Communication and Civil Engineering: An Integrated Approach to Senior Projects

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For the past year, Oregon Institute of Technology's Civil Engineering and Communications Departments have been developing a creative curriculum venture: a unique senior design experience that would combine the content of what had previously been three distinct classes: engineering design, technical writing, and group dynamics. Students would work in teams on a real design project, and the nine faculty involved would also work as a team to provide a multidimensional educational experience.

This paper describes the planning process, implementation, assessment methodology, challenges, and future plans. While this project certainly fulfills most of the EC2000 program outcomes criteria, our project vision extends further: to underscore the symbiotic relationship between engineering and communication and to afford students a realistic glimpse into their chosen profession.

Planning Process

Planning began approximately one year before the initial course offering in fall term, 2001. Prior to this class, the civil senior project consisted of a series of loosely related courses, designed to give students an greater understanding of the many sub-fields of the discipline and their complex relationships. The final course focused on design, but in a 10-week term, scope was limited.

To give students a better understanding of what they would be facing as professionals, several members of the Civil Engineering Department began exploring the possibility of an integrated senior project, involving engineering design, technical writing, and group dynamics. They interviewed employers and practitioners, performed an informal feasibility study, and approached two members of the Communications Department.

Formal meetings of civil and communications faculty began during spring, 2001, after the course proposal was approved by the campus committee responsible for curriculum development. To avoid problems with the communications general education requirements, students were to register each term for three separate classes (design, 3 credits; technical writing, 1 credit; discussion processes, 1 credit), although the faculty viewed them as essentially one course. We met on a regular basis, developed initial class materials, and held a very productive retreat prior to the fall start-up.

What emerged from these meetings was an overall design for a three-class sequence involving the

multi-phase development of a 1,300-acre parcel near a local subdivision. The class would be organized as a civil engineering firm, with students functioning as junior engineers assigned to work groups. Civil faculty would be senior project engineers, and two were designated as upper management. Communications faculty were "hired" by the firm as consultants.

Course content for fall quarter would focus on proposal development in response to a request for proposal (RFP), winter term on design of Phase I, and spring term on final Phase I design and report preparation. Writing and teamwork skills would be essential for project completion.

Implementation

Twenty-eight students registered fall term, 2001, for CIV 411, Civil Engineering Design I, scheduled to meet two days a week for two-hour blocks. About half also registered for the writing and speech courses. Classwork for the term was evenly divided between a conceptual plan competition and proposal development. In addition to the formal class meetings, participating faculty met formally for one hour a week, augmented by many informal hallway and office conversations.

For the first half of the term, faculty divided the students into five teams, and they worked on a conceptual plan for phased development of the entire parcel. One class period consisted of a lecture by a city planner, who informed the students about zoning, planned unit development (PUD) regulations, and contact information necessary for their designs. At the end of the five weeks, we held a poster competition, with a five-minute presentation by each team. The winning entry became the primary plan for the rest of the project, but creative elements of other designs could be incorporated.

In the remaining five weeks of fall term, students were divided into discipline-specific groups (environmental, geotechnical, structural, transportation), with a construction team consisting of representatives from the disciplinary groups. A supervisory three-person master planning group was added as an afterthought, but, as the process unfolded, this group became indispensable, providing a coordinating link between the other groups.

Communication work was intensive. For technical writing, students kept individual project logs and time sheets; wrote weekly group progress reports; prepared poster boards that included CAD drawings, bulleted lists of design highlights, and an executive summary; and developed group names and logos. For the proposal, each group was responsible or preparing a section of the report and a piece of the final presentation, all conforming to specifications set by the master planning group and the initial RFP. In addition, each student prepared a resume, focusing on technical experience, for inclusion in one of the proposal's appendices.

To strengthen teamwork skills, students participated in a number of workshop activities as well as writing three self-studies analyzing group processes. For example, in one session we viewed a video, *The Abilene Paradox*, and used it as a springboard for discussing ways to avoid group

dysfunctionality. For another workshop, students took the MBTI (a short form is available on the Web[1]), shared results in their project groups, and devised ways to help circumvent problems which might emerge, given the mix of personality types in their groups.

By the end of the term, students had prepared and presented a substantial proposal. Overall, they spent a collective 495 hours on the proposal part of this project, beyond the required class time. With the help of their faculty project engineers, they also identified work for the succeeding terms, and the next phase of the class started off on a solid footing this week.

Assessment Methodology

We conducted formal assessments three times during fall quarter–the conceptual plan, the final proposal/presentation, and peer review–in addition to evaluating the weekly progress reports and offering feedback on drafts of the poster executive summaries and the proposal.

Conceptual plan. During midterm week, we held the poster session in the College Union. Using a review form developed by communications faculty and mutually agreed upon by civil faculty, students, faculty, and the city planner scored the five posters according to common criteria: text elements, graphics, oral presentation, and engineering design. To preclude the possibility of a tie, we also requested that each reviewer give a final ranking. Student and faculty scores were remarkably consistent, with an overall difference of only 2.44 points, out of a possible 100. The winning group, Peak Engineering, squeaked by its closest contender by a mere .32 points.

For follow-up, the city planner spent the next class period methodically explaining the advantages and disadvantages of each poster, commenting on both the poster design and the proposed design of the property.

Final proposal/presentation. The proposal presentation was made in a formal presentation room; students were required to use PowerPoint and incorporate their engineering drawings. Each group chose a representative to speak, and the overall length was limited to 20 minutes. The master planning group designed the presentation template and provided the introductory and concluding frames for the presentation.

As with the conceptual plan competition, we used a common evaluation form with organization, delivery, and visuals as criteria. Pressure was on the speakers to perform well, since they were earning a grade for their entire group. The result was excellent because they were well prepared: the speakers held an in-class practice for feedback from the whole class, as well as several practice sessions with communications faculty.

The written proposal was scored by all participating faculty and the city planner. While certainly not perfect, we were impressed by what they had accomplished in only five weeks and by how well the master planning group managed to coordinate the efforts of 25 other students.

Peer review. Following the suggestion of Robert Martinazzi, University of Pittsburgh, Johnstown,[2] we had the students develop peer review criteria in an in-class brainstorming exercise. In their project groups, but without faculty input, we asked them to list what they considered to be fair items for evaluation. We then discussed each option and devised a common list consisting of the following: comes to meetings, displays professionalism, maintains effective communication, is committed to team, displays appropriate attitude, performs high quality work, is task/goal oriented, displays organization, demonstrates flexibility, contributes equally. To promote equity, we also defined abstract terms, such as "professionalism," and attached the definitions to the review form. The class decided to use a Likert scale, with space for comments. The class did a "dry run" at the end of fall term and seemed pleased with the results. For succeeding terms, peer review will account for 15% of their overall grade.

To determine final course grades, faculty held a review session for about two hours, discussing each student's performance. We decided that each student would receive the same grade for each course, since we had agreed during our planning sessions that we would treat the three courses as one.

Challenges

As with all new courses, we experienced some initial challenges, since an intensive team approach was new to both students and faculty. The major obstacles we faced were mid-year graduates, course repetition, and bifurcation of content.

Mid-year graduates. About one-third of our project class was scheduled to graduate at the end of winter quarter (none graduated in the fall). This presented a conceptual challenge, since the course was designed as a one-year process. To compensate, we decided that winter graduates would follow a normal path during fall term and then do "double duty" during winter, which necessitated preparing spring materials much earlier than we had initially anticipated. Students, however, seem satisfied with the extra load–or at least voiced no major complaints at our first class meeting.

To avoid damage to the groups with winter graduates, the students, in consultation with their project engineers, decided to split into subgroups, with winter graduates working on an aspect of the project that could be completed early: structures split in half, with one team designing an apartment complex and the other a sales building later slated for conversion into a restaurant; transportation split into on- and off-site teams, with the former designing the roads through the development and the latter studying traffic impact; and the lone geotechnical winter graduate conducted slope stability analyses, providing information necessary for both the structures and transportation teams.

Splitting into subgroups has solved the current problem with mid-year graduates, and we are investigating ways to have students enrolled in the project for three consecutive terms, thus obviating the need for doubling-up.

Course repetition. Of more concern for both faculty and students was a perceived repetitious element in the communications courses. OIT's general education requirements mandate four writing classes and two speech classes for all baccalaureate candidates, in addition to social science, humanities, and science courses. Two of the classes, Advanced Technical Writing and Discussion Processes, are generally taken at the senior level, although if students fulfill the prerequisites they may enroll earlier. Approximately half of our seniors had done so. This meant that students registered for variable credits for the project class: those who had not taken the writing and speech classes registered for 5 credits; those who had completed those classes registered for 3 credits. However, in order for the class to succeed as an integrated experience, it was necessary to include elements of those general education courses, and civil faculty agreed that all students in the project course would complete all of the work, regardless of whether or not they had completed the writing and speech classes.

Students who had already taken those classes perceived this as a major injustice and were not shy about expressing their concerns. In fact, they included comments such as "Writing things down is a waste of time" and "Group dynamics is not a part of engineering" in their papers evaluating their project groups. While faculty sympathized, we also understood that the project class required the writing and speech elements. This problem should disappear within a year or so, since students are being advised not to register for the regular writing and speech classes.

Bifurcation of content. When we designed the fall term class, we decided that we would devote one day a week to communications and the other to engineering design. What we did not realize, however, was that this tidy schedule was contrary to the integration we had envisioned: rather than seeing writing and teamwork as an essential part of the engineering process, students viewed them as separate boxes–more hoops for them to jump through.

To truly achieve integration, we had to make the content more seamless. Therefore, for the rest of this year, we are not designating "communications" or "engineering" days. We plan more of a workshop approach than a traditional mode, to more closely simulate an industrial environment. In addition, we have invited practitioners, including OIT alumni, to participate in a panel discussion on the necessity of good communication skills in engineering.

Future Plans

Our most immediate concern, of course, is to finish out the academic year and provide a meaningful experience for our students, one that will hopefully provide them a graceful transition from students to working professionals. Beyond that, however, we plan some changes:

Curriculum integration. We are currently writing a proposal to the institutional curriculum committee to make the project course 5 credits and eliminate the writing and speech classes as separate designations. Not only would this address student complaints about repetition and credits; it would reinforce our vision of integrated curricula.

Organization. While we knew where we were headed, the students didn't necessarily share that opinion. Also, we were unclear about what students would actually produce: we knew about poster sessions in a professional venue, but how students would handle that task was an unknown. In addition, we need to more clearly articulate goals and expectations as a faculty team. For example, we discovered some major differences regarding how engineers and how communications faculty viewed the progress reports.

Workload considerations. We also need to investigate in-load status for teaching the senior project. Currently, each faculty member is doing this on top of a regular full 12-credit load. The time expenditure is substantial: at least five hours a week in formal class and faculty meetings, as well as the time required to prepare class materials, read and evaluate student work, and meet to discuss grading.

Conclusions

As one of the communications faculty involved in this project, I must say that it has truly been a learning experience. While I have team-taught in the past, that has been limited to working with only one other instructor from my own department, not seven from a technical department. I am amazed at the creativity, energy, and enthusiasm displayed in our faculty meetings and impressed by our ability to agree on key issues. Even when the rare moment of conflict occurs, we are able to discuss the problem professionally and dispassionately and find a workable solution.

Beyond the personal benefits to participating faculty, we are impressed by our students: by their willingness to embark on a new curriculum venture, by their ability to meet deadlines, and by their relatively cheerful attitude towards group work: not one group has reported a "social loafer," someone who avoids work and rides coattails on the rest of the group.[3] At least this far, they have achieved what Johnson and Johnson call a "positive interdependence,"[4] the ability to trust and depend on each other to complete designated tasks in a timely manner. The skills they are learning in their senior project class should serve them well as professionals.

References

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