Small Steps and Big Strides: a Department-Based Plan for Integrating Technical Communication into an Engineering Curriculum

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Abstract

Providing technical communication instruction within existing courses can challenge the human and financial resources of a department. Such a challenge becomes even more daunting in the absence of university or college funded programs. The Department of Civil & Environmental Engineering at MSU has undertaken a three-year plan to integrate such instruction into its curricula and to assess the results of that effort. Based upon alumni and faculty surveys, the department has designated core competencies in this area and has developed activities to seed instruction and reinforcement of those competencies within upper level courses. These activities include annotated model lab reports, assignment templates, an online technical writing handbook, a student-run satellite writing center housed in the department, and teachable-points-of-view. The latter present the accumulated expertise of faculty members regarding a particular assignment. Roger Wallace and David Adams describe the genesis and design of the plan and offer examples that illustrate how the plan works. Wallace and Adams also discuss some of the issues encountered including how introducing a structured writing component sparked a reexamination of course content. They also present preliminary assessments of the plan.

I. Introduction

In recent years the Department of Civil & Environmental Engineering (CEE) at Michigan State University has faced a reality confronting many engineering departments across the country. Engineering undergraduates are typically not well prepared to undertake the sort of technical communications tasks that they will face upon graduation. If the concerns of faculty, alumni and employers were not enough, the ABET *Criterion 2000* standards have focused even greater attention on this issue.

After several aborted efforts to solve the problem, in 1999 the department committed itself to hiring a full-time technical writing specialist as part of a three-year plan to integrate technical writing instruction into its curricula. At that point, only one other department (Mechanical Engineering) in the college had such an effort in place, and there were no college-wide or university resources available to build such a program. That situation remains current. In addition, at MSU engineering students take the bulk of their first and second year courses outside the college of engineering, and do not choose their engineering majors until their junior year. Furthermore, a new engineering dean was hired with the expressed goal of improving the research reputation of the college. All of

these factors point to some of the conditions and constraints that affected the design of a plan that would suit this department at this institution.

Engineering colleges have employed a variety of strategies in attempting to improve the communications skills of graduates. Some require stand-alone technical writing courses, others employ some variation of a Writing-Across-the-Curriculum (WAC) model. Still others tie communications instruction with the delivery of either introductory or capstone design courses. A July 1999 special issue of *Language and Learning Across the Disciplines*[1] highlighted some of these approaches; it also serves as a useful summary of some of the issues involved at different institutions.

The plan that emerged for the Department of Civil & Environmental Engineering incorporated some of these strategies and the practical experiences of the technical writing specialist. It also reflected the need to produce some positive results with limited resources and within three years.

This effort is now in its fifth semester. This paper describes the history of the effort within the department, the plan that emerged, some reflections of a lead professor from a critical course, the problem of assessment, and some of the issues and opportunities encountered along the way.

II. History

Over the years faculty have complained repeatedly, "Our students can't write." Experience teaching a graduate groundwater course over the past 15 years has provided further perspective on this situation. Students in that course have backgrounds in either civil & environmental engineering or in the geological sciences. In general, the engineers handle the mathematics of the quantitative problems better than the geologists do. The engineers are accustomed to solving quantitative problems. However, on average, the engineers do not do as well as the geology students when it comes to interpreting the meaning, value, or perspective provided by the quantitative work. Writing provides one means of developing these higher-order thinking skills.

A 1997 experience with recent MSU engineering graduates at a General Motors sponsored forum reinforced the perception that students need more experience writing. This panel of students told MSU faculty that they had received more than adequate quantitative training, but that the university had failed to help them develop necessary communication skills. An alumni survey identified writing as one of the major areas where the department might improve instruction.

After several unsuccessful attempts at solving the problem by using part-time, local instructors, the CEE department conducted a national search for a full-time (3-year appointment) technical communications specialist. That effort led to the hiring of the co-author of this report in August of 1999.

III. Developing a Plan

We spent the fall semester of 1999 evaluating the department's curricula and developing the plan that would carry through the next three years. Department faculty endorsed the plan in December 1999. The plan was built on several core ideas:

- Faculty and alumni support would be key to sustaining the effort.
- The plan would rely primarily on resources at hand.
- The university's Tier II Writing Requirement* and the department's Continuous Quality Improvement model would inform design of the plan.
- The plan would rely on a core of motivated faculty to gradually transform the culture of teaching technical communication within the department.

In autumn 1999 faculty and members of the department's Professional Advisory Board (PAB) were surveyed regarding the communication skills of graduates. Surveys results indicated broad dissatisfaction with the communications skills of our graduates. These results also pointed to the sorts of communications products that both groups felt students should expect to produce as professionals. Combining these results with the semester's evaluations, we developed a set of core competencies in communications and applied these to developing the plan.

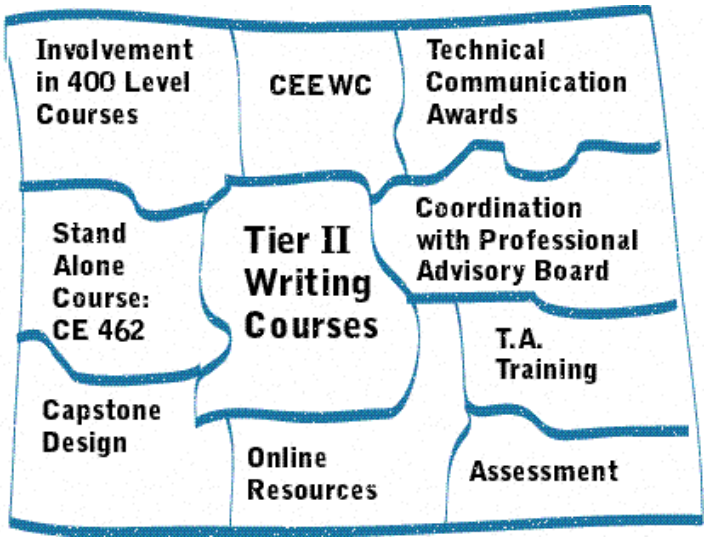

Figure 1. This puzzle illustrates the basic elements of the technical communications plan in MSU's Department of Civil & Environmental Engineering.

The Tier II efforts are at the core of the plan.

Figure 1 illustrates the basic elements of the plan. The idea was to seed instruction and reinforcement of the competencies throughout the department's curricula.

* Michigan State University requires each department to develop an upper level writing-intensive course for students in its majors.

Tier II Writing Courses. The department offers two such courses: CE 321, Introduction to Fluid Mechanics and CE 341, Introduction to Transportation Engineering. All students take CE 321 and this effort is described in some detail in the next section. Primary emphases in this course include learning to write lab reports, technical memos, and business letters. CE 341 is a lecture course in which students work in teams to study a transportation problem. We have revised the pieces of this assignment to place students in a consulting role. They then write a proposal in response to an RFP, submit an interim report and a final report—all with transmittal letters. We developed instructional materials and assignment sheets to provide students with guidance. Both courses incorporate one opportunity for a formal feedback/revision cycle.

Civil & Environmental Engineering Writing Center (CEEWC). The department sponsors a peer consultant writing center for students. Several students work in this center, providing coverage for 8-10 hours per week. The technical writing specialist supervises these students (who were already employed in the University Writing Center). The center has a dedicated space. Faculty e-mail copies of assignment sheets and course issues to these peer consultants.

Stand Alone Technical Communications Course (CE 462). The technical writing specialist also developed and gained approval for a three-credit technical communications course that is offered once a year as an elective.

Online Resources. The department has built a technical communications page, http://www.egr.msu.edu/cee/techcom/, onto its web site. This page includes an on-line technical writing handbook, *Writing Better Reports*, and an annotated list of resource links.

Capstone Design. The department is currently developing a new capstone design course. The new course will require students to work in interdisciplinary teams to design a solution to an engineering problem. This course will require written, Web-based, and oral communication and will provide a vehicle for a "capstone" portfolio to assess the department's communication competencies, as well as its other engineering competencies. This course will debut in 2002.

Involvement in 400-Level Courses. The technical writing specialist also works with faculty in upper level courses to refine the structure of writing assignments. One example is helping to build a summary/review assignment for students in an engineering ethics course. Another example is helping to design an assignment that asks students to review literature in technical journals and the popular press regarding a dam failure and analyze the different treatments of the event.

Alumni Involvement. Alumni involvement occurs on many levels. In CE 321 a recent graduate attends lecture and speaks with students about the importance of communication skills in her professional life. Members of the PAB advise the department on its efforts and participate in assessing those efforts.

TA Training. The technical writing specialist and lead faculty member meet weekly with TAs who grade reports in CE 321. We design report models and checklists to aid TAs as well as students. We also review grading issues in reports that students have submitted. A handbook on providing written feedback on student reports is in process.

Technical Communications Awards. We have prepared and circulated a case statement to seek support for a named cash award for outstanding student reports from the Capstone Design Course.

Assessment. We have designed a dual approach to assessing this program. We incorporate

short-term assessments to provide quick feedback for improving efforts within courses. We also evaluate our efforts each semester through course portfolios and student evaluations, and in the longer term through repeated faculty and alumni surveys. In April 2001 we conducted a review of the program by an outside subject matter expert who submitted a highly favorable report.

IV. Reflections of a Lead Professor

CE 321, Introduction to Fluid Mechanics, is a 4-credit, junior-level course that all undergraduates in Civil and Environmental Engineering are required to take. It is offered each semester and has an enrollment of 50 to 60 students. The course includes three standard 50- minute lectures each week and a two-hour lab. We run three lab sections each week. We have equipment for about ten students in each lab, so students attend lab every other week. CE 321 is central to our efforts because it is the Tier II course that all our students take. Nonetheless, this course presents us with a number of challenges because it is a difficult lab course that many of our students put off until late in their programs.

Challenge 1: The Course Content and Structure. Introduction to Fluid Mechanics holds some of the challenges of all required courses, particularly when many of the students in areas such as transportation engineering have little interest in the subject matter and will find its concepts difficult. The fact that many students delay taking this course means that they may be facing for the first time serious evaluation of writing in such a context. Students are not always overjoyed by this experience.

Challenge 2: Student Attitude. Historically, undergraduates in this course make little effort to write well. They appear to believe that good writing is unimportant at MSU. They support this notion with the argument that they receive acceptable grades despite handing in poorly written work. They also observe that the comments they receive on their written work seldom help them understand how to make improvements. They have little incentive to invest time writing. We have developed an approach that demands better writing and provides students with the guidance and feedback they need to be successful.

Challenge 3: Faculty Limitations and Orientation. Faculty members may have little time for either course development or direct involvement in grading student work. With limited experience teaching writing, faculty lack many insights and must struggle just to identify the critical difficulties that students are encountering with their writing. Faced with these difficulties it is easy to fall back on the old standby, assign more quantitative problems: problems that we have much more experience helping students master. But such a strategy just avoids the real issue of improving students' writing.

Challenge 4: TA Limitations. Our TAs are all MS students. We ask them to run the labs, provide constructive suggestions to students on how to improve lab reports, and grade the final reports. Often this is a TA's first experience grading. TAs have very limited writing experience and may never have been asked to provide guidance to other students who

struggle with technical writing issues. This can be a case of the blind leading the blind.

Challenge 5. Introducing Writing Necessitates Change. As we introduced writing into the course in a more structured and thoughtful way, the writing we received illuminated those parts of the course that were not sufficiently well organized or clear. As a result we have made substantial changes to the course that have improved it from an engineering viewpoint, as well as from the viewpoint of an opportunity to teach technical communications. We have taken a number of steps to address these challenges:

- We substantially increased the weight of reports in calculating the course grade. We grade these reports on a holistic basis to concentrate evaluation on how clearly the student has understood and expressed the important engineering issues.
- We assigned the technical writing specialist to work with faculty and TAs in this course to help plan and carryout the writing component of the course, to design instructional materials, to interact with students individually and in small groups.
- We have focused on addressing identifiable problems where we can implement long-term solutions. We developed an annotated model lab report that we give to students along with a "teachable-point-of-view"[2] table regarding the structure of lab reports. For two of the five experiments, we have replaced the usual lab report with letter or memo assignments. We create normal workplace scenarios for these assignments and provide an advice table with the assignment sheet.
- We meet with the TAs each week to discuss selected reports that the TAs have reviewed before they assign the grades. We set high grading standards so that students get a clear message that writing counts. These meetings provide an opportunity to guide and influence feedback provided by the TAs as well. When we determine that the reports demonstrate a common identifiable writing difficulty, we revisit the issue in lecture. That step demonstrates how common the problem is and that we value the writing issues enough to deal with them in lecture when appropriate. As an example, we found that students (despite the advice of the model report) neglected to use the objectives of an experiment as an organizing structure throughout their reports. By spending lecture time reinforcing this point, we found that students were more likely to organize the critical discussion and conclusion sections of their reports in a useful pattern.
- We incorporate a checklist into each lab assignment. These give us a means for focusing the TAs and the students on issues that we target. The first lab minimizes the computational busy work associated with the experiment by providing a spreadsheet to reduce the data. This step lets us engage students in interpreting and describing the experimental results. For example, a checklist item for the "Results" section may include directives such as these: *"Did you describe what your uncertainty propagation calculations show about the values of Q that you measured? Do these suggest that all of the uncertainty you observed in Q came from your uncertainty in V and Δt?"*
- We revised experiments to trim some of the time students spent on routine calculations so that they would have more time to spend thinking about their results. In making these revisions, we applied Bloom's Taxonomy[3] to the new tasks as a rough way to estimate how much new work we would require of students. We then

apportioned the tasks so that our emphasis on writing and thinking would not simply overwhelm students.

- We revised the course schedule to allow for a formal revision cycle after students turn in the first lab report. This change in schedule allows small groups of students to meet with the TA and the technical writing specialist to review the issues that emerged from their draft reports and consider ways to improve those reports.

While attempting to introduce self-teaching modules to help students deal with the concepts of *error* and *uncertainty* in discussing the results of their experiments, we were forced to confront the fact that these terms had not been used with appropriate care in some parts of the course manual that students received. The realization has forced overdue attention on improving the course manual. We have become much more conscious that our advice and materials reflect the care and precision of language we expect from students.

IV. The Assessment Troll

"Assessment" has probably overtaken "excellence" as the premier buzzword in higher education. Both regional and professional accreditation entities (such as ABET) have incorporated assessment requirements in revisions of their standards. We have tried to articulate an assessment plan that will work on two levels. On one level we want to provide quick assessment for students on how well they achieve the goals of particular assignments, and we want those assignments to provide us with feedback on how well we are leading them to achieve these goals. We also conduct longer-term assessments—portfolios, surveys, external reviews—that help us see how well our plan is progressing. We expect that the new capstone design course will provide a capstone assessment of communication competencies.

Table I. Progress of the CEE Technical Communications Plan.

Component	% Realized
Tier II Courses	80
CEEWC	90
Online Resources	85
CE 462	95
Alumni	60
400 Level	40
Capstone Design	30
Communication Awards	20
Assessment	60
T.A. Training	75

Table I gives a rough estimate of the plan's degree of realization in its fifth semester. Refinement of the communications component of capstone design remains a challenge. Assessment, of course, is an ongoing activity and will never reach 100%.

This set of experiences has taught us a few valuable lessons along the way about carrying out such an effort within a department and without plentiful resources:

- Faculty must be truly committed to supporting the effort to improve technical communications. That commitment will be tested when they realize just how much work and planning go into developing a successful writing-intensive course.
- Working within the small community of a department can make it possible to initiate change more quickly than one could in a larger unit.
- Models are helpful. Annotated models are more helpful.
- If we value writing, the grading structure of our courses should reflect that value. So should our course manuals and assignment sheets.
- Placing instruction and reinforcement throughout appropriate places in the curricula will make success more likely.
- In a little more than 30 months, we can see genuine differences in student attitudes. Business in the CEEWC doubled in each of its first three semesters and has increased steadily thereafter. Evaluations in CE 321 have been uniformly positive. Comparisons of new CE 321 reports with those written in earlier years show dramatic improvement in format, writing and expression of engineering content. The types of interactions of we experienced with students have dealt with writing and engineering issues at a much deeper level than before, which makes the courses more rewarding for everyone.

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Biography

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David Adams received an M.F.A. in poetry from Bowling Green State University. He has been a technical writer and teacher of technical writing for 23 years. He is currently technical writing specialist in the Dept. of Civil & Environmental Engineering at Michigan State University. Previously, he taught technical writing to engineers at Cornell University and the University of Maine. His fifth book of poems, *First Light*, was published in 2001 by Lost Shadow Press. He co-edited *Over West: Selected Poetry and Prose of Frederick Eckman.* 1999. National Poetry Foundation. His poems have appeared recently in *The North American Review, The Heartlands Today,* and *Hiram Poetry Review.*

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Roger Wallace is Professor of Civil & Environmental Engineering at Michigan State University, where he has taught for 20 years. He received his Ph.D. from the University of Michigan in 1981. Dr. Wallace specializes in groundwater and surface water hydrology. He has authored 22 journal articles and about 50 additional proceedings, reports and presentations. He has had research support from NIEHS, EPA, and the Michigan Department of Natural Resources.