

The Mentor Initiative: A Framework for Industry Involvement in the Capstone

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This paper describes how practitioners were integrated into a year-long civil engineering capstone sequence. Mentors participated throughout the project cycle, from project initiation through design completion. Assessment results demonstrate that all stakeholders—students, faculty, and practitioners—benefitted from the mentor sessions.

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Introduction: Capstone Overview

This paper focuses on the major design and project management experience, or capstone sequence (capstone), for the Department of Civil Engineering (Department) at Lawrence Technological University. The fall/spring sequence is comprised of CE Design Project 1 (Project 1), a one-credit course, and CE Design Project 2 (Project 2), a three-credit course. The capstone represents the culmination of the students' undergraduate education, providing them an opportunity to integrate various curricular components in preparation for careers as civil engineers.

Rather than following the typical lecture format, the capstone more closely resembles an independent study course. Students form teams and develop a project by generating conceptual designs and project management plans. Each team member is tasked with incorporating into the project one of the civil engineering subdisciplines.

Faculty involvement includes a course coordinator who is the instructor of record, has the responsibility of creating the syllabi, and performs various administrative functions, such as recording grades and disseminating rubrics. Each team is assigned a faculty advisor who serves as the team's unofficial senior engineer. Faculty also serve as subdiscipline advisors to individual students.

The overall goals in Project 1 are the initiation and early planning for the proposed project. Once the students form teams, choose their projects and select their sites, their focus shifts to establishing objectives and analyzing alternative designs in the context of real-world constraints. In Project 2, teams continue the planning and design processes, resulting in final conceptual subdiscipline designs and a complete project management plan.

The principal team deliverables for the capstone include an initial project proposal, poster presentations,

and progress reports. The individual deliverables for each student are periodic subdiscipline technical reports documenting the various aspects of design and project management elements generated over the two terms.

For its overall program assessment, the Department adopted the twenty-four outcomes set forth in the *Civil Engineering Body of Knowledge, 2nd edition* (BOK2), promulgated by the American Society of Civil Engineers.¹ Because the requirements of the capstone entails the integration of so many curricular elements, Project 1 and Project 2 address seventeen outcomes. Example outcomes, which are mapped to course objectives, include sustainability, social sciences, communication, design, project management, and public policy.

Representative Project: Urban Agri-Tech Vocational School

A representative project in the capstone sequence is the Urban Agri-Tech Vocational School by Earth Preservation & Recovery (EPR), a four-person team. Urban Agri-Tech is a 100,000 s.f. facility that houses classrooms, laboratories, offices, and a greenhouse. The surrounding grounds include an area for growing crops and demonstrating urban farming techniques. The project site is located in RecoveryPark², a planned housing and commercial redevelopment in a severely depressed area of Detroit, MI.

EPR's team scope included the construction, water resources, structural, and geotechnical subdisciplines of civil engineering. Project design elements are the structural system, foundations, and various water resources components, including a green roof and overall water management plan. The project management plan created by the construction engineer is comprised of various subsidiary plans, such as scope management, cost management, and schedule management.

The EPR team, in conjunction with another capstone team, won a 2011 NCEES Engineering Award^{3,4}. The main reason NCEES established the award is to encourage collaboration between the engineering profession and education. A jury member noted that the projects demonstrated “good use of industry and external mentors.”⁴

Practitioner Involvement: Mentor Initiative

In earlier versions of the capstone, involvement of industry practitioners was limited to the Civil Engineering Advisory Board (Board) attending the final oral project presentations. After numerous discussions, faculty determined that the capstone was too insulated from industry and students would benefit from additional opportunities for positive interaction with practitioners. Indeed, it is well documented that industry participation is a successful approach for enhancing a capstone experience for engineering students^{5,6,7}. Moreover, although not explicitly addressed, the tenor of the BOK2 suggests that practitioners should be involved with undergraduate education¹.

Faculty subsequently developed the Mentor Initiative, a three-pronged plan for industry participation in the capstone: 1) involve the Board earlier and more often in the project cycle; 2) involve practitioners early in the project cycle, including during the pre-proposal period (project initiation); and 3) involve practitioners at critical junctures of design and project management plan creation.

The first step in the Mentor Initiative was for faculty to contact and vet potential mentors. The subdiscipline mentors had to be licensed design engineers experienced in their specific area of expertise. The skill set of the reality check mentors (RCMs), however, was necessarily more diverse. Because the RCMs meet with the teams early in the project cycle, they had to possess knowledge on a wide range of issues, such as land usage, permitting, and zoning. Although most of the RCMs were engineers, they generally worked for construction companies.

The initial mentor interaction for the teams are with the reality check mentors (RCMs) in fall term, prior to the submittal of the project proposal. The charge to the RCMs is inherent in their designation; they need to discuss the viability of the proposed project, and to critically review the teams’ assumptions and potential constraints. RCMs are requested to allow the meeting to take place at their offices, so the sessions have a more professional atmosphere. Although the fall session is required, teams are given the option of meeting with the RCMs in early spring to seek additional feedback when their projects are further along in the cycle.

The next interactions for the students are the subdiscipline mentor sessions in the Engineering

Building, scheduled for mid-fall and again in mid-spring. Each meeting begins with a thirty-minute socializing period that includes introduction of the mentors to the entire capstone cohort. The students then go to separate classrooms and attend breakout sessions with their subdiscipline colleagues moderated by the mentors. In the fall, students present a two-minute overview of their projects and the mentors comment on initial design approach, and assist with identifying potential constraints. At the spring session, after students update the members on their progress, the mentors address issues related to refining and completing the designs.

To increase the level of involvement of the Board with the capstone, a poster review session was added in each term. Needless to say, since Board members are, for the most part, high-level construction or engineering executives, their schedules are usually full. Consequently, the poster sessions are scheduled for the same evening as the semi-annual advisory board meetings.

The first poster session in late fall is, in effect, advisory in nature. Because the students are still in the early stages of the project, the Board provides general comments on project viability, potential constraints, and the quality of the posters. The Board members, however, do not assess the teams’ performance. In the spring the teams are relatively far along in the project cycle, and the Board members comment on the adequacy of the designs and the project management plan. Moreover, the Board uses a detailed rubric to assess the students’ oral performance, graphical representations, and technical content.

Figures 1 and 2 depict practitioner participation in the capstone sequence by overlaying the mentor sessions onto the deliverables timetable.

Assessment of Practitioner Involvement

For curricular assessment and continuous improvement, the Department conducted online surveys at the end of fall and spring terms to elicit student perceptions on the value of the student/practitioner interactions in the Mentor Initiative. Answering a combination of Likert style and open-ended essay questions, student responses yielded insight as to the usefulness of the mentor sessions, and also ideas for improving the sessions.

For the Reality Check Mentor fall session, the great majority of students—88%—agreed that the RCMs assisted the team with understanding project requirements. A near unanimous number of students agreed or strongly agreed that the RCMs provided guidance for their research of project requirements. Student comments were almost all positive, and centered on two main themes: the mentors provided numerous avenues for research, and advice on how to

make the projects more realistic. Indeed, the concept of “practicality” was mentioned numerous times.

The fall Subdiscipline Mentor session was relatively well-received, with over two-thirds of the students agreeing or strongly agreeing that the mentors assisted with understanding project requirements and providing guidance for the research requirements. Students noted that the mentors were particularly helpful with clarifying specific design approaches and defining their scope of work. Moreover, several students stated that they found the mentors’ analysis of other capstone projects assisted with their understanding of their own projects.

Students were generally positive about Board participation in the fall informal poster session. However, while a little over 60% agreed or strongly agreed the interaction assisted them with understanding their project requirements, their comments suggested that the session was more useful as an opportunity to hone their presentation skills and for networking with potential employers.

The fall meetings with the RCMs were originally conceived as an interaction addressing issues faced during project initiation. 88% of students in the fall survey, however, stated that if given the choice, they would meet with their RCMs in spring term. Consequently, instead of requiring a meeting, faculty allowed extra credit if the teams decided to meet with their RCMs. Be that as it may, 78% of the students agreed that the spring session was useful, while only one-third stated that the reason for their participation in the session was to earn the extra credit.

The spring meeting with the Subdiscipline Mentors garnered high marks from the students: 81% agreed or strongly agreed that the meeting enabled them to refine their designs or project management plan.

For the spring formal poster session, which is assessed through the use of rubrics, 89% of the students found the Board input helpful. Many of the comments, however, suggested that the students considered the interaction with Board members served as a good warm-up for potential questions that might arise during final oral presentations.

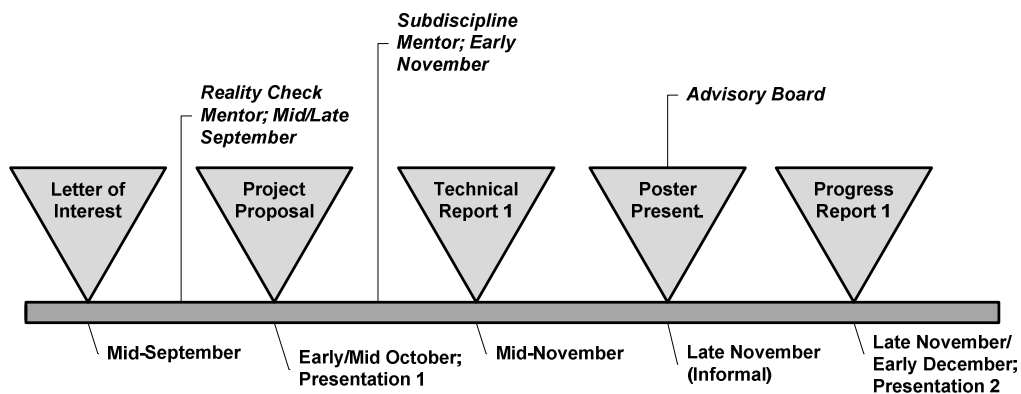


Figure 1: Project 1 Deliverable Timeline/Mentor Session

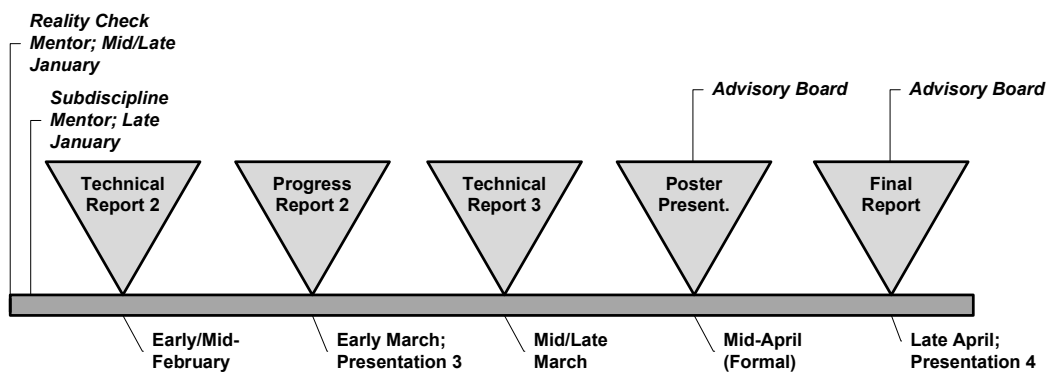


Figure 2: Project 2 Deliverable Timeline/Mentor Session

Final Comments and Potential Improvements

There is no question that the Mentor Initiative positively affected the capstone. From the perspective of the students, the practitioners provided additional breadth and depth to the various civil engineering subdisciplines. It was evident that students benefitted from hearing different voices from industry. Moreover, the various sessions allowed the students the opportunity to demonstrate their engineering and presentation skills to potential employers.

The Civil Engineering program also benefitted from the Mentor Initiative. Relationships with local construction and engineering firms were strengthened. The practitioners provided insight into what industry needs from a civil engineering curriculum, thus assisting with continuous improvement.

Finally, the practitioners benefitted. Their sessions provided an intimate look at student work product and capabilities. Furthermore, the interactions with the students served as an informal interview of potential employees. Indeed, several of the students in the capstone cohort were hired by mentor firms.

When the capstone presentations were discussed among the Advisory Board at the semi-annual meeting, the members were extremely satisfied with the students' work product. Several members believed that the projects were more complex, interesting, and of a higher quality than in previous years, prior to the Mentor Initiative. Another recurring comment was that the subdiscipline scopes were clear and well defined. When taken in conjunction with student survey responses, it is apparent that the mentors made significant contributions to student preparation.

Through the comments in the survey essay responses, and anecdotal discussions with project teams and individual students, there are some opportunities for improvement of the Mentor Initiative. For example, faculty needs to schedule the spring Subdiscipline Mentor session earlier in the term. In the past, the meeting occurred too close to the technical report submission deadline. The result was that even if students received useful suggestions from the mentors, there was insufficient time to integrate any of the feedback into their reports.

A change faculty is also considering is to assess the fall poster presentations with rubrics, similar to the spring presentations. The fall session was originally conceived as a "dry run" where students could create posters and interact with the Board with no grading and minimum pressure. Surprisingly, however, several students felt that if they were going to go to the trouble of creating a poster for review by the Advisory Board, they would prefer to receive a grade.

Based on student suggestions, faculty is also discussing ways to better prepare mentors for their

particular sessions. This preparation would require the input of both faculty and students. First, mentors are sometimes not as clear on the concept of project designs based specifically on civil engineering subdisciplines. Rather, they are used to complete designs that may include architectural elements. Consequently, faculty must better educate them on capstone requirements and expectations. Secondly, assuming mentors would have the time to review information prior to their sessions, teams may submit one-page executive summaries comprised of a project overview and the scope of each civil engineering subdiscipline. Thus, depending on the term, students will provide initial or updated project information, enabling the mentors to participate in the sessions with useful foundational knowledge.

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