Work In Progress: Using Project Documentation to Teach Creative Design

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Abstract - Project documentation can play an integral role in design by helping the students plan, theorize, analyze, and interpret their work; the need to communicate about their work pushes students to fully formulate project plans, understand the theories behind their work, and analyze their results more completely than they might otherwise. This project evaluates strategies for more fully integrating communication and design through studies in two senior-level design courses. Preliminary results show that while students can effectively use of writing and speaking assignments to further their projects, they need appropriate scaffolding to facilitate that process.

Index Terms - communication skills, engineering design, project management skills, integration, writing

INTEGRATING COMMUNICATION AND ENGINEERING DESIGN

Senior design courses often provide opportunities for students to develop not only engineering skills, but also communication skills as they create proposals, progress reports, and final reports about their work. However, as students grapple with open-ended projects requiring them to integrate concepts learned in multiple courses, communication assignments are easily perceived as “add-ons” – required by professors, important to grades, perhaps necessary for on-the-job success, but still independent from the design. Yet the scholarship on writing to learn, coupled with workplace experiences, suggest that project documentation can play an integral role by helping students flesh out vague project plans, clearly articulate tentatively-understood theories, and detail results and analysis more fully than they might otherwise. As a result, well-designed assignments and supporting classroom instruction can serve not only as opportunities to develop communication skills, but also as opportunities to develop design skills.

PILOT-STUDY AND PRELIMINARY FINDINGS

This study examines students’ use of communications assignments in two senior design courses at Virginia Tech, one in Materials Science and Engineering (MSE) and one in Engineering Science and Mechanics (ESM). In both departments, senior design is a two-semester course in which students work, either alone or in teams of two or three, to conduct a capstone engineering design project. Students can either work on projects initiated by faculty in their respective departments or create their own project. Each project has a faculty advisor; in addition, each department has a formal class that meets twice weekly in the fall and once a week in the spring. These classes are team-taught by a faculty member from the engineering department and the director of the departments’ joint Engineering Communications Program.

Both departments are relatively small (MSE had 19 students/8 projects in the 2003-04 course, while ESM had 16 students/10 projects), and the projects often bridge the science and engineering components of their respective disciplines and bear a strong resemblance to projects typically described in the literature about undergraduate research.

Although the MSE and ESM courses are separate, they are similar in structure, in part because of the shared communications program. Both include substantial writing and speaking assignments: a proposal at the project’s outset, several written and oral progress reports, an extended final written report, and a final presentation each spring to which the entire department is invited. Currently, the ESM course includes a formal literature review and more formal oral progress reports, while the MSE course includes an annotated bibliography and an informal in-lab progress report.

As the new communications program director, entering both courses midway through the Fall 2003 semester, I implemented few changes this year and instead gathered observational and survey data to determine how the communications components functioned in each course. Surveys were administered at the beginning of spring semester; each course also included final student evaluations, and students in both courses were asked to develop advice to pass on to next year’s class. In addition, I worked with students individually on their projects and graded almost all of the major assignments. This preliminary research highlighted several important points:

- Students found the proposals among the most useful elements of the course because these documents forced them to define deliverables and thus shaped their projects. As one student succinctly put it, “Direction is good.”
- Most students found the written progress reports useful “for staying on track,” particularly when the reports were tied directly to the deliverables outlined in the proposal. Interestingly, despite that perceived value, almost no group in either department completed the project on schedule. Most were still analyzing results (and sometimes collecting data) up to the final report, even though both courses had drafts due several weeks earlier.
• Responses to the literature review/annotated bibliography were mixed. Some students found these useful while others did not. Two comments reflect the range: “...we didn't have a great understanding of our project in the first weeks of the semester, so we just wrote down every book remotely related,” said one student, while another saw the literature review as “a good assignment if you know the basics of your project because you learn more about the background and can ... realize things you may be doing wrong or new ways to go.”

• The oral progress reports also received mixed reviews, though most students viewed them more favorably than the library research work because they provided practice in public speaking. Some students did not feel they knew enough about each other’s work to effectively engage the oral reports, while others simply saw them as boring. Yet in their final comments, several students suggested using class time to learn more about each other’s projects and get more feedback from one another.

• Few students reported keeping detailed laboratory notebooks; notebooks were not required in either course, though the faculty strongly recommended them. Yet the value of such notebooks made a strong showing in students’ advice to the next class, both from students who kept detailed notes and described how the notes helped them write the final report, and from students who failed to keep good notes and found themselves scrambling to remember important points about their work.

• Students’ work on their final reports, typically begun after spring break, often revealed significant gaps in project design and implementation that required either additional work, a revised project framework, or “creative” strategies to deal with the gaps.

These results suggest several strategies to more effectively use communication assignments to support the design process:

• Proposals are useful tools for helping students design projects, and particularly when they ask students to articulate a clear list of deliverables that can then be referred to throughout the semester.

• Written progress reports are most useful when tied directly to project deliverables. Yet students need explicit instruction in how to adapt their projects and/or project schedules in light of these reports to more effectively meet deadlines. That is, while “direction is good,” students also need help learning to effectively adapt that direction to the project’s own development.

• Oral reports, while useful for public speaking, need to be integrated into design courses in ways that foster student interaction. This integration may involve allowing more time for reports, having students provide classmates with written texts, and offering explicit instruction on engaging productively in one’s colleague’s work.

• Work on the final reports (including defining the report’s focus in light of the project deliverables; developing an outline; and creating a list of charts, tables, and other illustrations) should begin early in the process, possibly soon after students’ proposals are accepted, to help guide the design project itself.

• Finally, laboratory notebooks, though a familiar genre to most undergraduates, should be explicitly incorporated into the course, with an emphasis on both the deliverables outlined in the proposal and the information needed for the final report.

NEX T STEP

The next step involves adapting the existing assignments to address the limitations found in the preliminary study, as well as incorporating additional assignments such as required laboratory notebooks, and evaluating the results. The study will track the results through 2007, and the data collected will include:

• Three sets of student surveys (at the beginning of the fall semester, at the midpoint in January, and at the courses’ conclusions) in each senior design course to assess both how students are using the communications assignments and how they perceive those assignments.

• Outcomes assessments of both written and oral assignments and the projects themselves, particularly in light of the relevant ABET criteria, to determine whether the strategies are positively affecting students skills in both communication and engineering design.

• Faculty surveys conducted at the final presentations each spring to assess their perceptions of the quality of both student presentations and student projects. These surveys provide a second way to evaluate how the teaching practices are affecting students skills.

• Alumni surveys to help determine the long-term value of these strategies in preparing engineers for the workplace.

This data should help us answer several important questions about how we teach communications skills and develop students’ ability to engage in complex, self-directed engineering design projects, including:

• What elements of reports, presentations, and related assignments do students find most useful in developing and managing engineering design projects?

• What classroom practices and assignment designs best help students use communication projects to further their engineering design projects?

• What communications practices best aid engineers working on design projects in the workplace?

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