Designing the Report Process

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ABSTRACT

Written communication constitutes a key component in the education and future success of an engineering technologist. Developing skill in technical report writing requires practice coupled with timely, thorough feedback. At Purdue University's West Lafayette campus, the sophomore level course in strength of materials provides the core venue for this practice and feedback for mechanical engineering technology (MET) students. Such report writing demands a significant time investment from each student. The instructor makes a similar time commitment to adequately provide timely thorough feedback for each laboratory report during the semester.

The author has undertaken an experiment to determine if concurrent engineering practices can be successfully adapted to design an optimal writing/grading process which remains consistent with accreditation requirements regarding written communications. The resulting writing/grading process is explained and its successes and failures documented below. The experiment is discussed in the context of the continuous improvement process in place for the author's department, an additional accreditation requirement for engineering technology programs.

BACKGROUND

1997-98 accreditation criteria published by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) require instruction in written communications and practice in subsequent technical courses, as well as evidence that said writing is reviewed and evaluated as part of student technical work.[1] Technical writing is valued for its role in developing logical thought, as a communication tool, and as a necessity in industry. Numerous approaches to instruction and practice in technical writing have been documented, from the traditional laboratory and project report to more innovative use of personal journals and other forms of writing across the curriculum.[2-6] The Purdue MET Department follows a relatively traditional model for writing instruction. Students must complete a freshman level composition course; multiple writing assignments are given in a majority of the required and nearly all elective MET courses; and two additional technical writing courses are required for upper division students.

Among courses taught by MET faculty, the students' most extensive writing practice and evaluation come in the sophomore level strength of materials course. The laboratory portion of the course currently consists of ten sessions; with formal reports required for four experiments and memorandum reports required for four additional experiments. In-class activities are graded for the two remaining sessions. The required formats for the formal and memorandum reports are listed in Table 1, as well as the point allotment for each graded report section. The core sections are identical for both report types. The resume' section provides a brief summary of the report contents; the results section shows all data analyses (without detailing supporting calculations); the conclusions section discusses how the results conform to the purposes of the experiment; the sources of experimental error section demonstrates student consideration of the inherent problems which may be present in each experiment; and the original data sheet(s) must be included for all reports. The remaining sections (recommendations, equipment list, test procedure, sample calculations) are required only for formal reports, and are self-explanatory. The instructor evaluates each report for content, format, grammar, and spelling. For the formal laboratory reports, this constitutes an average time allotment of 22 minutes per initial report, and grading of subsequent reports eventually averages about 12 minutes each. For the memorandum reports, eight to ten minutes of grading time each is typical.

TABLE 1: Report Formats

Formal Report	Memorandum Report
Resume' (10 points)	Resume' (20 points)
Results (25 points)	Results (25 points)
Conclusions (10 points)	Conclusions (20 points)
Sources of Experiment Error (5 points)	Sources of Experimental Error (10 points)
Recommendations (2 points)	Data Sheet(s) (5 points)
References (3 points)	Format, grammar, spelling (20 points)
Equipment List/Specimen ID (3 points)	
Test Procedure (5 points)	
Sample Calculations (15 points)	
Data Sheet(s) (2 points)	
Format, grammar, spelling (20 points)	

As a relatively recent addition to TAC of ABET program criteria, each accredited engineering technology program must have plans for implementing continuous improvement and assessing if improvement results from any changes made. The Purdue MET Department has adopted a relatively simple method for conducting and tracking continuous improvement projects, based on the form shown as Figure 1. One or more faculty members develop a project to address a perceived need. The current situation is described (to establish a "baseline"). Action(s) required to improve the situation are determined, including what measures will be tracked to assess improvement. The actions are then implemented, tracked, and reviewed to determine whether or not improvement occurred. The project can then be continued, modified, or scrapped, as appropriate.[7,8] The remainder of this paper will generally conform to the content indicated by the main headings of the project summary form to provide an example of the continuous improvement process.

PROBLEM DESCRIPTION

Prior to enrolling in the strength of materials course, students generally complete their freshman composition course and at least one MET laboratory course with a significant number of short written reports. Unfortunately, these writing experiences fail to prepare the students for the writing time requirement, report length, and grading rigor present in the strength of materials laboratory. They often react with dismay and discouragement upon the return of their initial graded reports. After a nominal four hours of effort, most students expect to earn report grades in the A to B range, which rarely happens for the initial sets of

Figure 1: *Activity Summary: Course content and delivery*

Name: *Please type your name* Report Date: *Please enter the date*

❑ ***Check here if information is confidential and not to be released within the MET department.***
❑ ***Check here if information should be shared with MET faculty.***

Provide a **"project title"** by briefly describing the activity you are undertaking.
Provide a brief "project title."

Approximate time frame for activity: *Enter the approximate time frame for this activity (spring 97, 97-98 school year, January 98, etc.)*

Activity: *(Describe the need for improvement, what information/data will be tracked or collected for measurement, who will be involved, responsibilities.)*

Use this area to describe the activity involving course content or delivery. Please describe the need for improvement, what information/data will be tracked or collected for measurement, people involved, responsibilities, etc.

Results: *(Describe the outcome of your activity in words or with numeric data as appropriate.)*

If results are already available, please describe the outcome of your activity in words or with numeric data as appropriate.

Follow-up Actions: *(List actions taken or recommended based on results.)*

List any required follow-up actions (actions to be taken or recommended based on activity results) here.

formal reports. The combination of learning a new report format, lack of experience in development of logical arguments to support a conclusion, and often weak basic writing skills instead result in many initial C and D report grades. The disappointing grades produce a variety of undesirable student responses. Among the Spring 1997 semester students, these responses were dominated by frustration and anger with the instructor.

From the instructor's viewpoint, the time commitment to devote 15 to 25 minutes each to grading 70 formal laboratory reports on a biweekly basis or ten minutes each to grading 70 memorandum reports on a weekly basis is extremely high. When this commitment was met with very negative student response, plus little effort to improve their subsequent report quality, the need to change the writing/grading process was very clear.

DEVELOPING A SOLUTION

The author decided to adopt some of the philosophies of concurrent engineering to design of a new writing/grading process. Ullman defines concurrent engineering as the practice whereby "integrated teams of people having a stake in the product work together to simultaneously design the product and the processes used to develop and manufacture it."[9] The underlying philosophy is that quality products result from quality processes. A carefully selected team identifies and continually refines the constraints on the product and processes, based on communication with customers, suppliers, and among team members. Appropriate resources must be made available to the team so that they can simultaneously work to develop all necessary processes. The timely development and distribution of information is a key component in the success or failure of the concurrent engineering team. Relevant concepts for this experiment are listed in Table 2.

Table 2: Applicable Concurrent Engineering Concepts[9]

1. "Fail early, fail often."
2. Quality must be designed into every aspect of the process.
3. Use and support the design team.
4. Get the right information to the right people at the right time.
5. Plan information-centered tasks.
6. Focus on the entire product life.

PROCESS CONSTRAINTS

The existing requirements for writing four formal and four memorandum reports formed the base constraints for the new writing process. For purposes of the experiment, the existing point distributions among report sections were maintained. Consistent with TAC of ABET criteria regarding computer use, word-processing and spreadsheet graphing and calculations would continue to be required. New process constraints included limiting instructor grading time to ten minutes per formal report and five minutes per memorandum report while providing thorough timely feedback to the students. Students were to have the opportunity to make and correct report mistakes without harm to their report grades.

THE PROCESS

The new process required all students to submit report drafts for within a limited time period following completion of the experiment (usually one week) until the instructor was satisfied they understood the format and content requirements for the reports. Failure to submit a draft report before meeting the "satisfaction" requirement resulted in a ten-point reduction from their report score. The instructor then reviewed the draft reports, checking for general errors and omissions only, and returned the draft reports within a day. If desired, the student could come in to discuss the markup or resubmit for a second review to obtain additional feedback before submitting the final report for thorough evaluation and grading.

This process is intended to facilitate the concurrent engineering practices of “fail often, fail early” and “get the right information to the right people at the right time.” By requiring at least one un-scored report draft prior to submission of the graded report, the students can make and, hopefully, learn from their technical writing mistakes. By providing one-day turnaround on the feedback, the students have written comments on their initial work and sufficient time to obtain additional help, if appropriate. The instructor and each student were considered a “design team,” working together to develop quality reports and report-writing skills. The “product life” of the report was viewed as beginning with acquiring reliable experimental data in the laboratory, continuing through the development of calculated and graphical results and the report draft, and concluding when the final graded report is returned to the student. Quality is designed into the process in the sense that high writing quality and instructive evaluation remain core components of the technical writing practice obtained in the strength of materials laboratory course. The students’ writing process is improved because they must begin writing their reports well before the due date. This also serves to improve their subsequent reports, as they are more likely to have had sufficient sleep before conducting the next experiment. A plan to complete information-centered tasks is inherent to the process, and the instructor provides verbal and written instructions to help streamline that portion of the report preparation.

EXPERIMENT PARAMETERS

To determine if the new writing/grading process is an improvement, several factors need to be considered. Instructor grading time, student attitudes, and laboratory report evaluations were deemed most relevant to the determination. Other possible measures could include how quickly students demonstrated that they no longer needed to submit report drafts and overall report averages for the semester.

RESULTS

Although it is a very subjective measure, the student attitudes toward the instructor’s emphasis on writing improved considerably. The initial draft submission resulted in significant instructor/student contact during the first two weeks of the Fall 1997 semester, and generated very beneficial “team” attitude toward the writing process. No students indicated that they believed that they were unfairly graded. Students continued to complain about the rigor of the grading, but in a good-natured, rather than confrontational, manner. They maintained that the reports occupy too much of their time, especially the computer portions. It is the author’s opinion that the extensive time these MET students invested in their computer work results from a combination of inefficient work practices and a strong desire to use computer presentation features that go well beyond the scope of the report requirements.

The instructor time devoted to grading formal and memorandum reports did meet the respective ten-minute-each/five-minute-each time constraint set forth. This improvement was mitigated somewhat by the three or four minutes spent reviewing each draft report early in the semester, but constitutes a major improvement in use of instructor time. For formal reports, the reduction in time from 22 minutes per student report to approximately 14 minutes each represents an instructor time savings of over one-third.

Average formal laboratory report grades were higher than those obtained for the Spring 1997 semester (and historically) by approximately three percent overall. The average score for the first set of formal laboratory reports was 65.8% in Spring 1997 and 75.2% in Fall 1997, showing an increase of 9.4% with the revised writing/grading process. By the fourth formal laboratory report, the average scores were 75.9% and 75.8% respectively. The average report grades for the later memorandum reports were also essentially the same for both semesters. This is to be expected, since both groups were fully familiar with the report requirements and instructor expectations by the latter part of the semester.

PROCESS REFINEMENTS NEEDED

For future offerings of the strength of materials laboratory, the report draft requirement should be limited to the first two or three reports. (The author has always encouraged optional report reviews). Motivated students understand the report format within one or two iterations; disinterested students who participate only to avoid a grade reduction benefit very little from the review process. Additional instruction on streamlining the students' report writing process for efficient use of time should be provided, with particular emphasis on determining when computer applications will enhance the quality of the report content versus simply producing a more attractive appearance.

CONCLUSION

The redesign of the strength of materials laboratory report writing/grading process based on concurrent engineering concepts in Fall 1997 was sufficiently successful to warrant continued use of the process. Consistent with departmental continuous improvement practices, evaluation was conducted and minor modifications proposed to improve the process for subsequent course offerings. TAC of ABET criteria regarding written communications and implementation of continuous improvement plans were met through this process.

REFERENCES

1. Technology Accreditation Commission, Accreditation Board for Engineering Technology, "Criteria for Accrediting Engineering Technology Programs," ABET, January 1997.
2. Baren, R., "Teaching Writing in Required Undergraduate Engineering Courses: A Materials Course Example," Journal of Engineering Education, Volume 82, Number 1, January 1993.
3. Hawkins, S, Coney, M.B., and Bystrom, K-E., "Incidental Writing in the Engineering Classroom," Journal of Engineering Education, Volume 85, Number 1, January 1996.
4. Manuel-Dupont, S., "Writing-Across-the-Curriculum in an Engineering Program," Journal of Engineering Education, Volume 85, Number 1, January 1996.
5. Mishra, A., "Journal Writing and Student Learning," 1994 Annual Conference Proceedings, American Society for Engineering Education, June 26-29, 1994, pp. 2162-2165.
6. Ludlow, D., and Schulz. K., "Writing Across the Chemical Engineering Curriculum at the University of North Dakota," Journal of Engineering Education, Volume 83, Number 2, April 1994.
7. Corum, C.L., and Pagano, M.A., "Continuous Improvement in an MET Program," 1997 Annual Conference Proceedings, American Society for Engineering Education, CD-ROM, 1997.
8. Purdue University MET Department Continuous Improvement Committee, draft CI Activity process flowchart, January 1998.
9. Ullman, D.G., The Mechanical Design Process, Second Edition, The McGraw-Hill Companies, Inc., New York, 1992.

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