AC 2010-445: PARTNERSHIP BETWEEN ENGINEERING AND PROFESSIONAL WRITING

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Partnership between Senior Design Project in Mechanical Engineering Technology and Professional Writing

Abstract

This paper will describe the preparation required for a capstone mentored class, the approach taken and the skills needed by both engineering and writing instructors. In addition, the paper will show the methods used to “refresh” student memory about previous writing instructions, writing and presentation criteria established, and the progression of student skills in meeting these criteria for both technical reports and presentations. Recommendations for implementing this approach in other project settings are also discussed.

Background

All mechanical engineering technology (MET) students in our college are required to take three writing courses, Technical Communications 111, 241, and 481, scheduled for the first, fourth, and seventh semesters, respectively.

TC 111: Expository Communication. Extensive practice in expository writing, emphasizing objective, clear, concise form, with most readings from nonfiction prose. Provides experience in organizing and presenting individual oral and laboratory reports. Introduces library usage and research techniques. Prepares students for technical writing and oral communication in TCII.

TC 241: Technical Communication. Introduction to technical communication, including written and oral skills. The course emphasizes basic structures used in recording and reporting technical information, including analysis of audience, language, and purpose; techniques of persuasion; page design and graphics; and technical definition and description. Students also prepare memos, resumes, lab reports, and a documented technical research paper. Oral technical presentations are also required. The interrelationships of technology and society, along with the ethics of technology, are considered.

TC 481: Advanced Technical Communication. Applications of skills learned in previous technical communication courses, with emphasis on practical writing and speaking. Students prepare informal and formal documents, including instructions, proposals progress reports, and letters. Individual and group oral presentations, as well as group project and ongoing discussion of technology, society, and associated ethical considerations, are required.
These courses cover foundational rhetoric and practical aspects of technical report writing and design, as well as the rhetorical and applied aspects of professional presentations. However, engineering instructors realized that fourth-year students were not connecting their work in technical writing to the actual production of a report and presentation for industry sponsors, which was a key component of the senior design project (SDP).[1]

The Challenges of Teaching Writing in the Engineering Classroom

Our students take courses in increasingly complex engineering topics as well as in increasingly complex writing principles. In both course sequences, students have significant opportunity to put both engineering and rhetorical principles to work. Yet, in an SDP such as ours, there often remains a disconnect between what was learned in a previous class and how that learning needs to be accessed and used in the design project. It is beyond the scope of this paper to explore why this happens, but it does seem to be a part of the learning process itself. Understanding a concept (whether it's about engineering or about writing) often does not acquire meaning until students have to put that concept into "real world" use.

To learn how to write for the world of engineering practice, students must understand writing as a dynamic and active process[2] and not as merely a "production" of static written or recorded data. In addition, students, just like some writers in industry, often perceive written documents merely as a means to an end (to further a process, leverage more funding, meet regulator demands) rather than as valid ends in themselves.[3]

What our SDP course, by so visibly and deliberately integrating the rhetorical and the technical components of the senior project, attempts to do is to provide a context, a "situation that defines the activity of writing."[4] This approach seeks to move students' thinking beyond "Oh, it's just a report" or "just writing." It seeks to help students perceive the writing products of the course (technical report and presentation) as a lively conversation between the students and their industry sponsors and instructors. In addition, the approach emphasizes that just as the engineering design process is scrutinized, analyzed, reworked, and adapted, so is the communication design process.

As Paretti notes, it is essential that faculty understand this, so that they can create and implement communication assignments that help students develop an "analytical, metacognitive approach" to reports and presentations that resembles, to a large degree, the engineering design process.[4]

Finding Solutions

In an effort to explore better methods of helping students transfer essential knowledge and skills, the engineering faculty piloted an SDP course incorporating industry sponsors and a faculty consultant from the university's Rhetoric and Professional Writing program, which resides in the College of Arts and Sciences.

Over the past ten years, mechanical, electrical, and civil engineering faculty together with writing faculty in Arts and Sciences have developed team-taught classes for first-year writing and introduction to engineering courses. However, the challenge of the MET SDP pilot was to mentor students as they prepared technical reports and presentations, without creating a paired class, which was not possible due to credit-hour and scheduling constraints.

Goals and Outcomes of Mechanical Engineering Technology Senior Design Project

The SDP is a capstone course that gives students an in-depth understanding of how to approach open-ended challenges, and learn how to creatively analyze, synthesize, and apply technical knowledge from prior coursework. Teams of students work on either an externally-sponsored or in-house project and are advised by mechanical engineering faculty and engineers from sponsoring companies. This course culminates with a public and formal presentation evaluated by a professional jury of practitioners. Representative past projects include:

- Long-term compression set testing of silicone elastomers
- Design of tube cutting machine
- Sustainable tool design for planting amaranth seeds
- Evaluation of corrosion prevention compounds
- Diaphragm pressurization test
- Automated sensor pressure test system design

In the first week of the semester, students are required to contact industry sponsors to set up onsite meetings or orientations. Students then work with sponsors to refine the scope of the project, if needed, set deadlines, and assign tasks. Students are required to document site visits and copy instructors on communication going to the sponsor.

A substantial portion of students' final grade is based upon a professional technical report and an end-of-semester presentation to a panel of industry judges, faculty, and other students:

- Progress reports — 15%
- Written report content — 30% (10% each for relevant topic coverage, coverage depth, and logic and justification of conclusions)
- Written report quality — 20%
- Oral presentation — 25% (12.5% content, 12.5% professional delivery)

Technical Report Process

The first step in the writing process for students in the SDP class is the requirement to submit a weekly progress report. In the first week of class, students are introduced to the report worksheet (available through the class Blackboard™ site) and receive instruction on its use, through a brief lecture and a handout, "Tips for Completing Tracking Sheets" (Appendix A). The writing instructor coaches students in the use of the progress report as a documentation mechanism. These weekly progress reports were also a key component of the required thermo-fluids courses[6] in the 6^{th} and 7^{th} semesters. The open-ended experimental design used for this sequence as well as the written requirements (weekly progress reports and a formal technical report of results) help prepare students for the open-ended nature of the senior design course.
In the first or second week of the semester, target dates for report drafts are established. Students are able to access rubrics for teamwork and technical competencies; no formal teamwork instruction is provided although students can ask for "troubleshooting" assistance from an instructor if team issues arise and cannot be resolved.

Refreshing the Writing Memory

A key part of the writing instructor's objectives relate to reminding students that they have been exposed to the elements of reader-oriented writing through previous writing coursework, just as they have been exposed to necessary technical concepts in previous engineering coursework. During the first weeks of class, through brief lecture and discussion, students are asked to recall documentation assignments or similar writing tasks from previous classes. Since most classes beyond the first year are team based and have increasingly rigorous progress report or other documentation requirements, students easily recall experiences (often when the documentation was deemed insufficient) of making sure that a reader understood what happened during a particular activity.

This discussion is reinforced by feedback from instructors on the first week's progress reports. The engineering instructor comments on technical issues and clarity, and the writing instructor reinforces concepts of reader-centered writing. At this stage, reinforcement usually consists of reminding students that faculty were not "in the room" at sponsor meetings and thus thorough and coherent transmission of information is required.

As part of these memory-refreshing exercises, and to emphasize the essential aspects of appropriate professional writing for engineers, students also receive information (via lecture and PowerPoint posted on Blackboard) that reviews basic rhetorical principles such as audience and purpose. At this time, students are also directed to the report guide (posted on Blackboard), which lists the required report elements and general guidelines. Again, students used these guides in the thermo-fluids sequence, and this format was chosen to encourage knowledge transfer from one course to the next. Students are reminded that they have already used this format and are encouraged to access this knowledge, in conjunction with the provided information, and set up a working template for their technical report.

The writing instructor emphasizes that the material from weekly progress reports can be used to "fill in" the technical report template. This strategy helps students overcome the "dreaded blank page" and reinforces the process aspect of writing—the first draft is never the final draft.

Presentation Process

The presentation process in the SDP class is two-fold. The class meets for 2.5 hours, once per week, and beginning the second or third week of the semester, each student team is required to provide a brief PowerPoint presentation. This weekly presentation has a number of purposes:

1. to prompt students to regularly put their work in visible form so that they can receive feedback and review
2. to track and verify student progress by comparing the PowerPoint to the weekly progress report
3. to prompt students to regularly articulate the project's problem, parameters, possible obstacles, and potential solutions
4. to decrease presentation anxiety through weekly desensitization
5. to encourage other teams to provide constructive criticism on both technical and communications aspects as well as to avoid the "team vs. instructors" dynamic. This interaction between the teams facilitates seeing both processes, the engineering design and the writing, as active and dynamic.
6. to even out team members' oral performance

Students receive information from the writing consultant on building effective presentation after the first oral delivery; at that time teams are encouraged to improve their work using the posted tips.

Refreshing the Presentation Memory

In many ways the process of refreshing students' memory about presentations is a less complex task because all students at this stage have developed and completed numerous team and individual presentations and are thoroughly familiar with the tools available through PowerPoint. They tend to be more willing to develop and deliver a presentation than they are to write a report. The writing instructor, through lecture, discussion, and feedback, reinforces the rhetorical requirements of both weekly presentations and the end-of-semester presentation. Table 1 compares these requirements.

Table 1: Comparison of Requirements for Weekly and Final Presentations

	Weekly Presentation	**End-of-Semester Presentation**
Audience	Course instructors, other students; industry sponsors are always welcome to attend	Industry sponsors, instructors, department, other attendees (university administration, alumni, junior engineering and technology students, etc.)
Purpose	Update instructors on weekly progress; articulate key aspects of project including problem, analysis, solution	Present results of project and justify conclusions; show mastery of key engineering concepts
Format	Informal team presentation, with PowerPoint	Formal team presentation, with PowerPoint
Evaluation	Commentary and feedback from instructors and other students	Formal judging by panel of industry experts; additional feedback from writing expert and faculty

Although students are familiar with the presentation genre and its process in general, in this class they must learn to distinguish between and develop appropriate presentations for two very different audiences. They must also understand the difference between the weekly "update" presentation (with a strong focus on process) and the presentation for the sponsor (with a strong focus on results and validation).

Senior Design Project Class Outcomes—Without Mentoring

The decision to include a writing consultant on the instructional team for the MET SDP was based first and foremost on the quality of reports and presentations that were being submitted. In general, despite their instruction in Technical Communication classes, students tended to revert to old habits and treated the "write up" as an add-on to the engineering work, and thus something to be left for the last minute. Not surprising, report and presentation quality reflected those perceptions. These reports were, in the words of the engineering faculty members, "Unreadable, unprofessional, and unacceptable." The writing consultant's assessment of the unmentored reports noted:

- Lack of appropriate formatting: students wrote "one big document" without definitive sections, headings, or other visual organization;
- Minimal sense of audience: students insufficiently explained key processes and results, both for outside sponsors and for engineering faculty evaluating their mastery of essential engineering skills;

- Misuse of graphics: graphics used gratuitously—"It was a good picture!" or not used when needed to illustrate essential concepts or processes;
- Errors in grammar and usage, style (use of slang, informal tone), and spelling.

Presentations tended to fare slightly better but lacked visual appeal and, like the reports, had numerous errors, due to the "last minute" nature of their construction.
As a result, faculty began to develop a more deliberate scaffolding to help change student perceptions about the work and work product, including weekly progress reports; interim draft reports; clear, published rubrics; and evaluations that more heavily weighted the report/presentation component as part of the final grade, and more deliberate mentoring to help students transfer knowledge.

Senior Design Project Outcomes—With Mentoring

It was essential to develop clear expectations about quality, and then making those criteria available to students, early in the semester. These criteria were based on the rhetorical concepts that had been emphasized in previous technical communication courses and were reinforced throughout the SDP course through written feedback provided with interim drafts.

Technical Report Evaluation Criteria

- Appropriate for audience
    - Recognition of audience: engineering and writing instructors
    - Persuading instructors that educational requirements had been met
    - Persuading sponsor that viable solution had been accomplished
    - Appropriate use of technical terms, including definitions, for engineering and writing instructor audience
- Organization
    - Follows report organization format, with emphasis on problem and scope, definition, discussion of solution, justification of methods used, and verification of outcomes
    - Shows mastery of engineering concepts
    - Maintains clear, logical progression of points
- Format
    - Adheres to required formal report format (cover page, front matter, report body, appendixes)
    - Uses formatting (headings, font highlighting) to make key information visible and easy to read
    - Produces a report that has crisp, clean, professional appearance
- Appropriate use of graphics
    - Each graphic has purpose—not used as filler
    - Each graphic appropriately labeled, with key components inside graphic highlighted, if needed
    - Each graphic is appropriately sized and integrated into report format
    - Each graphic linked to point in text; graphics and points well integrated
- Use of standard conventions of English
    - Using grammar and spelling conventions for message clarity

- Avoiding errors that distract readers from report’s message.

A Tale of Two Teams

The outcomes resulting from this approach will be illustrated by comparing early semester and end-of-semester report and presentation drafts from two teams, Team Boosted and Team Out of the Woods. Team written abstracts of the projects are below (sponsor names and certain identifying details have been removed, due to a nondisclosure agreement with the project sponsor):

Team Boosted

The objective of this project was to design an automated machine to cut two different types of metal piping to different lengths (146.85 to 167.00 inches). This piping is a part of a fuel cell that [the sponsor] manufactures and upon completion is installed into a nuclear reactor and used to create nuclear energy. The two different species of metal piping are Inconel® and zirconium, the only materials that remain neutral in a nuclear environment. However, Inconel® and zirconium are difficult to cut using conventional cutting methods. Inconel® can only be cut with another extremely hard material, usually diamond-reinforced heads in cutting blades. If too much surface area of the cutting mechanism comes into contact with zirconium, the material can spontaneously combust. The zirconium must be cut at a slow speed or if a faster speed is used then coolant must be applied.

The project requirements are: Cycle time (operator loads the tube into the machine to the time the tube is extracted from the machine) must be less than 8 minutes. The footprint of the machine must be less than 4 ft x 18 ft. The objective is significant because the current cutting process is very time consuming and can complete only about 25 pipes in one work day, which in turn slows down the production of each fuel cell. If [the sponsor] cannot produce the fuel cells at the rate of the client’s request, the result may be loss of clientele. This design will cut pipes at a projected rate of 80-90 per day. The projected cutting speed can at least triple the current method and allow the rest of the plant to operate at a higher rate of speed. This can increase productivity, resulting in more clientele and more profit.

Team Out of the Woods

This experiment is to evaluate the long-term compression-set performance of several silicone elastomer compounds, so that [the sponsor] can compare and predict which o-ring compound performs to desired expectations. With this test, [the sponsor] will be able to determine which compound should be used in important aerospace applications. If [sponsor] uses an o-ring compound that cannot withstand high temperatures for long durations, then the o-ring might lose its integrity.

The parameter being evaluated is the compression set, a measurement that calculates the ratio of elastic to viscous material components and the elastomer’s response to a given deformation. The longer the o-ring molecular polymer chains, the better its set resistance, meaning the elastomer has an improved ability to store energy and return to its original shape. Ten different o-ring compounds from different manufactures were tested to determine which ring maintains its integrity through 70, 500, 1000, and 1500 hours at temperatures of 300°F, 400°F, 450°F, and 500°F, respectively.

Team Technical Reports

Since the early report drafts of the two teams were so similar, they will be discussed together, in Table 2.

This draft showed the issues typical for an early draft, as students were in the process of:

- Constructing their sense of audience (which some referred to as a “moving target”)
- Deciding which organizational structure worked for drafting vs. which one was appropriate for the final product
- Doing the admittedly tedious work of setting up headings, subheadings, headers, footers, table of contents, and other devices that add clarity and visual appeal
- Selecting graphics that served a purpose other than to “look good” and “make the paper longer” (one first draft, for example, featured several configurations of students posing by a piece of unidentified machinery: standing, sitting, with safety glasses, without safety glasses, etc.)
- Adhering to English conventions was not emphasized during the first draft as this activity is more appropriately taken up during later stages of revision.

Table 2: Report Criteria and Student Performance: First Rough Draft

Criterion	First Draft Report* (1 = poor, 10 = excellent)	Instructor Comments
Appropriate for audience	4	Addresses faculty audience but not attending to information critical to industry sponsor
Organization	3	Format follows layout provided but material is out of order and misplaced. Problem statement does not appear until near end of draft.
Format	0	No formatting other than paragraphs provided
Graphics	2	A few useful graphics included, but need to be labeled. Several graphics have questionable rhetorical purpose (why are they there?)
Standard English Conventions	3	Numerous errors; needs to standardize terminology and use technical terms consistently

*Copies of drafts can not be shown, due to nondisclosure agreements with sponsors.

The paper went through approximately three draft and revision cycles, with each team submitting a draft prior to a face-to-face meeting with the writing consultant, who provided written feedback for students to take away, as well as explanations and answers to student questions. Tables 3 and 4 show the report criteria and student performance for the final report draft.

Table 3: Report Criteria and Team Out of the Woods Performance: Final Draft

Criterion	Final Report (1=poor, 10=excellent)	Instructor Comments
Appropriate for audience	9	Cogent explanation of design/test problem, procedure, and results; some reporting of results had lengthy lists, but chronology clear
Organization	9	Follows report organization outline; all material in appropriate place and logical. Explanation of theory well integrated.
Format	8.5	Use of standard report features, front and back matter, clear heading levels, headers and footers; paragraphs double spaced rather than single spaced
Graphics	9	Graphics used to report experimental results; made all data results accessible at a glance; no extraneous photos or other graphics
Standard English Conventions	8	Occasional errors in grammar and usage; few proofing errors

For this team, the most obvious improvements were in the team's sense of primary audience (industry sponsor) and secondary audience (course instructors). In addition, the team used graphics purposefully rather than gratuitously and added significant visual appeal. Areas of improvement were to de-clutter some heading styles and to follow paragraph spacing conventions for reports.

Table 4: Report Criteria and Team Boosted Performance: Final Draft

Criterion	Final Report (1=poor, 10=excellent)	Instructor Comments
Appropriate for audience	9	Clear and thorough explication of the details of the design process with strong justification for the choice of final design over alternate designs. Kept focus on the sponsor's most prominent goal: to increase production speed while maintaining quality
Organization	9.5	Followed technical report format and adapted sections to meet unique requirements of sponsor
Format	8	Clear first-level headings with visual appeal; no real use of secondary headings or subsections, resulting in long text passages that were more difficult to read. Need to use single-spacing rather than double; avoid crowding on pages.
Graphics	9	Graphics on title page and one in text; remainder of design pictures in appendix—appropriate for this paper as design drawings too large to include in report body
Standard English Conventions	7.5	Some major errors in grammar (sentence errors); a few proofing errors

As with the other team, the most major improvements came in significant rhetorical areas—audience awareness, organization, and visual appeal (format and graphics) to make material clear and accessible to readers. Some of the grammar errors were discussed in conference but were not corrected by the team.

End-of-Semester Presentation

Evaluation criteria established for the end of semester presentations were based on the rhetorical concepts that had been emphasized in previous courses, throughout the current semester and also provided to students in a “dry run” practice session at the end of the semester:

- Appropriate for audience
    - Recognition of dual audience (industry sponsors as primary audience and instructors as secondary audience)
    - Balance between persuading industry sponsor that project requirements had been meet while persuading instructors that educational requirements had been met
    - Appropriate use of technical terms, including definitions, for dual audience
- Organization
    - Follows general report organization format, with emphasis on problem and scope definition, discussion of solution, justification of methods used, and verification of outcomes
    - Within general format, maintains clear, logical progression of points
- Appropriate use of graphics
    - Each graphic has purpose—not used as filler
    - Each graphic appropriately labeled, with key components inside graphic highlighted or labeled, as needed
    - Each graphic linked to point in text; graphics and points well integrated
- Use of standard conventions of English
    - Using grammar and spelling conventions for message clarity
    - Avoiding errors that distract listeners from team’s message
- Presentation/delivery standards
    - All team members participate as equally as possible
    - Professional demeanor, including avoiding inappropriate humor or digressions, not talking over other team members
    - Providing clear verbal transitions between sections of the presentation and smooth handoffs between team members
    - Avoiding distracting physical mannerisms (gestures) or verbal distractions (“um,” “you know”)

Again, because the early presentation drafts were so similar, they will be discussed together. Table 5 shows performance in the third week of class.
In some ways, early versions of presentations fared better than early drafts of reports, possibly because students had more practice and experience with presentations. In addition, students seemed to view the presentations as more practical and useful, since they were the locus of brainstorming and feedback about project questions, challenges, and frustrations. In these weekly sessions students truly began to see the “dynamic” aspect of the rhetorical product.

Table 5: Presentation Criteria and Team Performance, First Draft

Criterion	Presentation Draft (1=poor, 10=excellent)	Instructor Comments
Appropriate for audience	1	Presentation geared toward industry sponsor audience rather than instructor/student audience; terms undefined, essential detail not provided
Organization	2	Various components scattered throughout presentation; some attempt to organize material chronologically
Format	4	Uses template appropriately, though lack of consistency between slides
Graphics	2	Many graphics of the "vacation" variety, showing students at the industry site; some pictures of equipment or procedure, but not labeled or clearly identified; students showed minimal awareness that the instructors and other students had not been onsite with the team
Standard English Conventions	4	Inconsistent; significant number of errors (usage and proofing)
Delivery quality	6	Teams shared presentation duties reasonably and avoided most distracting gestures; students noted that the weekly presentations didn't seem "real" and they perceived the instructor/student audience as less demanding and delivery issues less important

As the semester progressed, the writing consultant increasingly emphasized the shift in purpose for the presentation. The weekly in-class presentation was a vehicle for feedback, troubleshooting, analysis and a friendly competition to see which team could provide information that passed muster from course instructors and other students.

The final presentation, however, was more typical in that it served to summarize and highlight the key aspects of the semester's work, and to do so in a way that satisfied both the requirements of the industry sponsor as well as the expectations of engineering and writing faculty. Tables 6 and 7 show the performance of the two teams, during the public presentation at the end of the semester.

Out of the Woods's presentation was deemed the second-best presentation by the panel of industry judges. They focused on the team's ability to explain and illustrate their testing process as well as their justification of results. Course instructors expressed interest in the team providing more information on the theoretical concepts that guided their decisions.

A significant improvement was in the use of graphics—all "process" photographs were purposeful and clearly labeled. The graphs allowed listeners to see, at a glance, which test results were most promising.

Table 6: Presentation Criteria and Team Out of the Woods Performance, Final Presentation

Criterion	Final Presentation (1=poor, 10=excellent)	Instructor and Industry Sponsor Comments
Appropriate for audience	9	Addressed all requirements for industry sponsor and most requirements for the instructor audience; terms well defined and process for testing clearly outlined, results well justified
Organization	9	Methodical coverage of problem, testing process, and results
Format	10	Format consistent and clear; good visual appeal and contrast of elements
Graphics	10	Excellent use of photographs to show test setup and apparatus as well as graphs to show testing results at a glance
Standard English Conventions	9	A few minor errors
Delivery quality	9	Clear and orderly, with good handoffs and participation by team members; team members occasionally talked over one another while going through the presentation and answering questions

Table 7: Presentation Criteria and Team Boosted Performance, Final Presentation

Criterion	Final Presentation (1=poor, 10=excellent)	Instructor and Industry Sponsor Comments
Appropriate for audience	10	Answered all sponsor concerns concerning quality and speed, provided justification for decision, showed alternate designs and key calculations in verifying design's appropriateness for task
Organization	10	Organization showed method and process clearly and cogently—more so than technical report
Format	9	Presentation design mostly consistent, not cluttered, professional
Graphics	10	All graphics had purpose, used to explain, illustrate, emphasize; all graphic elements clearly labeled
Standard English Conventions	9	A few errors, not too distracting
Delivery quality	10	Team functioned as a "seamless unit" with shared delivery, handoffs, expert answers to audience questions

Team Boosted presentation received the highest evaluations from the panel of industry judges who were impressed with the team's attention to concerns of industry sponsors and course instructors, the professional design and "look" of the presentation, its focus and the team's polished delivery.

Recommendations for Implementing

There is no doubt for us that student outcomes for the mentored classes are an improvement over the unmentored classes. Is this solely the result of the writing consultant? Likely not—attention to the processes of helping students connect current practice to past course experience helped both engineering and writing instructors be more deliberate. In the writing-mentored classes engineering and writing instructors, from the start, provided:

- Clear criteria
- Deliberate focus on knowledge transfer from previous course content
- A series of scaffolding techniques to assist students in knowledge transfer, including review and discussion of key concepts
- Attention to the process element of the project
- Multiple opportunities for keeping the documents alive—through repetition, feedback, and practice.

Benefits of Building a Multidisciplinary Team

Building a multidisciplinary team of instructors—with expertise in both engineering and writing—has a number of advantages but we found that the primary one was just that—allowing experts to be experts. Writing instructors, even those with a background working in engineering disciplines or firms, are not engineers. Engineers, even if they write for the academy or for industry, are seldom also rhetoricians. Developing a teaching team that includes both engineering and writing experts gives students access to a level of synergistic mentoring that greatly exceeds what instructors from just one discipline are able to provide.

In addition, engineering students are well aware of the difference between programs that pay lip service to collaboration and the importance of writing, and those that actually invest the time, money, and energy to ensuring that students receive "real-world" experience both in engineering design and the writing that accompanies it. Are students thrilled that the senior design course has a relentless and rigorous writing component? Not always (just as they are sometimes not thrilled with the open-ended complexity of their design projects), but the feedback they receive from sponsors during the design project, as well as from interviewers during the job search confirms the value of this multidisciplinary approach.

Suggestions for Getting Started

Our university has had significant success with paired writing and engineering courses that share learning objectives and outcomes, as well as course material and projects. But with the MET senior design project, it was not feasible to add on writing credits. Thus the writing consultant works the writing instruction and tasks into the current course schedule, often operating "in the cracks" and looking for instructional moments that arise in class. Obviously the writing instructor needs to be flexible and the engineering instructors also must be comfortable with this interplay. Writing consultants, of course, are not free. College prorates the usual semester adjunct rate to compensate the writing consultant.

We have built successfully on the ongoing relationship between the professional writing and the engineering programs. Both engineering and writing instructors have significant investment in and commitment to building communication skills of engineering and engineering technology students. Our initial steps included deciding which courses would most benefit from a writing-engineering partnership; bringing as many stakeholders into the process as possible, from both sides; developing a set of shared objectives and outcomes for selected classes; and using university resources (internal and external grants) for faculty professional development.

In the last three years, our team has developed and refined its approach to multidisciplinary teaching in the MET senior design course. While our students' reports and presentations are not perfect, they are a vast improvement over the unreadable reports and unprofessional presentations previously delivered. Our approach does not reinvent writing pedagogy but instead applies it creatively and persistently so that our students are prepared, as much as possible, for the "dynamic and active" writing of the workplace they are about to enter.

Bibliography

[1]Milanovic, I. M., and Eppes, T. A., 2009, 'Capstone Projects for ET: Issues, Benefits and Trade-offs' 2009 ASEE Annual Conference, Pittsburgh, Paper ASEE-2009-30.

[2]Bahktin, M. *Speech Genres and Other Late Essays*. 1986. Austin: University of Texas Press.

[3]Paradis, J., Dobrin, D., and Miller, R., 1986, "Writing at Exxon ITD." *Writing in Nonacademic Settings,* ed. L. Odell and D. Goswami. Guilford Press.

[4]Dias, P., Freedman, A., Medway, P., and Pare, A, 1999, 'Worlds Apart: Acting and Writing in Academic and Workplace Contexts,'Mahwah, NJ: Lawrence Erlbaum.

[5]Paretti, M.C., 2008, "Teaching Communication in Capstone Design: The Role of the Instructor in Situated Learning." *Journal of Engineering Education*, 97 (4), pp. 491-503.

[6]Milanovic, I. M., and Eppes, T. A., 2008, 'Modular, Adaptable, and Reusable Approach to Thermal-Fluids Outwitting the Norms (MARATHON),' 2008 ASEE Annual Conference, Pittsburgh, Paper ASEE-2008-440.

[7]Emanuel, J., and Kerns, H. D., 2007, 'Industry Based Capstone Design Projects: You Can't Sell the Solution If You Can't Communicate,' 2007 ASEE Annual Conference, Hawaii, Paper ASEE-2007-2246.

Appendix A: Tips for Completing the MET 482 Tracking Sheet

1. Be sure to enter all information—full names of team members, project title, etc.
2. Remember that
   - those of us evaluating your tracking sheet most likely didn't accompany you to the project site—provide enough detail for us to grasp what you did.
   - over 15 weeks, you'll forget a lot of details—provide enough information for your team to remember what happened, was said, changed, etc. If feasible, you might find it useful to fill out some of the sheet while on site, and while the information is fresh.
3. Don't be reluctant to discuss problems encountered of support needed—part of your job is to report accurately, even if it's not always good news.

Should you worry about grammar, spelling, and perfect sentence structure? Yes and no. Please don't spend hours checking every comma. Please do make every effort to be clear enough so that readers don't have to fight through your writing.

(Sample tracking sheet is attached to the tips, to provide students with an example).