

Teaching Portfolio for Engineering Lab Courses

Teaching Writing in Engineering: An Institute for Graduate Students
The University of Illinois at Chicago
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This four-week institute allowed graduate students in engineering to develop professional communication skills and plan for instruction in senior-level lab courses. Our pedagogical work proceeded on two assumptions:

- **Instruction in writing and communication should be fully integrated with ongoing instruction and taught in the context of engineering practices.**
- **Students should regard writing and communication instruction as a path to successful participation in their professional areas.**

The materials in this portfolio, developed by the workshop participants, offer support for teaching writing and communication in senior-level lab courses.

Communicating as an Engineer: Teaching assistants will want to make the point to students that communication is key to success in their profession.

What is a Lab Report?: This handout frames the lab report in a broader context, asking students to consider it as an important means for engineers to communicate about their work.

Teamwork: Most work in engineering is done in teams, and senior level lab courses are designed to prepare students for this. For this reason, the next two handouts are aimed at the team leader who will manage the project by assigning tasks, reviewing the team members' work, asking for revisions, and putting together the final report.

Review Protocol: This list of questions allows the team leader and members of the team to review their work against expectations for a well-written lab report.

Revising and Editing Lab Reports: This handout offers a strategy for approaching the dual tasks of revising to clarify meaning and editing for correctness.

Grading Rubric: This grading key, based on course objectives, allows students to see how they will be evaluated and allows instructors to evaluate and grade lab reports efficiently and effectively. Detailed rubrics such as this one can also provide feedback to the faculty and the department about how instruction might need to be changed in response to broad assessment initiatives such as ABET's.

Institute Faculty: Ann M. Feldman and John Casey, Department of English

Institute Participants: Dejan Depalov (Electrical Engineering), Mihajlo Galubović (Mechanical Engineering), Almila Güvenç Yazicioğlu (Mechanical Engineering), Wojciech Kalata (Mechanical Engineering), Bülent Özer (Mechanical Engineering), Emir Sarić (Electrical Engineering), and Yigit Yazicioğlu (Mechanical Engineering).

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Communicating as an Engineer

Communication is essential to the transfer of information and knowledge in every profession. Written communication differs from oral communication in that writing freezes ideas. The moment thoughts and conversations are written down, they will be readily accessible for further reference at any time. For this reason, writing is an essential means of recording and communicating information accurately and in detail. For engineers, written communication is vital since not only text, but also calculations, plots and figures need to be communicated in documents such as lab reports, progress reports, user manuals and journal articles. In most of these texts, the proper choice of language and format as well as the amount of detail and complexity can mean the difference between success and failure. An engineer with well-developed written communication skills will be successful in his or her career.

The example of the Challenger disaster proves how ineffective communication skills can drastically alter consequences. Morton Thiokol was the contractor responsible for the solid rocket boosters on the Space Shuttle Challenger. The engineers at Morton Thiokol, relying on data from lab tests, believed that due to erosion, one of the O-rings was not properly sealing and could lead to a catastrophic failure of the solid rocket booster. However, they could not convince the personnel at NASA, let alone their own managers, who relied on successful flight data, of the joint's deficiency. They apparently thought that if they **simply sent their data** to their managers, the managers would be convinced by it in the same way as the engineers had themselves been. What they failed to understand was that the existence of data alone was insufficient to persuade their managers. As a result, on January 28, 1986, the worst fears of the engineers were realized when the solid rocket boosters failed caused the shuttle to crash. (Cited in Dorothy Winsor's *Writing Like an Engineer: A Rhetorical Education*. Erlbaum Publishers, 1996, pp 2-3).

In ME341, the written form you'll learn is the lab report. The lab report is a linguistic solution to a real world problem; it is a method of communication. The lab report allows you to put your ideas and findings into an appropriate genre. In other communication contexts, you must identify your audience; organize your materials; and design your data to meet that particular audience's technical and informational needs. The same kind of work may look totally different when written with different sorts of audiences in mind. Only after considering the context for the work can you proceed to put together your findings by providing factually correct technical content, supporting it with theory and evidence, explaining it with sufficient detail, and presenting it in a proper document.

If you are not in a position to communicate orally, then the only means of presenting your ideas and abilities is through writing. The correct choice of genre, audience and context can determine whether you will get a scholarship, a job interview, a promotion or a grant. ME 341 aims to give you an opportunity to practice your writing skills and gain skills that will help you achieve your goals and come one step closer to communicating well as an engineer.

What is a Lab Report?

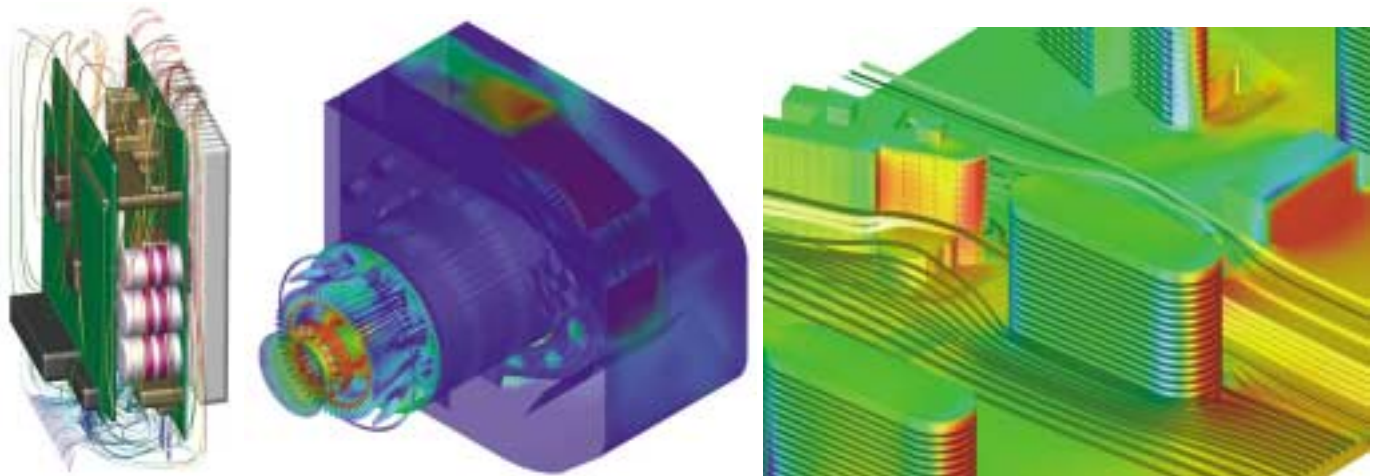
If I were to ask you this question in class, you would probably answer by naming off all the sections that make it up – abstract, introduction and so on. A lab report, however, is more than just a format to be learned and duplicated. The form is certainly important, but it is only a means to obtain a desired outcome. That outcome is communication among colleagues in the engineering community. Lab reports are a common way that engineers communicate their ideas and solutions to other engineers. Without them it would be hard for any technological progress to take place, since isolated groups of people in labs all over the country would have little or no formal means of communicating their research to one another.

What purpose do they serve?

Every project begins with an idea, a need to explain some natural phenomenon, or a solution to a problem. Let's say that NASA discovered that their current lunar vehicle had a suspension system that was inadequate to their needs. They would communicate their problem to a group of engineers that would then sit down and attempt to create a solution. Once that solution was discovered in the lab, the lab report would then be their formal means of communicating the proposed solution they had discovered to the people at NASA. It is important for you as an engineer to be able to communicate your research and results to others. Otherwise, as far as the world is concerned your research doesn't exist and therefore isn't important.

Why do I have to go through all this work?

Lab reports are a lot of work to write, especially when you consider the time constraints involved. However, they are a significant factor in your being prepared for a future career in engineering. Writing lab reports will be one of the major tasks that you are asked to do in your day-to-day work in the private sector. An ability to carry out this task will reflect upon your ability to perform as a professional engineer, and probably will be a significant factor in determining your promotion. Data and images like those below are useful tools, but they must be explained in order for them to be understood.



Results from computational fluid dynamics simulations (STAR-CD by adapco - www.cd.co.uk).

From left: Cooling flow through electrical appliance, cooling flow in a gas turbine power generator, and pressure contours around an office complex.

Teamwork is Shared Objectives

“It is about a group, irrespective of their individual roles, working together towards a common goal.”

Key questions to consider when working in teams:

How do members of the team receive criticism? How can participants give feedback to colleagues in a constructive way? How can teams improve their communication processes? What resources does a team need to increase its effectiveness? What do team members see/hear/feel being in the shoes of the other? How can the team leader motivate team members to participate fully?

Team Leaders' Guide

- Teamwork should be directed, goal oriented and personality driven.
- The team leader should choose between two modes of team operation depending on a goal:
 - An interactive mode (when all team members are present) is used to generate ideas, determine directions and resolve conflicts and
 - A nominal mode (when team members are working individually) is used for carrying out specific tasks.
- The team leader should schedule and run meetings, lead and guide discussions, provide balanced representation and visual reinforcement.
- The team leader should identify and distribute specific tasks and specify areas in which ideas must be generated.
- Every meeting should be documented and end with decisions, responsibilities, tasks, ideas, comments and criticism delegated and acted upon.

Essential Interpersonal Skills For Teamwork :

Listening: Team members listen to each other's ideas. They "piggy-back" (or build) off each other's ideas.

Questioning: Team members question each other -- interacting, discussing, and posing questions to all members of the team. They exchange, defend, and rethink ideas.

Respecting: Team members respect the opinions of others-- encouraging and supporting the ideas and efforts of others.

Helping: Team members help each other- offering assistance and reporting their findings and ideas to each other.

Participating: All of the team members participate and contribute to the project.

Review Protocol for Team Leaders

Reviewing your writing is critical to producing a successful lab report. It is possible for a person not to see their own mistakes even after several proof readings are done. Thus it is always a good idea to have someone else review the written material. Effective use of review can help you create reports that are complete, concise, and error free. As a team leader, you have the greatest responsibility of handing in a complete and well-written report. For this reason, you should evaluate each section and make sure your teammates did their job well and that the overall report is coherent. The checklist below will help you review each section according to the relevant features and make or suggest necessary changes.

Abstract

- Does the abstract briefly state what is contained in the report, refer to the experiment performed, materials and equipment used, techniques applied and the results obtained? (250 word max) Yes No

Introduction

- Are the purposes and the objective of the experiment identified? Yes No
- Is the approach to reach the objective explained? Yes No

Theory

- Are the terms specifically used in this experiment defined? Yes No
- Are the formulations used in analyzing the data written and the derivation and/or the sources of the equations included? Yes No

Experimental Apparatus and Procedure

- Are there diagrams or figures describing the experimental set-up? Yes No
- Is there a list and brief discussion of the experimental equipment? Yes No
- Is the procedure briefly stated in your own words? Yes No
- Have you discussed any situation that might have degraded the quality of the data taken? Yes No

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Results

- Does your results section have tables and figures? Yes No
- Does each figure and table have a descriptive title? Yes No
- Are the axes of the plots labeled with appropriate units? Yes No

Discussion

- Did you refer to the figures/tables presented in the results section? Yes No
- Is there a discussion of the differences between theoretical predictions and experimental results? Yes No
- Are there any suggestions to improve the equipment and data taking procedure to minimize the errors? Yes No

Conclusions

- Did you draw some conclusions from the analysis of your data? Yes No
- Did you refer back to the objectives of the experiment? Yes No

Appendices

- Is the data sheet attached? Yes No
- Are the sample calculations brief and explanatory? Yes No

Overall

- Is the format of each section consistent with the others? Yes No

If you had more time which part(s) of the lab report would you work on more and why?

Revising And Editing Lab Reports

Revising is an essential part of writing and it should be done after the first draft of the lab report is produced. Revision is a rethinking process where you go back and repeat earlier steps in the writing process, such as

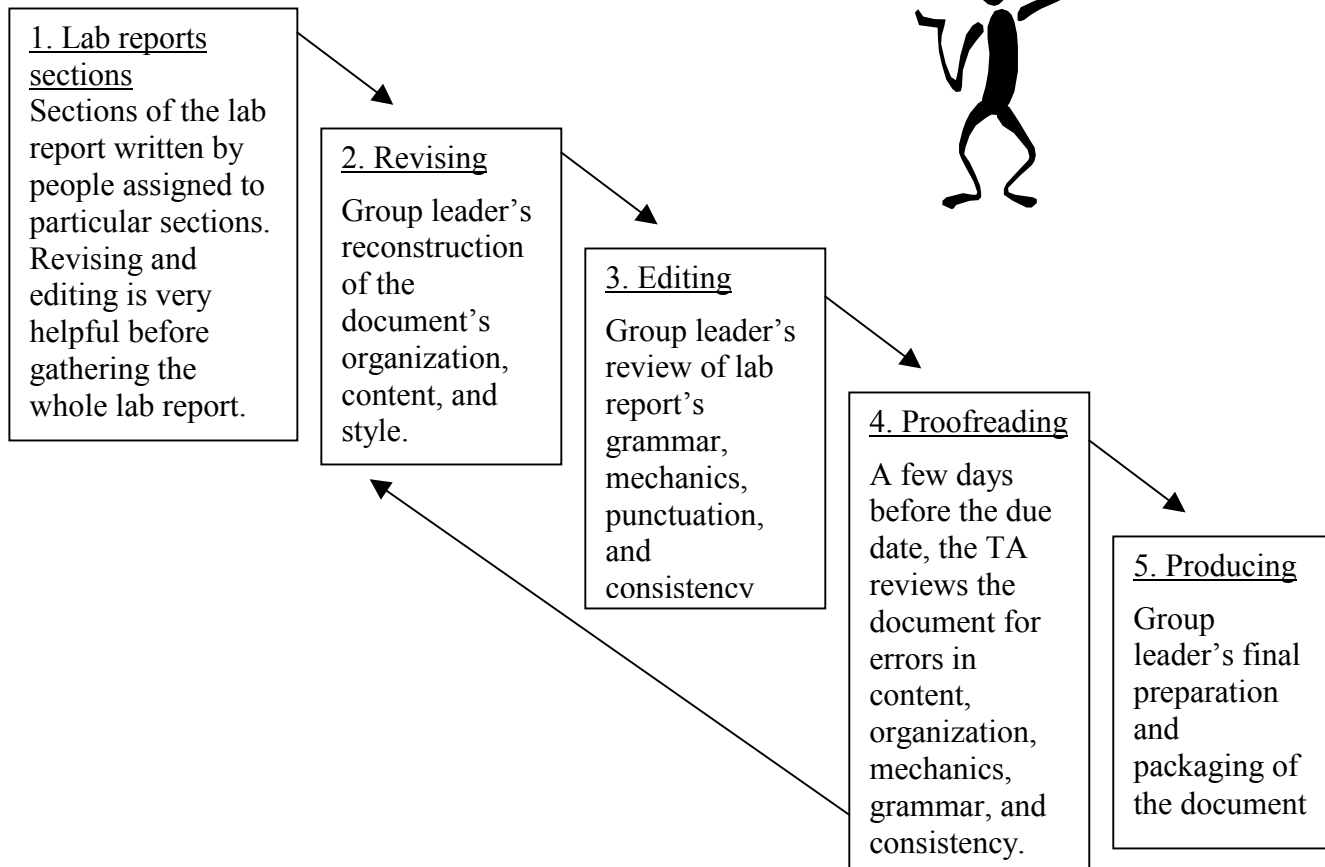
- Tailoring the detail to specific aims and audiences
- Improving logical development of the material
- Adding or deleting detail to make the report concise and understandable
- Highlighting important material



In this process the writer can discover gaps and errors in the original draft. It gives you a second chance to clarify your point and purpose.

Editing, on the other hand is the last stage in the writing process. It means getting the final copy ready for the audience. It involves checking your work for

- Sentences
- Word choices
- Punctuation
- Spelling
- Grammar and usage



Grading Rubric for Engineering Lab Reports

I. Abstract presents a clear and concise version of the report, summarizing what happened and the results of the experiment. (Abstract should not exceed 250 words –15 percent.)

- 4- The abstract contains the most important details of the report, including the objectives of the experiment, the method and the results.
- 3- The abstract contains some of the important details of the report, but either leaves out or incompletely mentions the objectives, method, or results.
- 2- The abstract contains many irrelevant details and tells the reader little about the experiment or its results.
- 1- The abstract tells little if anything about the experiment or its results.

II. Report demonstrates that the student understands the purpose and objectives of the experiment. (10 percent)

- 4- The report clearly states the purpose and objectives of the experiment. Furthermore, the entire report shows a comprehensive understanding of them, and is concluded by referring back to the experimental purpose and objectives.
- 3- The purpose and objectives are clearly stated, but the report shows an incomplete understanding of them.
- 2- The purpose and objectives are stated, but the rest of the report does not refer to them.
- 1- The purpose and objectives are either incorrectly stated or not at all. Little or no understanding of them is shown in the report

III. Report explains the theory and its application to the experiment. (20 percent)

- 4- The report gives a comprehensive explanation of the theory involved and shows clearly how it relates to the experimental procedure.
- 3- The explanation of the theory is adequate, but lacks some details. The connection between the theory and the experiment is not totally clear.
- 2- The explanation is missing key details necessary to understanding the theory. The report shows little or no attempt to connect the theory to the experimental procedure.
- 1- There is almost no explanation of the theory at all and the report makes no attempt to connect the theory to the experiment.

IV. Report contains a description of the experimental setup and procedure. (10 percent)

- 4- The experimental setup and procedure are explained in comprehensive detail along with appropriate diagrams of the setup.
- 3- The experimental setup and procedure are explained in sufficient detail. No diagrams are present.
- 2- Student apparently copied procedure from lab manual, little or no description of experimental setup present.
- 1- Incomplete or inaccurate explanation of experimental setup and procedure

V. Report presents data and results appropriately and accurately. (15 percent)

- 4- The data and results are accurately presented. Tables and plots are labeled appropriately.
- 3- The data and results are accurate but presented inadequately. Important results are obscured by data more appropriate for an appendix. Graphics are not always well labeled or helpful.
- 2- The data and results are only partially accurate and presented poorly. Charts full of unexplained data are given rather than carefully chosen graphics illustrating key details.
- 1- The data and results are mostly inaccurate and are poorly presented.

VI. Report analyzes results and discusses the extent to which the results meet the objectives of the experiment. (20 percent)

- 4- The results are well analyzed, both explaining what happened in the experiment and any possible deviations from the expected outcomes due to the equipment, procedure, and assumptions. Results refer back to the plots and tables and present a comparison with the theory.
- 3- The results are adequately analyzed but the discussion too often summarizes what happened rather than why. Only a partial explanation of possible experimental deviation and comparison with theory.
- 2- The results are poorly analyzed if at all. It is almost totally a summary of what happened in the experiment. Deviations are either not acknowledged at all or mentioned but not explained. No comparison with theory is given and the discussion does not refer to the figures and tables presented.
- 1- No analysis is present. The report basically summarizes the experimental procedure. There is little or no interpretation of data or results.

VII. Report exhibits consistent design and appropriate language usage. (10 percent)

- 4- The report is consistent in design looking like a professional report with all sections matching and well presented. There are few grammar and spelling mistakes.
- 3- Some sections of the report differ in style from the rest (either in font or page layout). There are many spelling and grammar mistakes.
- 2- Consistency in the report is poor, so much so that it looks like several reports put together rather than one professional document. There are an abundance of grammar and spelling mistakes.
- 1- There is no consistency to the report. Some sections are even handwritten (possibly experiment notes). The grammar and spelling mistakes are so numerous that the report is hard to read.