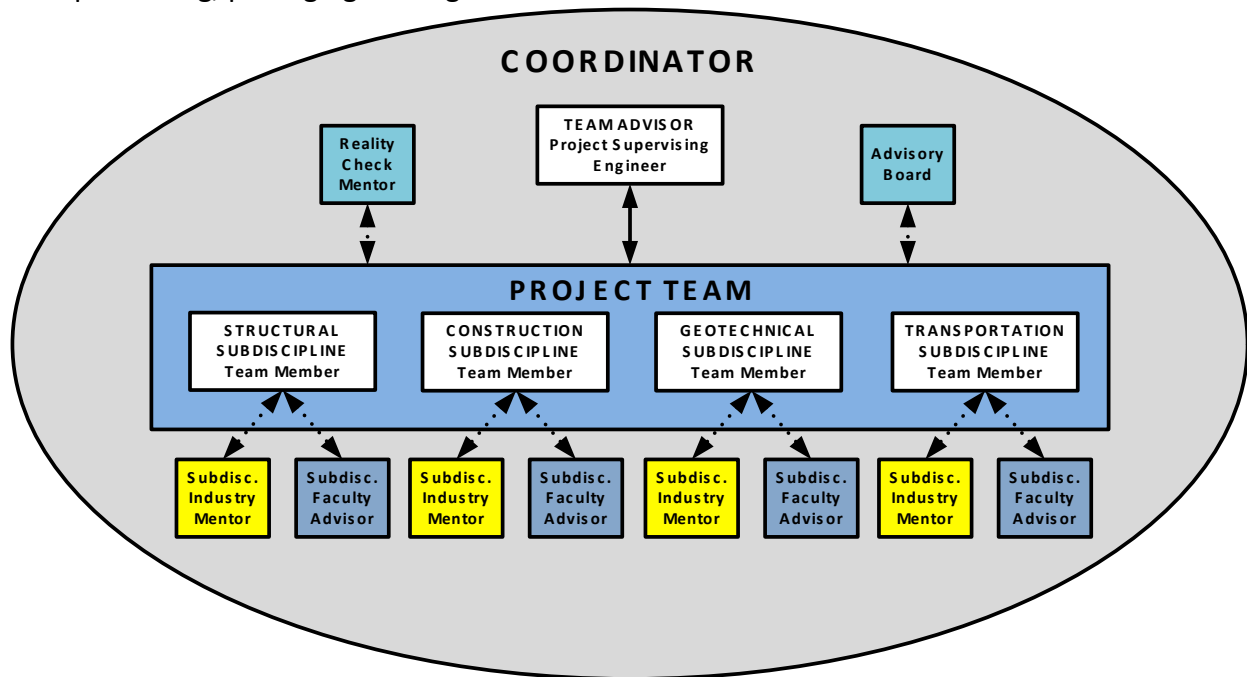


Figure 1: Capstone organization.

Plan E Design Build Inc. (Plan E) developed a conceptual design for the Detroit Urban Equestrian Center. The Detroit Urban Equestrian Center project rehabilitates twelve square blocks of otherwise neglected, contaminated and abandoned land. At the heart of the Urban Equestrian Center is a source of stability and safety that Detroit lacks, a mounted police force for crowd control and added safety. One of the major funding cuts for mounted police around the nation is due to high veterinary costs and Plan E's solution was to combine a mounted police station with a new large animal veterinary clinic affiliated with the Michigan State University College of Veterinary Medicine. Another feature of the project includes the renovation and expansion of the local landmark Chene-Ferry market. The renovation comprises the expansion of the facilities to support the equestrian exhibition area including a staging area for horses, an office area, concession stands, a gift shop, restrooms, and an information area.

The project also includes extending a converted railroad line into the project site to provide pedestrian and equestrian passage between the project site and the Detroit River. The geotechnical engineer was responsible for designing the earth retaining structures and the slope stability for the below grade-pass in addition to the foundations for the new and expanded structures.

The final scope component was defining the environmental remediation of the forty-six acre site, which was assumed to be contaminated by lead and BTEX as is common in these Brownfield developments. The site may require remediation to the level that would allow horses to graze. Site remediation was accomplished through several techniques including

contaminated soil removal and an innovative air venting system for bioremediation the BTEX. Finally, the design included native planting and naturalized stormwater detention to limit runoff.

Earth Preservation and Recovery (EPR) proposed to design and construct the Urban Argi-Tech Vocational School, a trade school specializing in urban farming and sustainable technologies. During the past ten years, the Detroit Public School system has struggled financially and academically closing more than a quarter of its 172 public schools last year. Moreover, three out of every four students are NOT graduating from high school. The proposed vocational school will offer adults an opportunity to develop a new lifestyle by learning new professions, becoming entrepreneurs and understanding the importance of a healthy environment. General education courses will be offered for adults and adolescents who did not complete high school, preparing them for higher level courses. However, the general education courses are not the main focus of the school. The main purpose of the school is to give Detroiters the skills and experience necessary for success in the real world and to positively impact the local community.

The cornerstone of the EPR project is the redevelopment of a 100,675 square foot vocational school. Phase I is the renovation of the old Frederick Douglass High School, located on Leland Street between Mack and Gratiot Avenue, on the east side of Detroit, Michigan. The renovated structure will provide classrooms, libraries and workspaces for general education courses. Phase II of the design involves a new addition to the site, which will house laboratories, administrative offices and include a greenhouse for vegetative studies. The structure is designed for a capacity of 750 students along with 50 faculty and staff. Populating the student body with local residents will provide significant benefits to the community.

Key design features incorporated by the water resources engineer include a conservation site development strategy with zero percent discharge by using a green roof, cisterns, bioswales, and naturalized detention. There is also an innovative grey water treatment system – indoor wetlands and rainwater harvesting. Structural design included structural steel for the addition and greenhouse and the geotechnical engineer designed all foundations.

II. Collaboration of faculty, students, and licensed professional engineers

Faculty recognized the importance of additional practitioner involvement and determined that while the longstanding Advisory Board participation in the final oral presentation was highly beneficial, it was also insufficient from the perspective of both the students and the program. Consequently, faculty added several mentoring sessions to the capstone schedule. The mentor initiative includes three types of interactions between practitioners and students:

Reality Check Mentors: teams meet with engineers and design-builders to review the scope and overall viability of their projects early in the process (Figure 2). The mentors ask probing questions and encourage critical evaluation by the teams. Faculty believed that as a way to make the interaction more professional, teams should meet the mentors at their place of business. Not only did mentors host teams

at their offices, several invited additional employees to participate, making the experience even more realistic and rewarding.

Subdiscipline Industry Mentors: subdiscipline-specific sessions with professional engineers where students receive feedback on their design and project management approaches. Mentors also speak to the entire group of students to provide general observations and insights. These sessions occur in both semesters so students can adjust projects based on mentor comments (Figure 3).

Industrial Advisory Board: the Civil Engineering Industrial Advisory Board members provide feedback on all aspects of the projects during oral and poster presentations. The informal poster session in November (Figure 2) serves to educate the Advisory Board on that year’s student projects. Board members thoroughly enjoy sharing their expertise, talking design, discussing construction techniques, etc., with soon-to-be engineers. The formal poster presentation in April (Figure 3) occurred at the executive conference facility of one of the Board members companies and included additional student interactions with professionals.

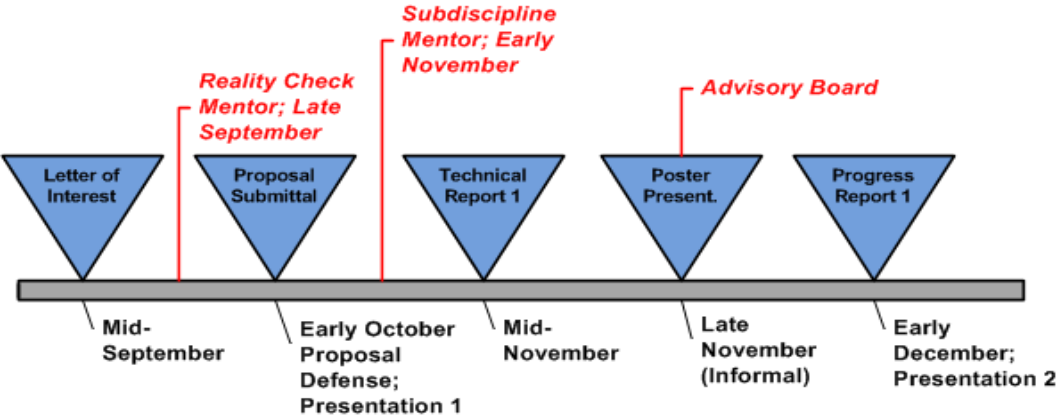


Figure 2: CE Project 1 deliverables and mentor participation

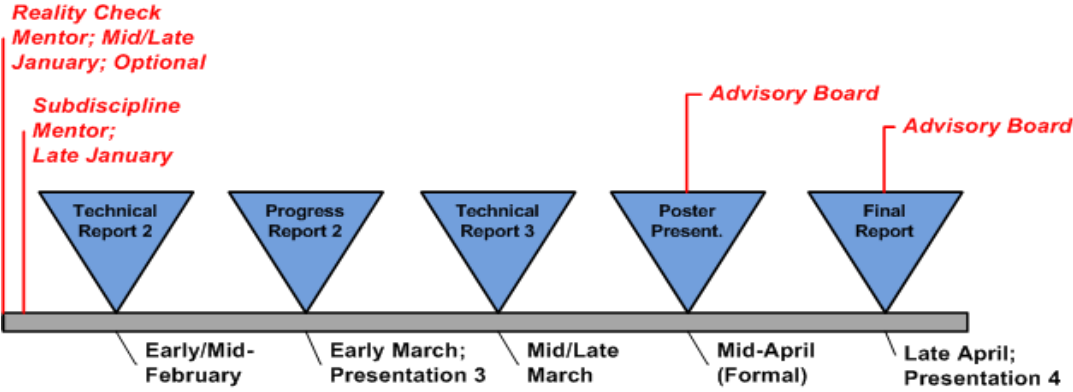


Figure 3: CE Project 2 deliverables and mentor participation

III. Benefit to public health, safety and welfare

These capstone projects were an enrichment to an existing regional redevelopment program (Recovery Park) developed to benefit the public health, safety and welfare of an impoverished and blighted neighborhood in Detroit, Michigan. The student projects were designed within the boundaries of the Recovery Park master plan and included an urban gardening facility (health), mounted police post (safety), vocational school (welfare), farmland (health and welfare), trails (health and welfare) and economic opportunities (health, safety, and welfare). It's difficult to describe how impactful this project would be in the region and how much our students' learned about an impoverished community within 15 miles of the University's campus. The local citizens have no access to fresh healthy food options (only pre-package highly caloric foods are readily available) and whose unemployment rate of approximately 40%. Through their capstone projects, the students put themselves in the place of the residents and learned about the numerous challenges they face in their daily lives.

The capstone experience was transformational for the students evidenced by their desire to continue the project past graduation. In fact, the four students of the EPR Team were issued misdemeanor trespassing citations by the Detroit Police when they were unable to produce written authorization during their inspection of the abandoned school. The citations happened early in the term and the students were given an option of not continuing the project and selecting a new endeavor, but they declined because of their commitment to Recovery Park.

On a more pragmatic level, the design process required students to review and apply all applicable engineering codes and standards and adhere to the ASCE Code of Ethics. The teams also researched regional demographics and familiarized themselves with zoning and planning documents. Possibly the most important point was that the students "listened" to the needs of their "client" through design meetings and public presentations to citizen groups as part of the Recovery Park planning process. The public presentations were above and beyond the requirements of the capstone and undertaken voluntarily by the students. Finally, both teams addressed sustainability issues by researching the USGBC Leadership in Energy and Environmental Design (LEED) process and computing point values for potential LEED certification for the projects.

IV. Multidiscipline and/or allied profession participation

The capstone instructional team includes ten faculty, twenty-seven practitioners representing fifteen companies, and several guest lecturers who discussed professional skills such as oral communication, writing, sustainable design and teamwork. As such, the students interacted with a broad range of professionals including professional engineers, lawyers, urban planners, technical writers, architects, and LEED accredited professionals. As an additional component,

the teams presented their projects to twenty-five urban planners from the Netherlands. The planners were touring Detroit as an international case study for urban renewal and were made aware of the projects by the SHAR Foundation. The planners elected to attend the capstone final presentation and a special session was organized to allow the seven students to spend additional time interacting with the international contingent and answering questions about their designs and experiences. This unexpected opportunity resulted in an exhilarating and rewarding experience. Indeed, the students rose to the occasion and discussed their projects with confidence and intelligence to an unfamiliar group.

Regarding the multidisciplinary nature of the project themselves, the students were required to apply a minimum of four civil engineering subdisciplines to the project. EPR focused on water resources, environmental, structural, geotechnical and construction management. Plan E focused on water resources, environmental, geotechnical and construction management.

As part of their research, the students interfaced with University of Detroit-Mercy Design Studio architects and urban planners who are overseeing the Recovery Park master plan on behalf of SHAR Foundation. While both student projects were unique designs of their own choosing, they did utilize the Recovery Park Master Plan as a framework for which to locate their projects.

Recovery Park relies heavily on its partner organizations and volunteers and the student research and design work was included in presentations by the SHAR Foundation in Washington DC as part of congressional funding requests. SHAR Foundation requested that student and faculty advisor effort be counted as in-kind matching dollars as part of foundation grant submittals and to document broad-based community effort. Over the two semester sequence, the two University student design teams accounted for 1990 hours and \$32,680 as in-kind match and the students assisted in completing design summary sheets that documented their time and effort on behalf of Recovery Park and the SHAR Foundation.

V. Knowledge or skills gained

Formal course objectives were written for the two-semester capstone sequence as part of the program assessment and continuous improvement plan. The objectives are consistent with ABET and the ASCE Body of Knowledge, Second Edition (BOK2) which provides the framework for the University Civil Engineering Program Outcomes. Published course objectives include:

1. Form an intradisciplinary project team, choose a leader, and assign responsibilities for at least four subdisciplines in order to master multiple portions of the technical breadth and specialization outcomes required to function as competent civil engineers.
2. Based on the design-build integrative project delivery method, generate a proposal describing a project that addresses real-world constraints and issues, including sustainable design and other sociopolitical considerations.

3. As a component of the initiation and planning process groups, create an initial project management plan that includes appropriate project management processes, such as scope, cost and communication management plans.
4. Investigate and review industry design and construction codes, as well as applicable local ordinances and state and federal laws.
5. Utilize civil engineering knowledge and skills to generate and analyze preliminary design alternatives for components of each subdiscipline, and choose the most appropriate alternatives for the project.
6. Integrate the designs of the various subdisciplines into the overall comprehensive design, in accordance with project requirements and industry standards.
7. Generate a cost estimate, a preliminary design and design schedule for the project.
8. Apply principles of technical and professional communication in preparing and organizing various written reports and oral presentations, by effectively integrating verbal, written, virtual and graphical information for the purpose of communicating observations and solutions to technical and non-technical audiences
9. Use the knowledge and skills in civil engineering to conduct final analyses and evaluations, and complete the designs of project components, in order to master multiple portions of the technical breadth and specialization outcomes required to function as competent civil engineers.

In addition to the above objectives, these two teams gained knowledge about an under-served population in the Detroit area and how their skills as engineers can be used for the benefit of society. The students also had to interact with broad range of constituents including community organizers, urban planners, architects, and the general public. These meetings honed the students' communication skills, especially when communicating technical information to non-engineering audiences, and enriched their capstone design experience.

Finally, each student is assigned a custom laptop loaded with industry standard software valued at more than \$10,000. Students applied state-of-the-art technology specific to their subdiscipline such as RISA-3D structural design software, Primavera scheduling software, AutoCAD, ArcGIS, the Bentley Water Management suite of software (StormCAD, WaterCAD, Culvert Master, PondPack, Sewer CAD, and Flowmaster), and visualization software for building renderings. As such, students not only learn technical design and project management fundamentals; they also learn to apply industry standard software in their projects.