When Less is More: Integrating Technical Writing Instruction in a Large, First-Year Engineering Course

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Abstract

Providing technical writing instruction within a large, first-year engineering course involves both logistical and imaginative challenges but can also yield substantive results. In the fall of 2003, the University of Maine initiated a new plan, called the Engineering Communication Project (ECP), to integrate technical writing instruction throughout the College of Engineering curricula. Civil Engineering Materials Laboratory (CIE 111) was the first course to incorporate the new plan. CIE 111 is a 1-credit laboratory component of a basic course in civil engineering materials, incorporating topics in material variability, plastics, metals, wood and concrete. Historically, students produced five full academic lab reports during the semester, with less than satisfactory results for the most part. Recent enrollment growth (to around 100 students) introduced further complication. The new ECP approach replaced the academic lab reports with five case-based memo assignments, which allowed for more specific instructional goals, more meaningful feedback to students and a reduced paper-reading load for engineering faculty. Specific goals for the memo assignments included learning memo format, and developing COPE writing skills (Clarity, Organization, Precision and Economy). The ECP is a cooperative effort between the Department of English and the College of Engineering and is supported by a grant from the Davis Educational Foundation. In summary, each engineering department will use alumni and faculty surveys to develop core competencies in technical communication. Departments will then integrate those competencies in appropriate courses throughout the curricula, with guidance from English department faculty. William Manion and David Adams describe the design and implementation of this assignment regimen and use examples for illustration. Manion and Adams also discuss some of the issues encountered and present initial assessments of the effort.

Introduction

The University of Maine has begun a multi-year effort to redesign the way it teaches technical communication to students in the College of Engineering. This effort is called the Engineering Communication Project (ECP). At its core, this new design will mean replacing the existing requirement of a stand alone course in technical communication (3 credits) with a sequence of three communication-intensive engineering courses. This sequence will be followed by a year-long capstone design course in which technical communication plays a substantial role. The capstone course will also provide the opportunity for a final assessment of the endeavor through project reports and presentations. The ECP is a cooperative effort between the Department of English and the College of Engineering and is supported by a grant from the Davis Educational Foundation.

The existing modes of instruction had proved problematic in several ways. The English Department found continued difficulty in staffing adequately the required number of sections of its technical communication course (ENG 317), which serves both as a core course in a writing concentration and as a service course for departments across the university. Both engineering faculty and employers of the university's engineering graduates shared the opinion that students do not "transfer" to engineering contexts the skills they might learn in ENG 317, and that perhaps some of those skills are not sufficiently appropriate for such contexts. Table 1 reveals these survey results for the Civil & Environmental Engineering department.

Table 1. Rating Technical Communication Skill Levels of CIE graduates, 2003.

Communication Type	Faculty (N = 7/12) & Alumni/Employers (N = 6/8)	Inadequate	Adequate	More than Adequate
Written	Faculty	34%	55%	12%
	Alumni/Employers	44%	32%	24%
Oral	Faculty	30%	56%	14%
	Alumni/Employers	30%	63%	7%
Visual (ability to design information, including complex displays of data)	Faculty	34%	51%	14%
	Alumni/Employers	35%	46%	19%

These problems are not unique to the University of Maine, and the communication-intensive model by itself is certainly not a radical innovation in 2004. And yet, the overall plan may prove interesting to others involved in such endeavors because of its structure and approach. Several guiding principles marked the development of this plan:

- Department-based core competencies derived from faculty and alumni/employer surveys;
- Technical communications instruction embedded, reinforced, extended and assessed at each level of the curriculum;
- Deep levels of integration with engineering content;
- Multiple layers of support for engineering students;
- Extensive planning and design that recognizes constraints and content pressures, while fitting within each department's approach to implementing ABET standards.

Since the university has a sequenced curriculum in engineering, it will be possible to phase in the plan for each entering class of engineering majors, creating, in effect, cohorts of participants. English department faculty will use a consulting model in their collaboration with engineering counterparts, with intensive involvement early on that gradually gives way to engineering faculty managing the writing component of the course.

When fully implemented, the ECP plan will provide such instruction in either a three-course or four-course sequence, depending upon the core competencies and course sequences deemed appropriate. In most departments, the capstone design projects will also serve as basis for assessing the cumulative skills in technical communication. Table 1 indicates the development of the plan as of December, 2004. The ECP has completed its third semester and has begun work with six engineering departments. The ECP has already provided this integrated writing instruction to 448 engineering undergraduates. When fully implemented, the project will work with 20 engineering courses and providing instruction to approximately 800 students.

Table 2. ECP Current and Projected Enrollments.

Engineering Department	Number of Majors	Number of students reached in ECP courses by 3rd semester
Electrical and Computer Engineering (ECE)	173	83
Civil & Environmental Engineering (CIE)	180	211
Mechanical Engineering Technology (MET)	132	32
Electrical Engineering Technology (EET)	--	14
Civil Engineering Technology (CET)	100	46
Mechanical Engineering (MEE)	210	62
Totals	795	448

Civil Engineering Materials Laboratory (CIE 111) marked the first partnership course in the plan, being offered in the fall of 2003 and 2004. This paper will outline the approach used in this course, discuss course issues, initial assessment and future direction, and explain how the course fits within the design of the larger plan. Table 3 provides a quick view of how ECP involvement has changed the writing component of CIE 111

Table 3. A Snapshot of the ECP at Work: Changes in CIE 111.

Prior to ECP	*Within ECP*
• Writing Assignments—Full-length (12-15 page) lab reports ill-suited either to the actual lab procedure or to the developmental level of 1st year students. • No time for students to write, or for instructors to read in a meaningful way, such lengthy reports from over 100 students. • High levels of frustration for students and faculty.	• Brief, case-based memo assignments that require students to report information in realistic contexts. • Greater focus on students' phrasing and organization of engineering content and more consistent feedback. • Annotated model assignments for students. • Small-group revision workshops based on students drafts. • Positive evaluations and feedback.

Course Background

Civil Engineering Materials Laboratory (CIE 111) is a first-year student course taught in the fall semester. CIE 111 is the hands-on complement of the Civil Engineering Materials lecture. The two courses are required for first-year students in Civil and Environmental Engineering as well as a smaller number of sophomores in Construction Management Technology. Enrollments have grown from about 60 in 1998 to around 100 in 2003 and 2004, nearly doubling the number of small lab sections from six to ten on a weekly basis. Each student attends one two-hour session with two lab groups of between four and six students. The specific topics taught are:

- *Material variability:* Thirty rough-cut wood samples are tested to failure in compression. The resulting failure stresses are analyzed statistically using spreadsheets.
- *Compressive strength of plastics at different temperatures*: Cylindrical HDPE samples are tested in compression at temperatures below zero, room temperature and about 100 degrees F. Load and deformation readings are recorded to calculate and plot stress – strain diagrams for observation of the strength change with temperature.
- *Tensile strength of steel and aluminum specimens*: One standard specimen of A36 steel and 1018 aluminum are tested to failure with computerized data acquisition equipment. The resulting data is used to calculate and plot stress-strain diagrams for identification of typical values such as yield and ultimate strength.
- *Concrete aggregate analysis, mix design, creation and strength testing (four weeks of lab):* the first week, aggregate is tested for moisture absorption and specific gravity used to design a concrete mix during the second week. The third week, a two cubic foot mix is batched and tested for slump, air content and unit weight. Standard test cylinders are also cast for compressive strength testing in the final week.
- *Compressive strength of wood*: Four specimens of eastern white pine are tested to failure in compression parallel to and perpendicular to grain. One of each is air dried and the other at approximately 25% moisture content to illustrate the effect of moisture on wood strength.

In addition to learning the engineering content, the course combination serves as an early introduction to the style of professional communication, including analysis, design and writing.

Old Writing Assignments

Historically, complete academic style laboratory reports had been required for each of the five topics. They contained a cover page, executive summary, purpose, procedure, results and discussion. Over the years, a number of different techniques were utilized to teach report writing, including highly detailed assignment presentations, outlines, examples, in-class outlining workshops, and even post-grading individual student meetings. Similarly, some combination of grading checklists or rubrics were invented and reinvented.

However, the students' overall writing quality was not improving. Of course, good students did well and poor students did not, but the majority did not produce reports showing clear, organized critical thought. Results of student evaluations were excellent, but low where reports or workload were concerned. Indications were that a more fundamental change was needed.

New Writing Assignments

In the fall of 2003, Adams suggested a new system of workplace writing, based on realistic scenarios. The approach was to follow the model of a materials testing firm. Memorandum requests were written from a project manager to the students, requesting material test results, comparisons and error analyses. In response, students wrote one-page memos, with attached data analysis, back to the project manager. The idea was that the project manager could easily rework the lab memo into a letter to the client. The materials topics of the course did not change, just the assignments and writing goals. In the fall of 2004, the process was further refined. For example, the following is the body of an assignment memo to the students.

> Bob the Builder had an unfortunate construction accident. A section of staging collapsed under the weight of a load of bricks, and several employees were injured. Our job is to test steel and aluminum samples from the broken staging to verify their strengths compared to the published standards.
>
> Perform the testing as detailed on the web site, plot the data, report the results and provide supporting representative calculations.
>
> Compare the yield and ultimate tensile strengths you found to the specified strengths in the table below. Use percent difference calculations to support your comparison.
>
> 1. Create six plots, three for each specimen:
>
> - Plot load-deformation for the entire data range.
> - Plot stress-strain for the entire data range, up to when the extensometer reading made a large sudden drop, or even changed to negative.
> - Re-plot a magnified stress-strain up to a point a just beyond yield to accurately determine the modulus of elasticity and yield strength.
>
> 2. From the plots, determine the following values and present them in a table. Show your detailed work on the plots. Compute the errors just like we did in the error analysis workshop, with load error of 10 lb and diameter error of 0.00005 in (careful – that's four zeroes and a 5, equal to half a ten-thousandth).
>
> - ultimate strength (+/-xx) psi from the load-deformation plots
> - yield strength (use the 0.2% offset method for the aluminum) (+/-xx) psi from the magnified stress-strain plots
> - modulus of elasticity (+/-xx) psi from the magnified stress-strain plots
>
> 3. From the punch mark measurements, determine the ductility for each specimen as measured by percent reduction in area and permanent percent elongation. Present in a table.
>
> Attach a page showing representative calculations for review as well. Include the formula, representative numbers and a solution for each. (area, stress, strain, E, and ductility) If in doubt, include all your calculations.

Figure 1. Body text from a memo assignment.

By reducing the writing quantity tenfold from academic lab reports to memos, writing quality was expected to increase significantly. Emphasis was placed on clarity, organization, precision and economy (COPE). Clarity means to write in unambiguous, easily understood style. Organization refers to the structure of the document, attachments and content. Precision refers to the ability to present appropriate and reasonable numbers, rationale and conclusions, and to use descriptive language and modifiers with great care. Economy means to work and write efficiently, without unnecessary language. These COPE emphases, as well as the use of memos, also reflect the concerns and priorities mentioned in the surveys (see Attachment 2).

Fall semester 2004 began with two recent alumnae visiting the lecture class to talk about the importance of communication in the workplace. Each spoke briefly about their first few professional years and offered examples of how communication had affected their jobs, setting the stage for an introduction to the ECP and the writing component of the lab course. During the first week of lab, wood variability testing was performed, and the first memo from the project manager was distributed. Following a short discussion of the assignment objectives, framed by the three fundamental questions below, students were assigned to respond to the manager's memo by email and on paper by 9pm the following day.

1. What is the answer to the most important question?
2. What supporting data and statements will follow the answer to the question?
3. What topics should be avoided in the memo?

A model memo package, with assignment and two annotated versions of the response (see Attachment 3), was also distributed. The following week during the workshop, the authors returned the graded paper memos and discussed specific examples from the emailed memo drafts. Students were then allowed to revise and resubmit their work, although many did not.

A new grading scheme was also developed to assess the memo assignments. Markers of success and weakness were distributed on the back of the assignment memos themselves. Below are the markers of success and weakness for the steel and aluminum tensile strength assignment in the example above. A copy was used to grade each memo, marked up to indicate both successful and weak points in the student's work. It appears to be a yes or no style solution, but in practice it was used to indicate partiality as well. Sometimes the instructor would write "maybe," "ok," or "partially" next to specific markers. Comments were written below markers as well for clarification. Based on the specifics of the memo and previous student responses, markers were customized along with each assignment memo as well.

	markers of SUCCESS	markers of weakness
Goal of the memo	o Provides reliable information to address the client's concerns. o Calculated results are reasonably correct.	o Does not provide reliable information to address the client's concerns. o Calculated results are incorrect.
Clarity	o Includes clear answers with logical supporting statements. o Uses consistent wording for the same parameters.	o Offers confusing answers or lack of adequate supporting statements. o Uses different words for the same parameters.
Organization	o Most important answer is stated first, followed by supporting statements. o All requested answers, data, plots, and calculations are provided.	o Most important answer is buried in text, with mixed supporting statements. o Some answers, data, plots, or calculations are missing.
Precision	o Answers are within scope of the question. o Pencil construction lines on plots indicate where numbers were determined and what the numbers are. o Appropriate units are indicated o Representative hand calculations include the equation, example numbers plugged in and the resulting answer. o Data is noted using appropriate significant figures.	o Answers go beyond the scope of the question and may incur liability. o Construction lines and/or numbers are missing from plots. o Units are missing or inconsistent o Calculations partially completed. o Data is given using too many or inconsistent significant figures.
Economy	o The memo consists of short, direct sentences that couldn't be shortened. o Data and statements are only made once on the memo page. o The memo does not include original spreadsheet data.	o The memo contains some longer, more ambiguous sentences with extra phrases. o Data and/or information is repeated on the same memo page. o Original spreadsheet data are included.

Figure 2. Markers of success and weakness assessment for memo assignment.

Benefits of the New Writing Assignments

Overall, the new writing assignment strategy reduced the quantity to a manageable amount and raised the quality of graded material for the instructor and the students. The instructor was able to provide constructive criticism for each individual paper, and the students were better able to concentrate on a shorter, more structured assignment. Students began to employ COPE principles in constructing their assignments rather than following the odd academic habit of writing everything they know on a particular topic (instead of what the readers need).

Instead of attempting to master a wide range of writing skills at once, students focused on practicing document organization and on writing clear, precise, well-constructed sentences. Subsequent courses in the ECP sequence will reinforce these skills and extend them through more advanced assignments such as proposals, lab reports, design papers, and so forth.

In addition, students enjoyed the realistic assignments far more than the academic style used in the past, setting a positive tone for professional writing. This writing style is likely to be a useful skill for summer employment as well.

From an institutional perspective, assignment scenarios are also relatively easy to change independent of the engineering course content, reducing the effects of students sharing graded assignments from year to year.

Lessons Learned and Future Plans

In fall 2003, since the ECP had just started, the new assignment approach did not begin until a couple of weeks before the semester began. As could be expected, the first assignment was a little rough, but each subsequent one improved, as students and faculty gained experience with the new assignment regime. In fall 2004, each assignment and assessment was further refined to balance much better with student performance. A summary of student evaluations of the first two years is attached to this paper.

In fall 2003, problems included students' lack of experience with the memo format, as well as a similar lack of experience in communicating experimental results to a specific audience with a specific need. For fall 2004, a model memo was prepared to illustrate format, organization and typical content, substantially minimizing these issues. Accordingly, the assignments and assessments were revised to work around other topics and improvements to student writing. It is a continual improvement process, really. In addition, an online writing handbook is being drafted to provide broader support for a variety of writing topics.

Another issue requiring further emphasis is the concept of calculations as part of a document. Beginning engineering students are often disorganized and sloppy in their approach to written calculations. In fall 2004, increased structured guidance and consistent emphasis were provided both in the lecture side of the course and as part of each lab assignment with some success. Calculation format and presentation will continue to be emphasized in the future.

The memo assignments and assessments will be revised again as a regular part of the process. New assignments and markers of success and weakness will require students to communicate engineering content ever more thoughtfully in practical settings.

References

Manion, William P. (wmanion@maine.edu). "University of Maine Civil Engineering Materials Course Manual CIE 111." 2004. http://www.umeciv.maine.edu/cie111/.

Author Biographies

WILLIAM P. MANION is an Instructor in Civil and Environmental Engineering at the University of Maine in Orono. Mr. Manion teaches lab courses in materials, soil mechanics and computer applications. Although his research has been limited to occasional projects with the Maine DOT, he is interested in undergraduate curriculum development and experiments with new course strategies on a regular basis.

DAVID ADAMS is an Assistant Professor of English and Director of the Engineering Communication Project in the University of Maine English Department. He has previously worked in such programs at Michigan State University and Cornell University. Professor Adams has worked as a technical writer and is a senior member of the Society for Technical Communication (STC).

Attachment 1: Student Evaluation Items with Scales and Results 2003, 2004

1. My technical writing skills improved as a result of taking this course.

No Significant Improvement		Marginal Improvement		Significant Improvement
1	2	3	4	5

2. I now feel confident in my ability to write a technical memo.

No Confidence		Marginal Confidence		Significant Confidence
1	2	3	4	5

3. I now use language with greater care and precision in my technical writing.

No Significant Change		Marginal Change		Significant Change
1	2	3	4	5

4. The revision workshops were helpful in improving my technical writing.

No Significant Help		Marginal Help		Significant Help
1	2	3	4	5

5. To what degree would a model memo report have helped you complete your assignments.

No Significant Help		Marginal Help		Significant Help
1	2	3	4	5

6. To what degree were the comments you received on your memos helpful in improving the next assignment.

No Significant Help		Marginal Help		Significant Help
1	2	3	4	5

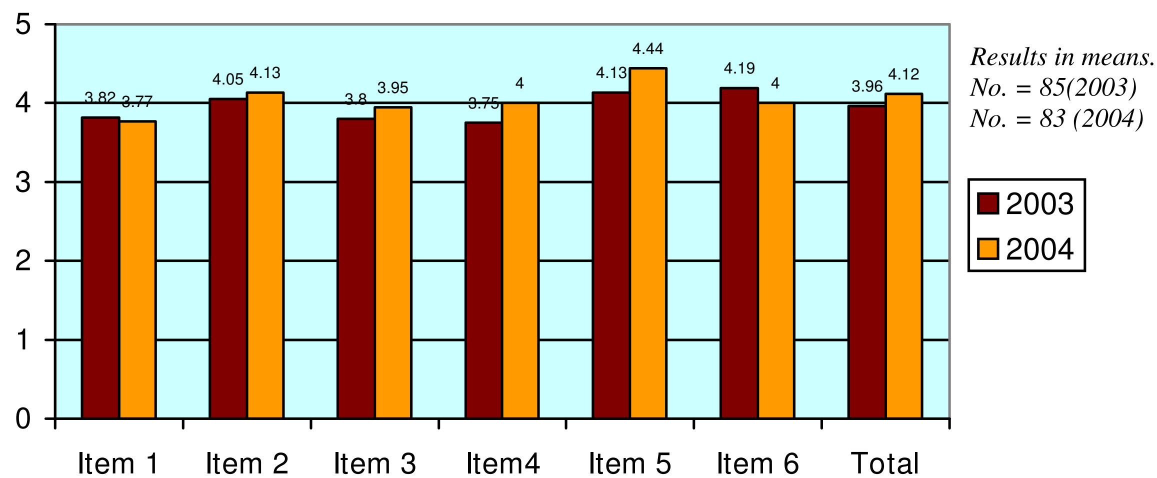


Figure A-1. Evaluation Results for ECP—CIE 111, Fall '03-Fall '04.

Attachment 2: CIE Faculty & Alumni/Employer Survey Results

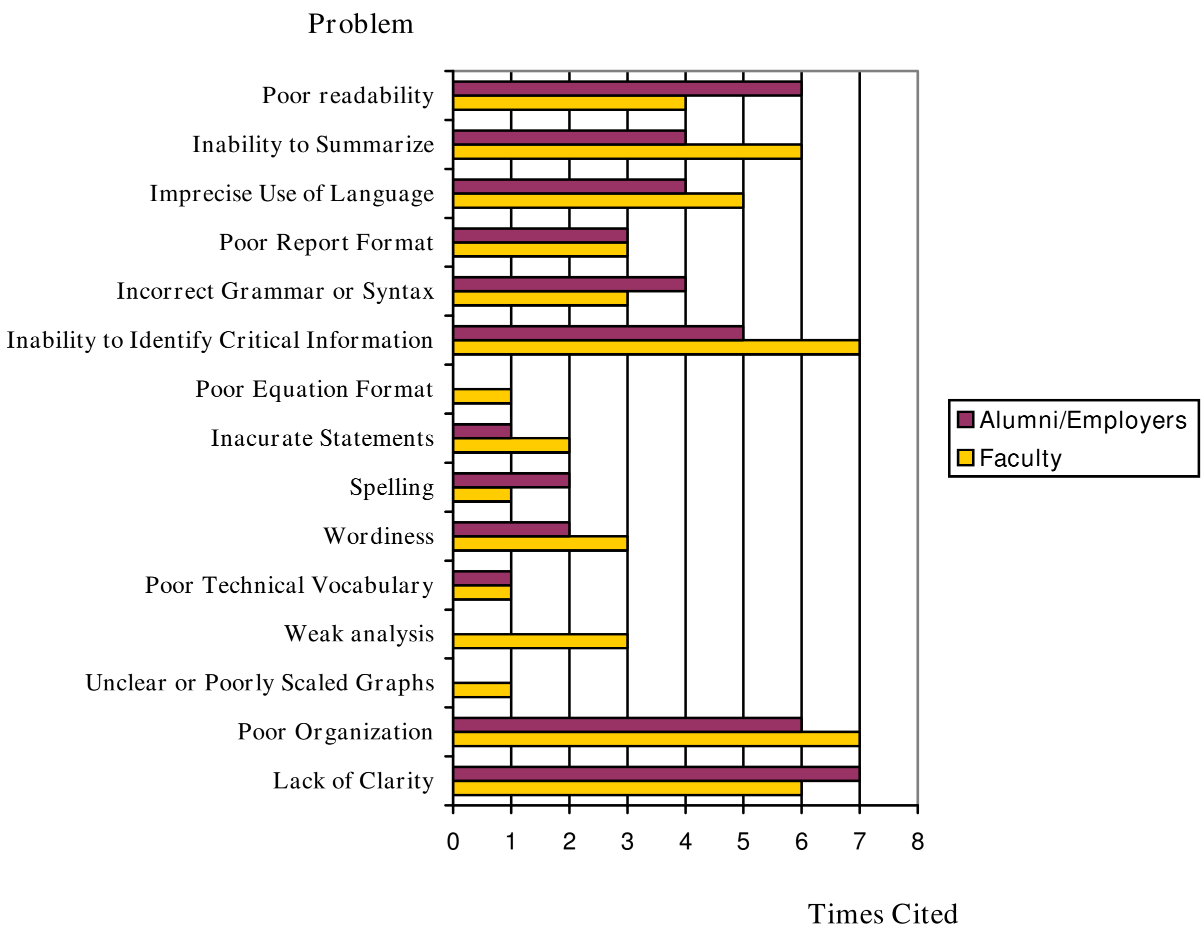


Figure A-2. Characteristic Problems Cited in Student Reports.[1]

[1] A single bar means that only one group cited this problem.

Table A-1. Which Technical Communications Should We Teach and When?

Best Taught in[2] 100/200	300/400	Rating	Faculty (N= 7/12)	Employer/Alumni (N = 8/8)	Rating
	7	1.0	--Proposals	--Letters/Memos	1.0[3]
3	3		--Analysis/Decision Papers		
	7		--Design Documents		
7	1		--Charts & Tables		
5	2	1.1	--Presentation Slides	--Proposals	1.1
		1.2			1.2
7	1	1.3	--Lab Reports		1.3
2	6		--Specifications		
1	6	1.4	--Cost Benefit Analyses	--Meeting Minutes	1.4
		1.5		--Design Documents	1.5
7	0	1.6	--Letters/Memos	--Specifications	1.6
5	3		--Abstracts	--Regulatory Compliance Reports	
6	1		--Procedures	--Charts & Tables	
3	5		--Progress Reports		
7	0	1.7	--E-mail		1.7
0	7		--Environmental Impact Statements		
2	5		--Literature Reviews		
		1.8		--Analysis/Decision Papers	1.8
				--Progress Reports	
3	5	1.9	--Poster Session Displays	--Cost Benefit Analyses	1.9
				-- Environmental Impact Statements	
				--Remediation Plans	
				--Presentation Slides	
				--Poster Session Displays	
		2.0		-- Journal Articles	2.0
0	7	2.1	--Remediation Plans	--E-mail	2.1
		2.2		--Procedures	2.2
		2.3		--Lab Reports	2.3
0	6	2.4	--Regulatory Compliance Reports	--Abstracts	2.4
				--Trip Reports[4]	
2	4		--Meeting Minutes		
0	5		--Journal Articles		
3	3		--Trip Reports		
0	6		--Business Plans		
		2.5			2.5
2	5	2.6	--Material Safety Data Sheets (MSDS)		2.6
		2.7			2.7
		2.8		--Literature Reviews	2.8
				-- Material Safety Data Sheets (MSDS)	
				-- Business Plans	
		2.9			2.9
		3.0			3.0

Priority Scale

1 = High
2 = Moderate
3 = Low

[2] Number exceeds 8 when faculty checked both columns.
[3] Single respondents mentioned the following reports with this rating: Engineering Report, Field Report, Summaries of phone conversations, verbal field reports, reports in foreign languages.
[4] For this item N = 7.

MAINE Destructive Testing, Inc.

Assignment for Model Memo

Memorandum

To: Laboratory Staff
From: Will Manion, Project Manager
Date: 9/11/2004
Re: Eastern Bay Farms: Strength of barn beam

Eastern Bay Farms has hired us to test the strength of a wooden beam in an old barn they recently purchased. A structural engineer from Isolated Structures Co. is already working on the project and recommended in-place testing to confirm bending strength performance. Her calculations suggest that a 10 ft long beam should deflect less than 2 in. under a loading of 2500 lb/linear ft.

Your assignment is to load test the beam in place, using solid concrete blocks for load and a dial gauge for deflection measurements. To move the blocks, you will need a team of about 5 people. Follow this procedure:

1. Accurately measure the length, width, depth and span of the beam.
2. Install a dial gauge below the beam at midspan.
3. Weigh several representative concrete blocks to determine an average weight.

Load the beam with one layer of blocks at a time, covering the whole length of the beam and halfway to the next beam on both sides. The area should be about a 10 ft by 8 ft for a 10 ft long beam spaced 8 ft apart.

4. After each layer of blocks, record the total number of blocks, total weight and deflection as measured from the dial gauge.

To achieve the target maximum loading of 2500 lb/linear ft, four layers of blocks should be sufficient After testing is completed, write me a memo with the results. *I will rework your memo* into a letter to the client and structural engineer. Include the following:

- Actual deflection results compared to the structural engineer's calculations.
- All details and measurements of the testing setup (attach calculations).
- A plot of loading and deflection measurements.

This instruction provides an important key to defining success in this task. The easier you make it for the Project Manager to rework the memo, the better you will have done your job.

If he has to come back to you with questions or has to spend extra time correcting your writing, he will certainly remember that.

Memorandum

First Response to Assignment for Model Memo--with Project Manager's Comments.

To: Will Manion, Project Manager
From: A. Sirius Student
Date: 9/8/2004
Re: results of strength of beam

?

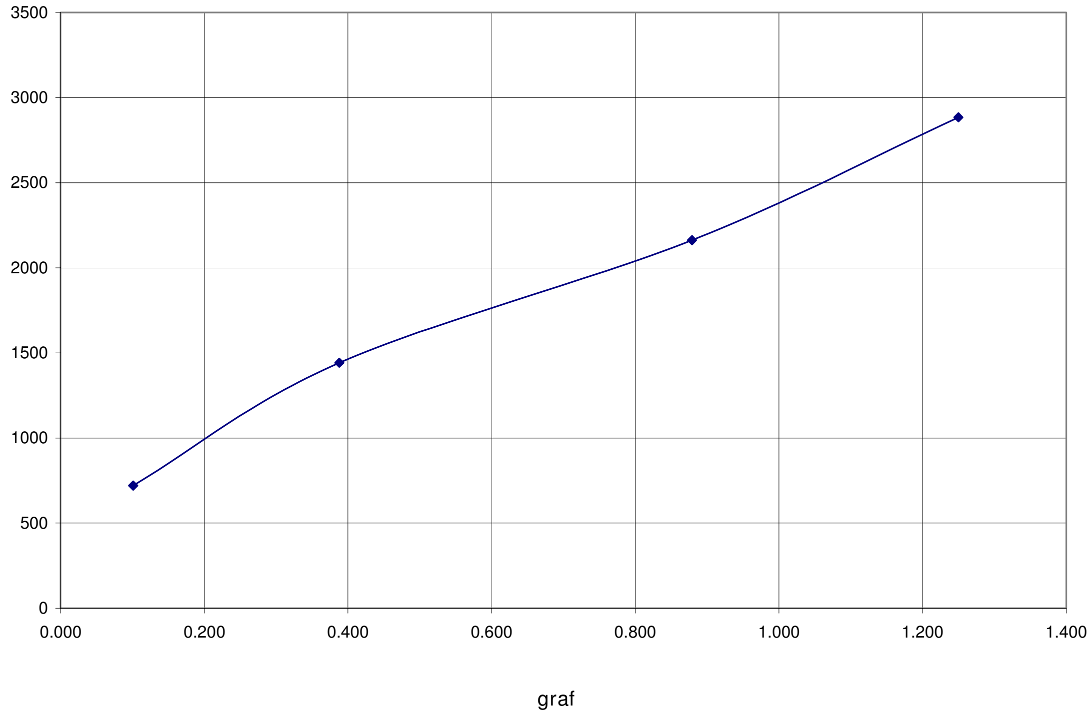
As was requested, it can be absolutely verified that a field-test was performed on the barn beam that was identified as a subject for testing in a previous memo. ~~Such testing is a common and accepted way of measuring the strength of a beam in the field and is ordinarily in times like this.~~ In terms of dimensions, the beam tested was 10.25 feet in length and 7.50 inches in width. In our field test ~~it was confirmed that the beam in question exceeds the strength of the structural engineer from Isolated Structures who did the calculations by 38%.~~ The beam ~~was~~ deflected 1.25 in. under a maximum loading of 2884 lb/linear ft, 38% below the 2 in. deflection the structural ~~engineer had predicted. The loaded area during the test was 10 ft. long by 8 feet wide and it was~~ consisting of 7.5 blocks in the long direction and 12 blocks wide for a total of 90 blocks having been utilized. It should also be noted that the beams were spaced 8 ft. apart on center. In addition, it is also a matter of interest that the average weight of the blocks used was 80.1 lb. This data is given as an indication that the performance of such beams is satisfactory on all counts.

THE ANSWER

BREAK OUT DETAILS!

NOT ALL!!

- ALL TECH DETAILS ARE INCLUDED, BUT DIFFICULT TO READ AND ORGANIZE MENTALLY V. BAD
- WHAT EXACTLY DOES THE FIRST SENTENCE TELL THE READER?
- THIS IS DIFFICULT TO READ! SHORTEN SENTENCES
- SEE ME!!



Note how this graph is poorly labeled with one misspelled word & it doesn't even display units!

Furthermore, this memo fails to include attached calculations.

Memorandum

To: Will Manion, Project Manager
From: A. Sirius Student
Date: 9/11/2004
Re: Eastern Bay Farms: results of strength of barn beam

Assignment for Model Memo—Improved Version

Note the detail of the subject line (Re:). Such detail helps busy readers quickly identify the topic of the communication.

Our field test confirmed that the beam in question exceeds the strength calculated by the structural engineer from Isolated Structures. The beam deflected 1.25 in. under a maximum loading of 2884 lb/linear ft, 38% less than the 2 in. deflection the structural engineer had predicted. The list below summarizes dimensions, test parameters and results from the single beam test in the field.

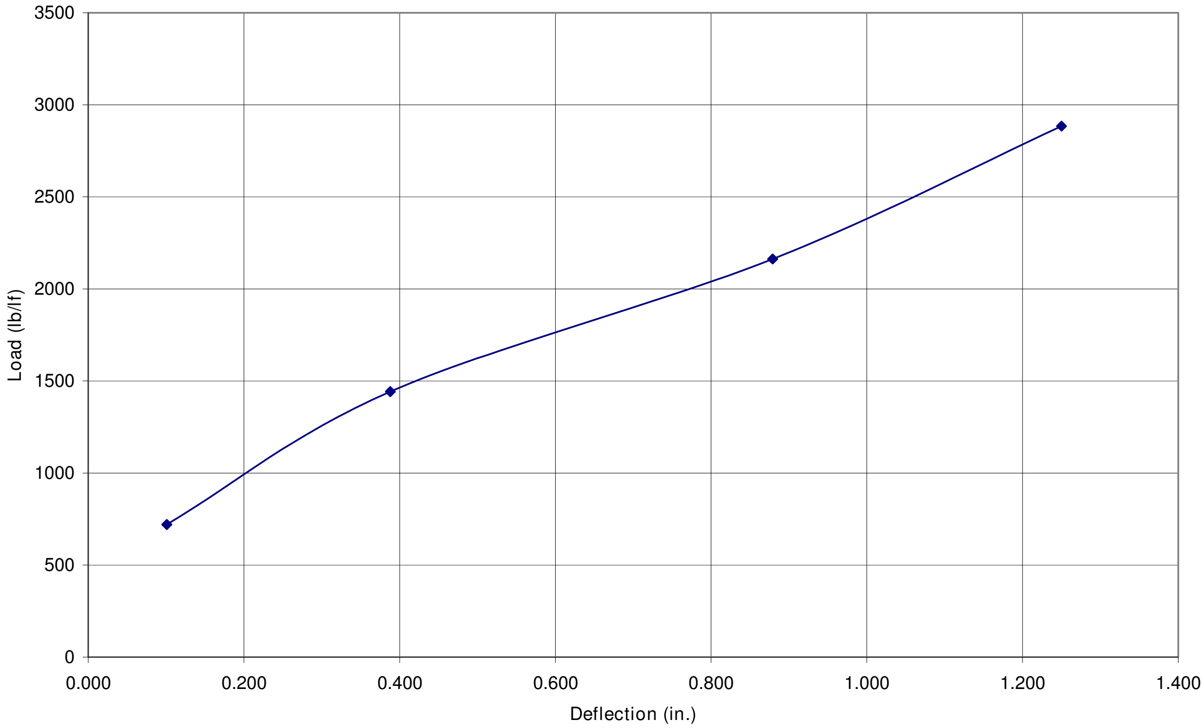
The basic question gets answered clearly in the first sentence, followed by a sentence with supporting detail.

Beam dimensions:	length 10.25 ft. width 7.50 in. depth 11.75 in. beam spacing 8 ft. apart on center
Loaded area:	10 ft. long by 8 ft. wide 7.5 blocks in the long direction by 12 blocks wide 90 blocks per layer total
Maximum deflection:	1.25 in. at midspan under 2884 lb/linear ft. loading
Block dimensions:	16 in. long by 8 in. wide by 8 in. deep 80.1 lb. average weight

Note two other things about this revision:

- *The informal table makes it easier for a reader to find specific data.*
- *The attachments line identifies the contents of the complete memo packet.*

Attachments: load – deflection plot
calculations



Eastern Bay Farms barn beam load - deflection (tested 24 August 2004)

Notice again the specific language of this graph title—always a good thing.

EASTERN BAY FARMS
FIELD TEST OF BARN BEAM

FORMULAS AND SAMPLE CALCULATIONS

AVERAGE BLOCK WEIGHT

$(W_1 + W_2 + W_3)/3 = W_{AVG}$

$(78\text{ lb} + 82.5\text{ lb} + 79.8\text{ lb})/3 = 80.1\text{ lb AVG}$

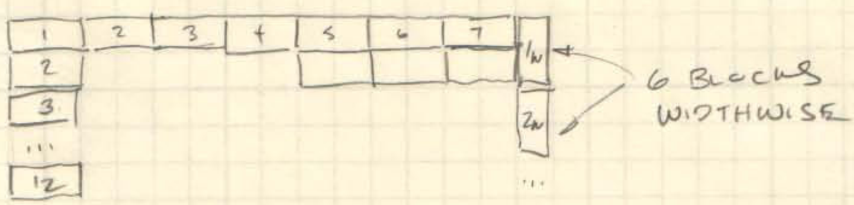
NUMBER OF BLOCKS IN LOADING AREA

LENGTH = 10 FT $\quad 10\text{FT}(12\text{IN}/\text{FT}) / 16\text{ IN BLOCK} = 7\tfrac{1}{2}$
USE 7 BLOCKS LENGTHWISE
AND 1 BLOCK WIDTHWISE

WIDTH = 8 FT $\quad 8\text{FT}(12\text{IN}/\text{FT}) / 8\text{ IN BLOCK} = 12$
USE 12 BLOCKS WIDTHWISE

SO, TOTAL # BLOCKS IS
7 BLOCKS LONG × 12 BLOCKS WIDE
+ 6 BLOCKS WIDTHWISE ON THE END

= 90 BLOCKS TOTAL (8 IN. × 8 IN. × 16 IN)



TOTAL LOAD PER LAYER = (# BLOCKS)(AVG WEIGHT)

= (90 BLOCKS)(80.1 lb/BLOCK) = 7209 lb

UNIT LOADING PER LAYER = BLOCK WEIGHT / BLOCK AREA

$= 80.1\text{ lb} / (8\text{IN.}/12\text{IN}/\text{FT} \times 16\text{ IN.}/12\text{IN}/\text{FT}) = 90.1\text{ lb}/\text{FT}^2$

BEAM LOADING DISTRIBUTED ALONG LENGTH

= TOTAL LOAD PER LAYER / BEAM LENGTH

= 7209 lb / 10 FT = 720.9 lb/FT