Fundamentals of Engineering Technical Communications

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A Resource & Writing Guide for the Fundamentals of Engineering Program

LEAH WAHLIN

FE & FEH INSTRUCTIONAL TEAM

Introduction

This guide is designed for students in the **Fundamentals of Engineering Program at The Ohio State University**. It will introduce the general principles of technical communication in the context of engineering, serve as a guide during the writing process, and provide links to additional resources.

"Technical Communication" is a broad category that includes numerous ways of sharing information about specialized subjects. Some examples include user guides for software, product specifications, patents, assembly instructions, technical diagrams and illustrations, and websites about medical products. The most important principle of technical communication is that the information be presented in a way that is clearly organized, audience-appropriate, and easily understood.

We want students to establish strong technical writing skills that will transfer into their major areas and develop essential professional skills. Students should recognize the difference between context-specific rules (like assignment requirements) and general best practices to prepare for further coursework and professional roles.

The goals of this guide are:

1. To make information available that will help students successfully complete technical communication assignments in the Fundamentals of Engineering Program.
2. To connect students to additional resources that will help them further improve the quality of their technical communications.

Chapter 1. Engineering Your Writing Process

In this Chapter

- Discussion of the importance of writing in engineering
- Discussion of writing as a process with multiple steps aligned to DR PIE
- Benefits of writing for learning and thinking
- Strategies for optimizing the writing process (planning and writing better drafts, getting helpful feedback, and proofreading)
- Strategies for managing the writing process as part of a team

Communication skills have generally been one of the most underrated aspects of an engineer's education. Many students enter their engineering programs expecting to use calculators and CAD rather than their writing and presentation skills, but writing and other forms of communication are among the most important skills an engineering student will learn.

An engineer's work, no matter how impressive, is useless

unless it is communicated to others. Engineers must be able to document their ideas in industry standard forms, such as project proposals, pitch presentations, lab reports, progress reports, and even daily project communications such as emails and status updates in team meetings.

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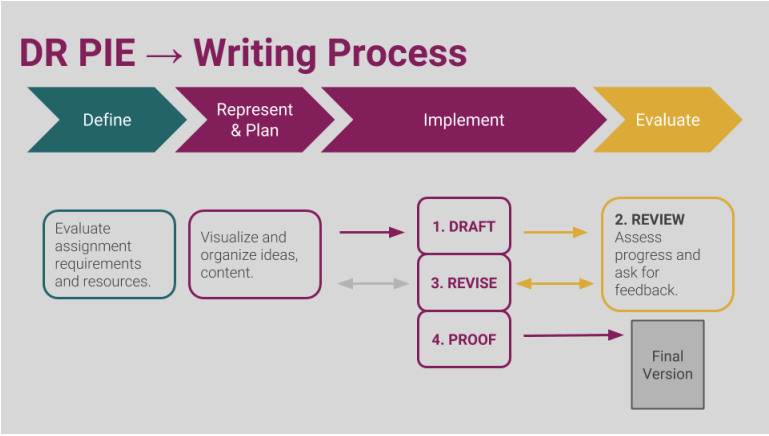
That is not to say that technical writing or communication is effortless. It is a learned skill and, like any other skill, it must be practiced and honed. Technical writing is different from the style most students have done throughout high school, and if you are not careful in developing your communication skills for the work you will do as an engineer, technical documents can easily become dry and cumbersome and therefore less likely to achieve their purpose.

You have a great opportunity now—at the start of your engineering studies—to think strategically about how to become a better, more effective writer. It all begins with following an effective writing process.

The Writing Process

You are likely familiar with the basics of the writing process (pre-write, draft, review, revise) from other writing classes. Those steps still apply to technical communication, but now you should also consider how the writing process aligns with the engineering design process, represented here as

DR PIE (Define, Represent, Plan, Implement, and Evaluate)



Thinking of it in these terms might help you shift your perspective to practice writing as a technical exercise.

Define: Evaluate the requirements and context.

- Read the assignment description (and rubrics) carefully—*What is the purpose of the document? Who is the audience?* Ask questions to ensure you understand the context for what you are going to be writing.
- Review available resources (templates, guidelines, examples) and keep them handy (download files, bookmark this guide, etc.).
- Research the document genre (lab report, memo, white paper, etc.) to enhance your understanding of the communication type.

Represent & Plan: Visualize and organize.

- Brainstorm, prewrite, and/or outline document sections
- Consider and discuss the voice and writing style for the document (determined by audience and purpose)—see Understanding Your Audience
- Create plan for drafting—*What order will you draft the document sections in? If working with a team, who is responsible for which sections? How will you share progress and information?* —See Managing Project Communications [Link]

To be successful, you must allow enough time to write in stages—draft, review, revise, and proofread.

To be successful, you must allow enough time to write in stages—draft, review, revise, and proofread. This is especially important when writing as a team. These are complex documents where precision and consistency are key—it is too easy to shift tone and voice, misrepresent data, or miss requirements if the whole team doesn't take time to carefully contribute to and review the entire document.

Implement & Evaluate: Write—draft, review, revise, repeat.

This is the core part of the writing process, where you turn the information and your understanding of your audience's needs and expectations into a piece of writing. The steps are shown

here as linear, but look at the arrows in the diagram above and think of it as cyclical. You may need to repeat steps, moving back and forth between reviewing and revising multiple times before a document is complete.

1. DRAFT

Begin drafting (or writing) the document according to your drafting plan, but don't be afraid to adjust the plan when needed—you might find your initial assumptions or understanding of the requirements have changed once you start writing.

- For the first draft especially, just write. Know it will not be perfect—get all of the information out, even if it's messy at first.
- Don't get locked into writing beginning to end—skip around, leave space or notes, highlight text → *Having a solid understanding of the document requirements and a working outline of the document makes this much easier.*
- Don't worry about formatting, grammar, or mechanics—document the information and content first, then address writing style and mechanics.

Tips for writing better drafts

No one sits down and writes a perfect document from beginning to end, especially not complex technical documentation. Writing is a necessarily messy process, but many writers still get "stuck" as they're writing, feeling like they have to get something just right before they move on and this is counterproductive because we often waste time on things that will be much easier to address later on.

Here are some simple strategies to help during the drafting process:

- Add notes/reminders for yourself to come back to using the comment feature or even just in text in brackets: [Need intro here–talk about the connection to the previous week's findings] or [get updated data]
- Highlight or change text color to remind yourself that something needs further attention and you should come back to it.
- Keep a "junkyard" at the end of the document where you can cut and copy sentences or sections of text that you wrote but aren't sure you should keep—it can be difficult to delete, so this can allow you to make a needed revision without feeling like you're "losing" your work.

2. REVIEW

Review the document by assessing your own progress and requesting feedback from a variety of sources.

- Take a step back and look at what you have produced, assessing it against the requirements—*Does it meet the requirements? Are there gaps? Do you have any questions?*
- Ask reviewers to read the draft and provide feedback, focusing first on the ideas and organization (rather than mechanics and grammar).
- Review and assess the feedback—*Do you agree with it? Does it align with your understanding of the goals and requirements of the assignments?* Remember, you need to understand and evaluate the feedback, not just apply all "corrections" you are given.

Tips for a better review process

Request reviews and feedback from multiple sources who will provide different types of feedback—"internal reviewers" are those familiar with the project and its requirements, "external reviewers"

are those who do not know the specifics of the project, but can still provide valuable feedback on the writing and logic of the document.

You might ask for feedback from:

- Group member
- Classmate
- TA (attend office hours or technical communications sessions, if offered)
- Peer (friends in other sections, people who have taken the class before, or just someone who is a good reader)
- Writing Center tutor

Set them up for success! Give your reviewers any information they need to understand the scope of the assignment and the requirements. Guide their attention to sections or issues that you need particular help with:

"The Introduction seems disjointed to me—please look carefully at that part."

"I struggled with using the same verb over and over again, so I'd love your help finding different ways to describe that process."

3. REVISE

Re-write and re-organize the draft. “Re-vision” means “re-seeing” and “re-working” the piece of writing. This is not an easy process—it takes practice and time.

- Make *significant* changes to the writing. Work toward precise and concise sentences, focused and coherent paragraphs, logical transitions. [add links to Writing Style sections]
- Apply feedback from your reviews and go over the writing until all sections are complete and the document is clear and consistent throughout—check that the document is “whole,” has achieved its purpose (referring back to the assignment or request), and makes sense from beginning to end. The final document should be whole and logical.

4. PROOFREAD

Finally, proofread/copy edit and format the document—check for correct spelling, tense usage, and punctuation; and consistent fonts, spacing, page numbering, etc.

Applying the Writing Process as a Team

In many cases, you will be asked to write a document as a member of a team. The temptation might be to simply assign different sections to different team members, write them

separately, and then stick them together, but this approach can cause problems with cohesion, completeness, and consistent writing style. Even worse, groups often find themselves in the position of relying on one or two "good writers" to "fix" the document at the last minute, putting undue burden on part of the team and robbing the others of a valuable opportunity to develop their writing skills.

The key with all of these strategies is to remind yourself that even if you are directly contributing only a *part* of a document, you still need to be concerned with the "whole."

Plan ahead and work to avoid these issues when you are assigned team writing projects. Here are some strategies to ensure that groups produce excellent writing as a team:

- **Complete the "Define" step** of the writing process as a group. Make sure everyone has a shared understanding of the requirements and involve everyone in the writing process from the first step.
- **Use the "Drafting Plan" and the "Review" part** of the writing process to make time for the team members to review each other's writing.
- **Identify strengths and weaknesses** of the team members' writing abilities, but *do not exclude anyone from the writing process*—everyone needs the chance to contribute and learn. Consider these strengths and weaknesses while you're sharing feedback and helping each other revise.
- **Allow adequate time for *everyone* to proofread** the final document (together in person or online in a collaborative environment, like Google Docs), paying particular attention to and revising the following:

- Formatting (line spacing, margins, heading styles, numbered or bulleted lists)—errors in these visual elements are a giveaway that the document was pasted together.
- Paragraph length—if the paragraphs in one section are much longer than the paragraphs in another section, the writing begins to feel uneven.
- Writing style—issues related to Voice and Tone and Grammar and Mechanics should be addressed consistently; check that a consistent vocabulary and level of technicality are present across all sections.
- Transitions—it can be particularly helpful to focus on those points where one section shifts to the next and ensure that it is not abrupt or confusing.
- Cohesion—try to take a step back and read the document as if you are seeing it for the first time, asking if each piece works together and serves the overall purpose of the document.

The key with all of these strategies is to remind yourself that even if you are directly contributing only a *part* of a document, you still need to be concerned with the "whole." Successfully writing as a group requires additional awareness, effort, and sometimes negotiation—these are valuable skills that deserve attention.

Establish good habits to support you as you learn and develop your skills in technical communication. Understanding and applying the approach to writing process outlined here are important steps toward developing good habits as a writer that

will support your academic and professional progress in the future.

Key Takeaways

- Assess your strengths, weaknesses, and habits as a writer and develop strategies to improve your process.
- Approach writing projects as a multi-step process, based on the engineering design process.
- Allow ample time to write, evaluate, and revise in stages.
- Familiarize yourself resources that will help you with future writing projects.

Additional Resources

OSU Writing Center (consultation services)
The Writing Process (OWL)
Writing in Engineering (OWL)

Chapter 2. Understanding Your Audience

In this Chapter

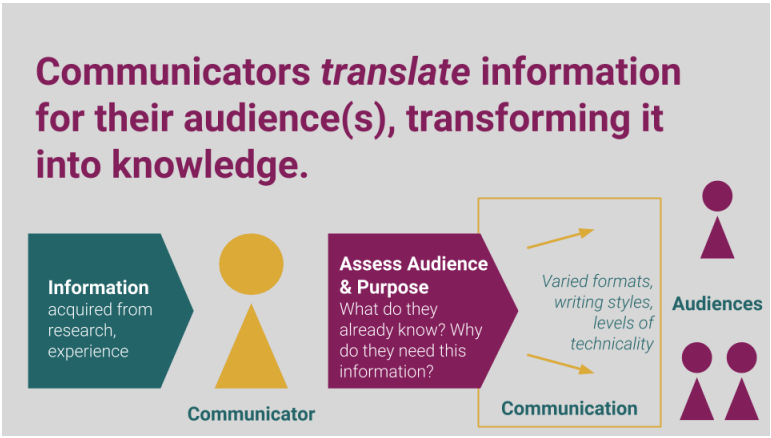
- Discussion of the role of understanding audience and purpose in technical communication
- Strategies for assessing audience and purpose
- How to assess the levels of appropriate technicality in engineering communication
- Tips for understanding “audience” in FE & FEH writing assignments

At the start of the writing or communication process, carefully consider your “audience”—the person or persons who actually be reading your document, receiving your email, or watching your presentation. As a communicator, your primary goal is to transmit information efficiently and effectively. *How* you choose

to transmit that information—the way it's written and the form it takes—must depend to a large extent on who your audience is and what *their* goals are.

As a communicator, your primary goal is to transmit information efficiently and effectively.

Good communication is the result of a complex process that factors in your reader and their goals. Think of it as an act of translation—you possess information and knowledge, and you need to deliver that information to your audience in a way they will understand. This process asks you to consider the language you use, but also the way you deliver the information (a document, a presentation, a diagram, a phone call). The same information might be communicated in multiple ways, depending on your audience and the context.



Approaching your technical writing as a series of requirements to be checked off might earn an *acceptable* grade, but it will

not elevate your writing style or your ability to communicate effectively in other situations, such as classes with different requirements, or a job or internship.

Audience and Purpose Affect Your Choices as a Communicator

Even in a technical communication style, there are multiple ways to present the same information based on **audience and purpose**.

Be prepared to communicate to many different types of audiences—your audience must affect your decisions as a communicator. Factors that define **audiences** are

- their level of expertise or familiarity with the subject (e.g., a fellow engineer or a person in a non-technical position in the company or a layperson),
- their role or goals (what they will do with the information),
- their position relative to the organization (internal or external), and
- their position relative to you (peer, superior, or subordinate).

A clearly stated purpose is a key feature in most technical and professional communications because it improves efficiency—your reader should know right away why they are reading your document. Some common **purposes** for technical communication are

- to inform
- to recommend
- to request

- to propose
- to persuade
- to record
- to instruct

Consider the following examples and how the content of the communication is affected by the audience and purpose:

- If a report is being written to a practicing engineer in the appropriate field, it would not be necessary to describe a common concept (e.g., stress and strain for a mechanical engineer or current for an electrical engineer) in depth.
- If a lab report is being written for direct supervisors or peers who are familiar with the experiment, dispensing with the need for some of the background or methodology details.
- If you are preparing a progress report for a *client*, your perspective and approach might shift to focus on demonstrating competence and a positive outlook on the project, while an *internal* progress report written for your colleagues might be more likely to focus on problems with the project and risks that the team needs to address.

Here are the types of questions you should ask as you assess **purpose and audience**, especially during the planning phase as you prepare to write:

PURPOSE	• What does this document need to achieve? • What role does it play in the project / professional / academic ecosystem? • What result or action do I want to see after my reader/audience reads it? What effect do I want this document to have on my audience?
AUDIENCE	• What does my audience already know about this subject? • What do they value? What is their mindset or attitude about this information? • Why do they need or want this information? What are their goals? • What are their expectations about the form it will take?

During the writing process, the answers to these questions should guide your decisions as a communicator as you make decisions about what information to include, how to communicate that information effectively, and what the finished product should look like.

Practice & Application: Exercise A – Audience and Purpose

Determining Appropriate Levels of Technicality

As an engineer, you will communicate highly technical information from the perspective of a trained expert. But not all of your audiences will share your training and background, so you need to be able to adjust the level of technicality in your writing, while still communicating the information accurately.

A writing style and vocabulary that is overly simplified might bore an expert-level target audience or cause the writer to lose

credibility. An overly complex style might overwhelm a target audience of laypersons, causing the writer's message to get lost and not achieving the purpose of the communication. Technical communicators must ask:

- What level of detail does my audience need for how they will use the information?
- What type of vocabulary will my audience understand and find useful?

The chart below describes some of the ways language and communication might change as you speak to various audiences.

Audience Type	Language Characteristics
Expert *Highly skilled, trained practitioner (e.g. fellow engineer); often the audience for Lab Reports, Progress Reports.*	• **Level of detail:** Facts and figures need little explanation; may include formulas and equations; measurements and specifications have a higher degree of precision. • **Vocabulary:** Acronyms, technical terms, and jargon used; high level of technicality in the language without needing to define words. Examples: PTFE layers are hydrophobic. Devices finished with tints of black can have zero color saturation. The piece is 2.921 cm long.
Informed Persons *Familiar, but perhaps not working directly with the technology (e.g. business side); often the audience for R&D Presentations, client-facing progress reports.*	• **Level of detail:** Technical information is provided, but advanced concepts are explained; application examples or comparison / contrasts often included; might acknowledge audience concerns (e.g. business or financial implications); measurements given, but may be less precise. • **Vocabulary:** Jargon and technical terms include definitions; acronyms more likely to be spelled out or replaced; vocabulary supports understanding of application rather than technical precision. Examples: Fluorocarbon coatings are non-reactive to water. Devices painted gray appear to be muted. The piece is nearly 3 cm long.

Laypersons *No professional or specialized knowledge (e.g. a general "public" audience); often the audience for websites, press releases, public relations communications.*	• **Level of detail:** Concise, few specific technical concepts; technically detailed information provided in service of the audience's needs and goals (e.g. a user manual); measurements provided in common, familiar units. • **Vocabulary:** Simplified language, avoiding unnecessarily complex terms; new concepts and terms are clearly defined and explained; provides commonly recognizable examples and familiar analogies. Examples: Nonstick coatings do not absorb water. Items painted gray appear to be washed out and hard to distinguish. The piece is about 1 inch long.

The three types outlined here are general examples for the sake of illustration—there are many variations, and you will need to consider the unique needs of your audiences in every situation. As always, consider the purpose and ask yourself how your audience will use the information as you decide the right level of technicality for a communication.

Practice & Application: Exercise B – Adapting Word Choice for Audience and Purpose

Assessing Audience and Purpose for FE & FEH Assignments

If you are writing a report at work, the audience is obvious—a report turned in to a supervisor is intended to be read by that supervisor. In an academic setting, it might be easy to assume that the audience is the instructor or TA (whoever is doing the

grading), but that assumption can be limiting and actually make it more difficult for you to write well.

So, how should you think about audience when writing in FE or FEH?

Pay attention to the assignment description. Most assignments will provide a "scenario" with an audience and purpose to imagine as you're writing. Even though the audience isn't likely "real," taking time to imagine and assess them will make you better able to write a complete, meaningful document. This is what your instructors are asking you to do when they ask you to write for different audiences.

Most assignments will provide a "scenario" with an audience and purpose to imagine as you're writing.

The assignment scenario might also ask you to imagine that you are writing from the perspective of an employee at a company. Fully embrace the scenario and imagine yourself in that role as you assess the audience and purpose—let that mindset guide and affect your decisions throughout the writing process.

APPLICATION:

The purpose of a lab is to explore a scientific question, and the content of the lab report should reflect this. Instead of writing "*The purpose of this lab was to complete Lab 3: Circuits*," consider how "*The purpose of this lab was to design and build a circuit*

that could individually control six LED's" shifts the focus to the scientific question rather than the fact that it was an assignment.

To improve your writing, don't approach this as an academic task—think of it as a scientific task and embrace your role as researcher.

Learning to account for audience and purpose will allow you to become an adaptable and effective communicator in any situation.

Practice & Application: Exercise C – Articulating Problems and Problem Scope in Context

Key Takeaways

- The same information can *and should* be communicated in different ways, depending on who your audience is and what you are trying to achieve (the purpose of the communication).
- Assess audience and purpose in every communication situation, and use that assessment to guide your choices as a communicator as it relates to the appropriate

level of detail and technical vocabulary.

- Embrace and work within the scenarios described in writing assignments to understand and "write to" the audience and purpose—this exercise will elevate your writing style and skill level.

Chapter 3. Writing in a Technical Communications Style

In this Chapter

- Understanding writing style and recognizing the importance of writing in a style that meets readers' expectations
- Discussion of effective technical communications style that is defined as *concise*, *precise*, *direct*, and *well organized*
- Recognizing and using meaningful, precise language

3.1 Voice and tone

- Understanding and using appropriate language, voice, and perspective in engineering communications
- Addressing common issues with writing in

the discipline—active vs. passive voice, nominalization, personal vs. impersonal tone

3.2 Mechanics and grammar

- Learning to recognize and address habits and errors in your writing
- Reviewing common grammatical issues that affect students in FE and FEH

3.3 Citations and citation styles

- Recognizing the role of citing sources in written documents
- Reviewing the basics components of citations in IEEE and APA style

A technical communications writing style is (almost always) **concise, precise, direct,** and **well organized**. The following sections outline useful tips and best practices, but know that these are only a starting point. Writing style is something you must be aware of and continually work to refine as you develop your communication skills.

A technical communications writing style prioritizes the *efficient transfer of information*—this may be a change from

the types of writing you have done in the past. “High school writing” is more typically descriptive expository essays with a length requirement. Technical communication asks you to document information and communicate it in a concise, precise, and professional way. The focus tends to be more on how well the writing achieves that goal rather than on proving that you read or understand something.

Writing assignments often provide specific structures or lists of required elements; however, simply fulfilling these guidelines is rarely enough to create a cohesive, clear document. To be a successful writer not just in first year engineering, but in your major courses and career, you must be attentive to the ways your writing style needs to vary from one situation to the next.

Understanding “Writing Style”

To understand what “writing style” is, think about all the different ways people talk. With their tone of voice, volume, and speed of delivery, they are able to project different moods, personalities, and purposes. Think about how a person sounds while they’re telling a funny story. Then think about how a person sounds while telling you about their problems.

You might also intuitively know that certain ways of speaking are appropriate for some situations, but not for others. If you wanted to deliver a passionate speech to persuade your audience to vote for you, you certainly wouldn’t want to sound like you were delivering a eulogy at a funeral (or vice versa).

Those same concepts apply to your writing. *How* you deliver information—the voice, tone, mood of your writing—is the “style.” It affects how well your audience will understand and respond to the information you are trying to communicate.

Since writing style affects how your reader responds, be aware of and *use* it to help you achieve your purpose.

In most situations, you must also communicate in the style your reader expects. This is often driven by genre (type of document) and context. If you are asked to produce a lab report, your reader will have certain expectations about what goes in it, and if you don't meet those expectations, it will reflect poorly on you as a communicator and make it less likely that your message is delivered.

Since writing style affects how your reader responds, be aware of and use it to help you achieve your purpose.

Audience and purpose, then, will always affect your writing style, as discussed in Understanding Your Audience. In this chapter, you will find guidance for developing a general technical communications writing style for documents common to First Year Engineering.

Concise

Sentences should be clear and simple, communicating one concept per sentence. In situations where you want your message to be unambiguous, simple, short, direct sentences are best.

Avoid "filler" or "fluff" that clutters up your writing and does not provide useful information. Here are some common types of "filler" to be aware of:

Vague or hedging language	*Avoid:* basically, to a certain extent, kind of, sort of, stuff, things, something, about (+ number)	
Redundancies	each ~~and every~~ present ~~time~~ ~~end~~ result ~~absolutely~~ essential ~~completely~~ eliminate enter ~~into~~ ~~fellow~~ teammate ~~final~~ conclusion cancel ~~out~~ ~~the month of~~ [August]	
Wordy phrases	make an adjustment	= adjust
	make a decision	= decide
	provide assistance	= assist
	a large number of	= many (or quantify)
	at the present time	= now
	due to the fact that	= because
	in order to	= to
	in the near future	= soon
	prior to the start of	= before
	until such time as	= until
	in the event that	= if
	serves the function of being	= functions *or* is
	do not hesitate	= (omit—just invite an action)

Examples of editing for concision

Before: Keep this information on file for future reference.

After: File this information.

Before: Ideally, it would be best to place the billing ticket just below the monitor and above the keyboard.

After: Place the billing ticket between the monitor and the keyboard.

Before: We need to act on the suggestions that the supervisors offer us.

After: We need to act on the supervisor's suggestions.

Before: Due to the fact that we reduced the weight of the AEV, we used less energy.

After: We used less energy because we made the AEV lighter.

Before: It was the offset battery that made the AEV fall off the track.

After: The offset battery made the AEV fall off the track.

Before: There is a danger of poor communication causing a bad outcome in the team project.

After: Poor communication can negatively impact the team project.

Keep in mind, however, that shorter is not *always* better. For example, there may be times when you might sacrifice concision for the sake of sounding more personable, friendly or conversational. If you have to deliver bad news, a two-sentence email might come across as rude or uncaring, while writing a longer email that builds rapport and includes more qualitative,

personable touches might soften the blow. This approach could have a positive impact on a team dynamic or a client relationship so that, even with a slightly higher word count, the final outcome is better.

Practice & Application: Exercise D – Software Design Pitch Video Prep

Precise

Precise wording avoids ambiguity and ensures the correct information is conveyed to your reader. This is obviously essential to engineering settings, where highly technical information is being communicated.

Precise writing will generally meet the following criteria:

1. **Statements are verifiable.** Ambiguity might provide a sense of security, but leads to documents that, at best, need to be further investigated. Imprecise language in the workplace can lead to dangerous misapplication of results.
2. **Statements are specific and meaningful.** Phrases or descriptors that are used in everyday life are often not appropriate in a technical document. Words like “cold” or “best” are meaningless unless a standard of comparison is established. What is considered “cold” for a metal? For organic material?
3. **Descriptors are quantified whenever possible.** If exact data is not known, it should be replaced with objective observations, e.g., “The water began to boil.” When making quality determinations like “better” or “best,” determine what criteria you are using and instead of making a subjective statement, share that criteria with your reader.

4. **Word choice accurately represents the level of certainty.** Words like “prove,” “guarantee,” or “certainty,” communicate a finality that rarely exists in science and engineering. You will often draw conclusions based on evidence, but it is unlikely that you will ever prove or guarantee the results of your experiment or design. Use words that are accurate and still allow for uncertainty, such as: “indicate,” “suggest,” “highly likely,” “reduce,” “decrease” or “increase”

Imprecise:	More precise:
Several holes were drilled in the plank.	*Three (3)* holes were drilled in the plank *four* (4) *inches apart.* *Quantifies the number of holes and the spacing.*
A few of the LED's on Design 1 were kind of faint.	*Two* LED's on Design 1 were *noticeably less intense than their counterparts on Design 2.* *Quantifies the number of LEDs and provides a specific point of comparison.*
The beaker of water was placed in the ice bath until it was cool.	The beaker of water remained in the ice bath until its temperature *reached 23°C.* *States a specific temperature to define "cool."*
Using a lower water cement ratio in the concrete mix will eliminate cracking.	Using a lower water cement ratio in the concrete mix will *help reduce* cracking. *Avoids an absolute statement that could set unrealistic expectations.*
The tests performed proved that the custom data structure does not have errors.	The tests performed using the custom data structure *did not encounter errors.* *Avoids overstating ("proving") the conclusion that can be drawn from the test.*
The team determined that Design A was the best.	Design A *completed the test successfully and used the lowest amount of energy.* *Explains the basis for the determination of what specifically made the design "the best."*

Application: Addressing error in lab documentation

In lab documentation, **systematic and random error** should be addressed. The report should address both the potential errors that could have occurred and the effect those errors would have on the results.

Systematic error is an error that cannot be lessened through continued trials. These errors often occur when tools are not sufficiently accurate or a model is used that does not fully explain the system being studied. Address inaccurate simplifying assumptions made in the experimental design or analysis. For example, many experiments assume that there are no frictional losses in a system. This may significantly impact the results of an experiment testing the performance of a motor. Results should acknowledge that additional losses due to friction were not considered.

Random errors are unpredictable factors that affect the data gathered from the experiment. The effects of random errors can be minimized through repeated trials. For example, if a beaker should be filled to exactly 20ml, it is approximately equally likely that the researcher would fill the beaker slightly above or below that level. After multiple trials, the

average level should be close to 20ml. If it is not, there are likely systematic errors also affecting the experiment.

Practice & Application: Exercise E – Making Data Meaningful

Direct

Technical communication should get to the point quickly—readers need to know right away what to expect and if the document will meet their needs.

A key aspect of directness in writing style is vocabulary. The most direct approach will use vocabulary that is right for the situation and doesn't use "fancy" or "flowery" words in an attempt to sound "smart" or impressive.

It is tempting to write unnecessarily complex sentences in an attempt to elevate the perception of your expertise, but this can obscure the message being communicated... *Wait, let's try that again...*

Writing unnecessarily complex sentences is tempting when you are trying to seem smart, but this can make your message less clear. *Better!*

In most professional communications, the goal is to sound knowledgeable, yet unpretentious and natural *for the situation and audience*. Use jargon only if it improves the quality of the communication. See Understanding Your Audience for a discussion of appropriate levels of technicality based on audience type.

Some examples of "flowery" language (and more direct replacements):

- ascertain (determine, learn)
- terminate (end)
- utilize (use)
- employ (use)
- endeavor (try)
- herein (here)
- procure (get)
- rendered inoperative (failed)

Here are some additional practical ways to ensure directness in technical and professional writing:

- Clearly state the purpose and scope of a document or communication at the start—get to the point quickly.
    - When possible, put the most important information near the beginning—stating a request in the first lines an email or making a recommendation in the opening of a report are both examples of being direct in the ideas/information.
    - Some types of documents, like memos, will require a specific purpose statement, but any communication should clearly tell the reader what they can expect to find, similar to the "In this Chapter" call-outs used in this guide.
- Use concise, meaningful subject lines for professional emails. Include specific keywords and indicate the purpose of the communication (words like "request," "scheduling," or "update" help the reader identify the purpose).

This is important for communicators in many contexts, and the

policy of Plain Language is a useful example of a real-world application of "directness" in communication.

Plain Language as an example of "Direct" communication

In 2010, the U.S. Congress passed the Plain Writing Act, which established that government documents issued to the public must be written clearly. Guidelines for plain language have been developed around the world to enhance the public's access to information. The U.S. guidelines state that users should be able to *find what they need, understand what they find, and use what they find to meet their needs.*

Plain language is a method of communicating information that focuses on the reader's experience. How can the information be presented in a way that is useful to the reader? Different types of communication will require different levels of background information, but the important information should always be easy to access.

Well Organized

The order in which information is presented affects how easily it will be understood. As a communicator, you will need to make sure that any document, email, or presentation you create has an intentional, logical, and consistent organization.

To be successful as a communicator, you must first understand the organization of the communication and then project that to your audience. Having a "big picture view" of the document's purpose and structure early in the writing process is key—it is difficult to impose good organization on a piece of writing unless you have carefully considered organization from the start.

Here are some practical ways to make a document clearly well organized:

- **Outline the document** during the "Represent & Plan" stage of the writing process. This is especially useful when writing as part of a team because it ensures that each team member has a shared understanding of how each section "fits" into the larger document.
- **Use an advance organizer** to "forecast" the content of a document and set your audience's expectations for the structure of the communication. For example:
    - "This report outlines the need for this program and then offers specific evidence to support the proposed plan."
    - "In the following sections, we provide an overview of the experimental methodology, present the findings, analyze the data, and offer our conclusions and recommendations."
- **Divide longer documents with headings and subheadings**

so your reader can navigate easily; give presentation slides meaningful titles, section headings, and slide titles. These types of cues will make your organizational patterns visible to your audience.

- **Use transition words and phrases** to help your reader understand connections as they move between sections, paragraphs, and sentences. Here are some useful "transition" words and phrases:
    - Addition or connection: *also, first/second/third, in addition to, moreover*
    - Result: *as a result, and so, therefore, because, as a consequence*
    - Comparison: *similarly, likewise, in the same way*
    - Contrast or alternative: *however, yet, still, otherwise, on the other hand, on the contrary, nevertheless, notwithstanding*
    - Example or explanation: *for instance, for example, specifically, in fact, in other words*
    - Summary or conclusion: *finally, in conclusion, in closing*
- **Use simple, direct topic sentences** to open paragraphs (BLUF) and then support them with more detailed information. See Paragraphs [link] for more information.

There are several models that technical communications often follow to present information.

Model	When to Use
Chronological	Highlights the progression of events that occurred or tasks that should be completed. Often used in: • Progress reports • Project plans
Spatial	Describes a physical structure using an organizing principle like east-to-west or top-to-bottom. Often used in: • User manuals • Product design descriptions
Priority	Presents information in order of importance or emphasis. Often used in: • Safety documentation • Proposal • Feasibility study
General to Specific	Familiarizes the reader with context or theory before introducing a complex idea. Often used in: • White paper • Proposal • Presentation
Problem → Method → Solution	Discusses the methods used to address an issue and their effectiveness. Often used in: • Lab reports and lab memos • Technical report • Experimental documentation

While your reader should be able to find specific information easily, they should also see a clear direction for your document as a whole. Consider your reader's experience empathetically. If you were reading this document, where would you expect

to find certain information? Will your reader gain a clear understanding of your process from reading the document from start to finish?

A Note About Lab Report Organization

A Lab Report contains sections for Results and Discussion. Students often present the data from a specific portion of the lab, then immediately discuss the meaning of that data within the Results section before moving on to the results of the next portion.

From a chronological perspective that seems logical, but that is not the structure of a lab report. Switching back and forth from results to interpretation is awkward and may leave your reader looking for data interpretation in the Discussion section that is not there.

See Lab Report Content Guide for more information.

Practice & Application: Exercise F – Precision and Paragraph Organization

Key Takeaways

- When you are revising or editing for writing style, ask...
    - Meaningful?
    - Verifiable?
    - Useful information for my reader?

Additional Resources

The Basics of Scientific Writing (University of Nebraska)

3.1 Voice and Tone

Voice and tone are the elements of writing style allow you to manage how your reader "hears" and understands what you are saying. Depending on the communication situation, you might want to create a sense of objectivity, authoritative distance, or make the information active and immediately accessible. You might want to present yourself as a formal, consummate professional or build a friendly rapport with your client.

Similar to evaluating the appropriate level of technicality for your audience, considering how your word and grammar choices affect your reader will give you better control over how well the information is understood.

Active vs. Passive Voice

It is important to know the difference between active and passive voice and when to use them. Both active and passive voice can be valid and correct, but, used inappropriately, they can lead to confusing and needlessly complex sentences.

In the **active voice**, the subject of the sentence is the actor—the main verb describes what the "doer" is doing. This is an efficient way to construct simple, direct sentences that communicate an action.

- She threw the ball.
- We wrote the lab report.

In the **passive voice**, the subject of the sentence is the thing

acted upon. It directs the reader's attention to the thing that experienced the action (the verb) of the sentence.

- The ball was thrown.
- The lab report was written.

NOTE: The passive voice typically uses some form of the verb "to be" (is, was, were, had been, etc.).

There are perfectly sound reasons to use both "voices" in writing. There are cases when the actor (the "who") is unknown, unimportant, or implied:

- The city was founded in 1806. (By whom? *A lot of people. That's not the point here—I'm focusing on the date.*)
- My laptop was stolen! (By whom? *I don't know, obviously!*)

There are also times when you might consciously choose to minimize the role of the actor:

- The deadline was missed. (*I'd rather not say who's to blame...*)
- Part of the track was broken. (...due to circumstances out of our control, but that isn't important to my reader.)

However, ineffective use of the passive voice can cause issues with concision and clarity in large part because it relies on "to be" instead of more precise action words—why say "The report was written by me" when you can say "I wrote the report"?

In scientific or technical writing, there is a common (but not universal) perception that personal pronouns can undermine the objectivity of the writer or distract from important information. This is one of the main reasons passive voice appears so frequently in scientific or technical writing—the focus is shifted away from the person doing the action.

Personal vs. Impersonal Voice

In technical communication, where the focus is on conveying data and important information, it is common for writers to avoid using personal pronouns (I, you, he, she, we, etc.). This is one reason writers opt for the passive voice—saying "The wire was cut" rather than "I cut the wire."

There is not a universal rule against personal pronouns in scientific writing. Different contexts and situations will require different approaches, so you must be aware and adaptable.

For FE and FEH, different assignments will require different tones:

- **3rd person** preferred in Lab Reports, Lab Memos, Technical Reports, Progress Reports
- **1st and 2nd person** preferred in Email, and potentially in writing for websites

To avoid first person, but still use active voice, use "the team," "team members," or "the group" rather than first person pronouns:

- Two team members analyzed the code. (Rather than "We analyzed...")
- The team calculated the speed of the vehicle. (Rather than "We calculated...")

Nominalization

The passive voice inherently requires more words than the active voice, but a concise, simple passive voice construction is still

possible. Technical or scientific writing is prone to wordy, sluggish phrasing—what Lanham (2007) calls "Official Style" [cite]—caused in large part by inappropriate **nominalizations**, which are a result of *misusing the passive voice*.

Nominalization is turning a verb into a noun—essentially describing an action as a thing. For example:

Past tense verb: analyzed → We **analyzed** the results.
Noun: analysis → An **analysis** of the results was made.

Verb: to describe → The witness **described** the suspect to the police.
Noun: description → A **description** of the suspect was given to the police.

While nominalization might be *grammatically* correct, it can distract from the "real" action of the sentence by replacing the main verb with a form of "to be." As with passive voice, writing with too many nominalizations creates sentences that are difficult to read and overly complex. This type of writing is more demanding for your reader and you will be more likely to lose their attention or understanding.

Active Voice	Passive Voice	AVOID: Passive Voice with Nominalization
The team verified the contents of the lab kit. (or "I verified..." in 1st person)	The contents of the lab kit were verified.	A verification of the lab kit contents was carried out.
The team member removed the insulation with a wire stripper. (or "I removed..." in 1st person)	The insulation was removed with a wire stripper.	Removal of the insulation was completed using a wire stripper.

Tone

Avoid emotional or qualitative language in technical documentation. Keep your reader's focus on the measurable, verifiable information and the objective aspects of your decision-making, not personal or emotional responses.

For example, these types of phrases would not aid a reader's ability to understand or verify the information and would be **too "emotional"** in tone:

- It worked beautifully.
- The result was terrible.
- We were thrilled.

Go here for more information about using precise language effectively.

Minimize overly casual language. Many of the things you say in casual conversation with your classmates do not belong in a Lab Report. You might *know* this, but it's surprisingly easy during the writing process for those phrases to creep in... show up... no, *appear*. See?!

Here are some examples of language that would be **too informal** in a Lab Report:

- figured out, got it
- came up with
- bouncing off [ideas], thinking outside the box
- checked out, test out
- ran into
- messed up, screwed up, threw off
- hard (in the sense of "difficult")

You might use this type of casual, conversational language

strategically in specific situations (it could show personality in an email or even some types of presentations, for instance), but it does not usually have a place in formal technical writing or documentation.

Key Takeaways

- Writing can be technically correct yet still ineffective for communicating your message if the writing style is not appropriate.
- Use the passive voice when appropriate or strategic, but don't allow it to affect the clarity and concision of your writing.
- Avoid unnecessary nominalizations—give preference to "real" verbs that describe the main action in a sentence rather than is/are/was/were.

Additional Resources

Passive Voice

Resources on subjects/verbs
Cohesion, Coherence, and Emphasis

3.2 Mechanics and Grammar

Writing correctly is vital to being an effective communicator. Errors like misspellings, subject-verb agreement, and incorrect punctuation are distracting to your reader, making it less likely that your communication will achieve its purpose. Your reader won't likely notice correct grammar (correctness is expected), but they *will* notice errors. Incorrect grammar reflects poorly on you as a communicator.

Your reader won't likely notice correct grammar... but they *will* notice errors. Incorrect grammar reflects poorly on you as a communicator.

As discussed in Engineering Your Writing Process, the review and revision process is essential to producing clear, correct writing. You need to give yourself time to "re-see" your own writing and be able to spot the errors.

To get better at this, try to predict your mistakes. When you receive feedback on your writing, you need to be able to not just correct the errors that were marked, but recognize patterns and weaknesses so you can learn and improve in the future. Become aware of the types of mistakes you tend to make and focus your effort on correcting those issues:

- **Observe and reflect.** Carefully review feedback you receive on your writing in FE/FEH and other classes or experiences. Do you see any patterns? Any repeated comments or corrections? What issues are most challenging for you to see in your own writing?

- **Learn and develop.** Work to understand the problem areas—read, look at examples, rewrite things you have written in the past. Visit the Writing Center and ask for coaching on the topic.

There are an incredible number of excellent resources online and on campus available to help you address grammatical and mechanical writing issues. As you start to learn how to write in college and in the engineering discipline, make it a priority to fill in any gaps in your skills.

The topics outlined here frequently affect students beginning to write in a technical communications style.

Tense

The "tense" we write in indicates to our reader when something happened—past, present, or future. These subtle differences carry important distinctions.

Past: I provided the report. (*I sent it to you last week.*)

Present: I am providing the report. (*It's attached to this email.*)

Future: I will provide the report. (*I am still working on it and will send it soon.*)

This might seem easy and it typically is intuitive for people fluent in a language, but in technical communications and the complex documents you will write (often as a team), it is important to be aware of tense and use it consistently and correctly in the right places.

Past tense is most common for the engineering technical communications you do in FE and FEH because you are reporting activities that already happened—describing a

procedure, lab, research process, or results of an experiment or test. Be consistent with tense as you describe what you and your team did and what your findings were.

Present tense is logical and acceptable for writing emails or communicating with a public audience on your website. In lab reports, present tense might be used to define problems in the Introduction or in making recommendations in the Conclusion ("The team recommends…").

Future tense is necessary when describing next steps and upcoming planned activities in progress reports, and might also be useful in emails when describing what you will do next.

Parallel Structure

Parallel structure or **parallelism** is about maintaining grammatical consistency in lists. In a list, you are essentially creating a set of things for comparison and those things should be of a similar type to make the comparison useful.

It is easiest to see in simple sentences:

Not parallel: I like to bike, play baseball, and skiing.

Parallel: I like to bike, play baseball, and ski.

Parallel: I like biking, playing baseball, and skiing.

When writing a formatted list, the same rule applies. A list requires a clear lead-in and then all listed items must be the same grammatical form.

This list maintains clear parallel structure:

For the camping trip, I am packing the following:

– *Tent*

– *Sleeping bag*

– *Bug spray*

– *Bottled water*
– *Camping stove*

But this list includes varying grammatical forms:

On the camping trip, I want to do the following activities:

– *Hiking*
– *S'mores* [Noun instead of a verb—should be "Making s'mores" to be parallel with the first item]
– *Go stargazing* [Different verb form that the first list item—should be "Stargazing"]

It is easier to make mistakes with parallel structure as sentences get more complex because you lose the connection to the "lead-in." Edit sentence and bullet point style lists carefully for parallel structure.

Example: Editing for parallel structure

Original:

This memo contains an overview of the lengths of pipes by themselves and with their fittings, a sketch of the finished roller coaster that met all lab requirements, analyzes how well built the roller coaster was, and explains the challenges that were experienced while executing this lab.

Visualized as a bulleted list to make the grammatical comparison easier to see:

This memo contains

– **an overview** of the lengths of pipes by themselves and with their fittings,
– **a sketch** of the finished roller coaster that met all lab requirements,
– **analyzes** how well built the roller coaster was, and
– **explains** the challenges that were experienced while executing this lab.

NOTE: The first two are nouns and make sense following the phrase "This memo contains…," but the next two are verbs, so they don't maintain parallel structure or logical grammar. You would never say "This memo contains analyzes…" and formatting as a list helps make that error clear.

Revised so all the listed items are nouns:
This memo contains **an overview** of the pipe lengths alone and with their fittings, **a sketch** of the finished roller coaster that met all lab requirements, **an analysis** of the quality of the roller coaster's construction, and **an explanation** of the challenges experienced while executing this lab.

Paragraphs

A **paragraph** is not just an arbitrary collection of sentences, but a meaningful set of information. Learning how to paragraph effectively will help you move from an outline to fully written document and develop better organized, coherent documents.

Paragraphs should be focused on one main idea. Ideally, all the sentences in a paragraph should work together to explain and build on the idea in the topic sentence (typically the first sentence).

Another way to think about the role of a topic sentence in a paragraph is that they put the **"bottom line up front" (or BLUF)**. Rather than giving your reader all the details before you tell them what the point is, the topic sentence states the main idea, then fills in the supporting information. Topic sentences need to be meaningful and specific—they should contain specific keywords and present an idea that *can* be developed further in the paragraph instead of vague, placeholder language. For instance,

- **Avoid:** The team reviewed the results.
- **Better:** The team reviewed the testing results to understand the design efficiencies.

- **Avoid:** It is necessary to change the process.
- **Better:** It will be financially beneficial to change the product testing process.

In general, paragraphs should be short and focused. There is no absolute "rule" about paragraph length, but 7-10 lines on the page is typically a reasonable range for most document formats. If you see a paragraph that stretches on much longer than that, it likely contains more than one main idea and could be broken up into two or more better focused paragraphs.

Paragraph Cohesion

Cohesion refers to the degree to which a reader can follow the

logical progression of ideas developed in a given piece of writing. We can talk about cohesion at the level of a paragraph, a document section, or an entire document.

But how is cohesion achieved? Cohesion occurs when the reader can easily resolve, from sentence to sentence or section to section, the relationship between

- the given information (what they already know)
- and the new information.

This becomes more difficult when the information is more technical in nature, so make use of the following strategies to increase cohesion:

Transitions: Transitions are words, phrases, and sometimes entire sentences that act as logical bridges between ideas developed in one sentence, paragraph, section, or document, and another. It's important to note that transitional devices are not interchangeable, but rather, they signal to your reader how you want them to interpret the relationship between what has come before, and what will come after. Therefore, when making a comparison between two things, it's appropriate to say "on the other hand..." but if you were summarizing or concluding a section, you would select a different transitional device, such as "consequently," or "as I have shown...". See more about useful transition words here. [Link to "Well Organized"]

Threading words: Threading words can clarify connections among topics and actions in sentences and paragraphs expressing complex ideas. Threading words include the following types:

- **Repetition of key terms** can be particularly useful when referring to a sequence of events that involve multiple, complex steps with technical names. Repeating the terms

helps the reader keep track of the development of the paragraph's subject and actions.

- **Synonyms** for the key term and **pronouns** (it/they) can also enhance cohesion, and are helpful when you want to avoid beginning each sentence with the same construction or style.
- **Demonstratives** (this, that, these, those) can also help clarify which topic/subject from the previous sentence or paragraph that you are referring to in the following new sentence/paragraph.

Notes	Sample Paragraph
Topic sentence states a main idea or "claim." The idea is meaningful and specific. Supporting sentences clearly relate back to the claim presented in the topic sentence, adding detail and explaining. Sentences connect and build on each other, moving from a general statement about the value of communication skills, through the benefits to their future academics, and then career tracks. This serves as a transition to guide the reader's focus from academics to their future career.	Technical communication skills are valuable for first year engineering students. Writing in an engineering or scientific context might be new for these students, but emphasizing communication skills at the start of a student's academic career will help them perform well in their degree program. Engineering students must develop effective written and verbal communication skills alongside their technical skills. Beyond academics, these skills will support students' future career development and advancement in or out of the engineering field, allowing them to not only have innovative ideas, but to share and promote them successfully.

Examples: Well-structured, coherent paragraphs

The context of a document is often needed to fully *assess the effectiveness of a paragraph, but these paragraphs generally show good attention to BLUF and adequate development.*

The experiment showed that increasing the size and quantity of propeller blades increased the power output of the turbine. The three-blade manufactured propeller produced 0.25 W, while the two-blade propeller produced 0.12 W. Design 2 produced 10% more power than the smaller Design 1 (see Table 3), suggesting that blades with a larger surface area may produce more power. 30 degrees was the more powerful pitch tested, producing 5% more power than the 45 degree pitch (Table 5).

—

The team will use concept scoring to evaluate whether the team should move forward with their design changes. Concept scoring allows qualitative factors to be compared systematically. The matrix will be used to score each design on criteria from the mission concept review. These criteria scores will be compared to determine whether the team's design changes are aligned with the client's priorities. To

increase accuracy of results, designs will be scored in a set of trials. This process will clarify the differences between designs.

The specific heat of the unknown metal was determined to be 0.242 cal/g°C. Using the values obtained for the energy released by the metal and the change in temperature of the metal, equation 3 was used to calculate an experimental specific heat.

$$C = \frac{Q}{m\Delta T}$$

Specific heat (cal/g°C) = energy lost (cal)/ mass(g) * change in temperature (°C) (3)

The experimental values are shown in Table 4 (see Appendix C for sample calculations).

Table 4. Experimentally determined specific heat values

Trial	Specific Heat (cal/g°C)
1	0.241
2	0.244
3	0.242

The average of the experimental values was 0.242 cal/g°C with a standard deviation of 0.00153.

The data suggests that vehicles on Woody Hayes Drive consistently travel 4-5 mph faster than the posted speed limit. The speeds of all cars observed can be found in Table A3. The data set indicated with strong central tendency and low dispersion that the typical vehicle speed on this section of Woody Hayes Drive was between 29 and 30 mph. This value was reasonable, given the posted speed limit of 25 mph.

Practice & Application: Exercise G – Logic, Cohesion, and the Bottom Line

Key Takeaways

- Readers care about grammar and correct writing, even though grammar is not the only requirement for effective writing. Incorrect or messy grammar and mechanics will undermine your authority.
- Pay attention to patterns of grammar or mechanical issues in your writing and work to

improve them—seek feedback and resources that will help you.

- Use tense consistently and correctly—past tense is most common in lab-related writing for FE and FEH.
- Be consistent when writing lists—all items in a list should have the same grammatical form (parallel structure).
- Give paragraphs a clear main idea or "claim" that is clearly stated in a topic sentence and developed in the supporting sentences.

Additional Resources

Center for the Study and Teaching of Writing – Writing Mechanics handouts
Parallelism (parallel structure)

3.3 Citations and Citation Styles

As in all academic writing, you will be asked to document your sources in engineering technical communications. When you reference information or ideas from a book, article, website, handout, presentation, etc. in your own writing, you must tell your reader where it came from—failure to do so is plagiarism and academic misconduct. Citing sources also connects your reader to a broader range of sources and information, and it ultimately builds your credibility as a communicator.

Citation styles are a set of conventions or rules for giving credit to source material. Different disciplines use different styles. For instance, you are likely familiar with the Modern Language Association (MLA) style from English or writing classes, since this style is most commonly used in the arts and humanities.

At this university, Institute of Electrical and Electronics Engineers (IEEE) and American Psychological Association (APA) styles are most commonly used. Familiarize yourself with the basic guidelines of those styles—an overview is provided below. You can find a longer list of citations styles and information from the Ohio State Libraries here.

Check the assignment sheet or ask your professor/TA about their requirements for citations because they may vary, but always assume that you need to cite your sources.

Recognize that various citation styles exist—you can research and use them when needed. Even if you make a mistake in the

punctuation or formatting, you *absolutely must make an effort to credit source material*. Check the assignment sheet or ask your professor/TA about their requirements for citations because they may vary, but always assume that you need to cite your sources.

Citing Sources — the Basics

Citation styles typically define the rules for two main components:

1. **In-text citations.** Indicate basic, limited information about the source in the flow of the text, wherever the information or idea is directly referenced in your writing. Also referred to as "textual citations."
2. **List of sources.** A separate listing of all sources used with detailed and complete publication or location information. Depending on style, this list has different names and will follow various organizational patterns. Anything referenced in an in-text citation must have a corresponding entry on the source list.

IEEE

The **Institute of Electrical and Electronics Engineers (IEEE)** developed a citation style that is used widely within computer science and engineering and is similar to many of the styles used by other specific engineering disciplines.

In-text citations

Numbers in square brackets are used to identify the source in the sentence—use space before the bracket and place before any punctuation.

It is not *necessary* to reference the author's name, although the author may be referenced in the sentence—this is your choice as a writer.

Multiple sources are presented with each number in brackets and separated by commas.

Sources are numbered in order that they are presented in the text (i.e. the first source is [1], the second is [2]); once a source is numbered, use the same number if it is referenced elsewhere in the document.

Examples:

The provided material had a thickness of .347 mm [5].

For complete findings, see [4].

...consistent with findings of recent studies [2], [3].

Jones [6] identified the contradiction.

List of sources

A list titled "References" is placed after the main text of the document.

Sources are presented in numerical order; bracketed numbers are flush left with a hanging indent.

Article titles are in quotation marks; book/journal titles are in italics.

Author names are given as first initial(s) and last name (e.g., J. Smith, M. J. Jones).

Basic format—include relevant or available information:

J. Doe and B. Deer, "Article or chapter title in quotes," *Book / Journal Title in italics*, vol. #, no. #, Month Year of publication. [Format]. Available: retrieval URL or database name. [Accessed Mon. Day, Year].

Examples:

Course materials

[1] Ohio State Fundamentals of Engineering Program, "Stress and strain." [Course documentation]. Available: carmen.osu.edu for ENGR 1182. [Accessed Mar. 8, 2018].

Journal article retrieved from the internet

[2] A. Huang, "Understanding interpersonal dynamics in peer review assignments," *Current Issues in Technical Communication*, vol. 63, no. 5, July 2010. [Online]. Available: http://cietc.edu/volume63/number5/. [Accessed Dec. 7, 2017].

Book (print) with multiple authors

[3] P. Rogers and C. Lauper, *Musical Vision*. New York City, NY: Purple Press, 2016.

APA

American Psychological Association (APA) style was developed for use in the social and behavioral sciences, but is often used in other scientific fields, including engineering and engineering education.

In-text citations

Sources are indicated in line with author's name (last name only) and date of publication.

- If the author's name is in the sentence, the date is alone in parentheses after the referenced information: "Smith (2017) found that the material measured…"
- If the author is not named in the sentence, name and publication date are placed together in parentheses, separated by a comma "… findings supported by the data (Smith, 2017)."
- If there is no person or persons named as author, the name of an organization may be used instead.

Publication date is presented only as year. If there is no known publication date (common in online sources), the date is replaced with "n.d." NOT the retrieval date (that is provided only in the References list).

Examples:

Jones (2014) identified the contradiction.

The provided material had a thickness of .347 mm (Ohio State Fundamentals of Engineering Program, n.d.).

A report from the U.S. Environmental Protection Agency (2013) shows an increase in mercury levels. The results were consistent with findings of similar recent studies (Doe & Beer, 2009).

List of sources	A list titled "References" is placed after the main text of the document. Sources are presented in alphabetical order based on the start of the entry (typically the author or source name—whichever was used to identify the source in the in-text citation); use hanging indent. Article titles are in plain text (without quotation marks); book/journal titles are in italics. Author names are given as last name followed by first initial(s) (e.g., Smith, J., or Jones, M.J.). Basic format: Doe, J., & Deer, B. (2007). Title of article. *Title of Journal in italics*, volume #(#). Retrieved from http://www.someaddress.com/full/url/ Examples: *Course materials* Ohio State Fundamentals of Engineering Program. (n.d.) Stress and strain [Course documentation]. Retrieved March 8, 2018 from carmen.osu.edu *Journal articles retrieved from the internet* Huang, A. (2010, July). Understanding interpersonal dynamics in peer review assignments. *Current Issues in Technical Communication*, 63(5), Retrieved from http://[fullURL] Jones, M.J. (2014). Contradictions in technical documentation. *Journal of Made Up Things*, 4(2). Retrieved from http://[fullURL] *Book (print) with multiple authors* Rogers, P., & Lauper, C. (2016). *Musical Vision*. New York City, NY: Purple Press.

Key Takeaways

- Cite all sources that are not your original work.
- Use the recommended style for citations, if

provided. If not, choose a style you are comfortable with.

Additional Resources

APA formatting guide from OWL

Chapter 4. Using Graphics and Visuals Effectively

In this Chapter

- Reviewing types of visuals commonly used in technical documents
- Establishing a standard format for tables, figures, and equations that appear in a document

Most technical communications require more than text to concisely and accurately communicate concepts or techniques. In first-year engineering you will likely use tables, graphs, sketches, equations, and photographs to present data as clearly as possible. The text should tell the story and figures, tables, and equations can be used to support or organize the text. Most assignments in these courses will only require simple data visualization such as graphing a set of points, but it is important to establish good habits when creating graphics.

Graphics can make large amounts of data accessible to your

reader. However, graphics have to be created properly in order to aid understanding. Crowded or busy graphics can leave readers more confused than they were before. Graphs drawn incorrectly can cause readers to draw inaccurate conclusions. Data can be used to mislead readers when not represented responsibly.

Visuals should be chosen based on their ability to communicate the intended message. Lab directions will often suggest what type of visualization to create, but you should know which to select if it is not dictated.

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://ohiostate.pressbooks.pub/feptechcomm/?p=51

Visual Type	When to Use
Table	A table is useful when many specific values need to be accessible (e.g., comparing trial runs, displaying measured speeds or mass).
Scatter plot	Scatter plots are ideal when plotting many points where both the independent and dependent variables are numerical. Once the data is plotted, trend lines might be identified and drawn in Excel or other data software to suggest an approximate relationship between the two variables.
Bar graph	Bar graphs are typically useful in cases when the independent variable is a category (or rank) and the dependent variable is numerical (e.g., showing number units sold in the last 4 quarters, enrollment numbers for classes).
Line graph	Line graphs are often used in situations where there is a mathematical relationship between X and Y, such as graphing equations. In other contexts, they might be used to visualize trends (past and/or predictive) and other dependent relationships.
Pie chart	Pie charts can be useful when you are trying to group items or populations by percent, into five or fewer categories (e.g., categorize a city's age demographics). Percent values should be labeled.
Equation	Formulas are needed whenever a calculation is part of the analysis, unless it is a calculation where there is a universal understanding of the associated equation, such as the average of a set of numbers.
Sample calculation	Sample calculations are used to provide the reader with step by-step examples of values obtained from data analysis.

Practice & Application: Exercise H – Telling a Story with Numbers

Formatting Tables, Figures, and Equations

Each table, figure, and equation should be introduced in the text before it appears. An introduction consists of the visual number and description of the contents. If the visual is on a different page or in the appendix, the page number should be included as well. For example,

- "Table 1 on the next page illustrates how the output voltage and magnitude gain decrease as the frequency increases" or
- "Figure 2 (page 3) highlights the stress vs. strain trends."

The description should fit in with the remainder of the text. If a table or figure is mentioned more than once within the text, it should be located after the first place it is mentioned.

Within the body of the document, only equation formulas should be given. Definitions and units for each variable should be provided. Sample calculations should be given in the appendix and referenced within the document.

Visuals located in appendices should mention the visual's number and which appendix it is located in. Figures and tables commonly combine the appendix letter and figure number into Figure A2 or Table C1.

Tables

Tables arrange information in a row and column format. Each table should have a label above the table that contains a number and a title. Labels should be centered and follow the

format “Table 1. A brief descriptive title in sentence case.” Tables do not need to follow specific color or formatting standards, but they should be easy to read and uniform throughout the document.

Table 1.
Blank table to demonstrate correct formatting and labeling.

Note. Reprinted [or Adapted] from Title of Work, by Author. Retrieved from URL. Date of Copyright by Copyright Holder.

Figures

For the purpose of lab documentation, anything that is not text, equation, or a table is a figure. Graphs, sketches, and photos are all figures. Figure labeling and referencing is almost identical to that of tables, except that figures are labeled below the figure. Labels should be centered and follow the format “Figure 1. A brief descriptive title in sentence case.”

Figure 1. Gray box placeholder to demonstrate how to caption a figure. Reprinted [or Adapted] from Title of Work, by Author. Retrieved from URL. Date of Copyright by Copyright Holder.

Graphs should always follow proper formatting practices and include axis labels with units, titles, and legends where appropriate. They do not need to follow a specific color scheme or style, but they should be easy to read in both color and grayscale and uniform throughout the document. Titles should provide context and meaning for your reader.

Practice & Application: Exercise 1 – Using and Explaining Graphics

The slides below provide an overview of best practices for formatting and using figures correctly.

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://ohiostate.pressbooks.pub/feptechcomm/?p=51

Equations and Sample Calculations

Use the Word Equation Editor for all equations, found under the Insert tab.

- Use built in structures like fractions, integrals, and radicals, to create equations.
- Use the Symbols tool to add common symbols.
- All equations should be numbered. In this class, numbering should continue in the appendix. Styles can vary based on context and discipline, so ask if you are unsure of what numbering convention to use.

Equations should be centered, with a single space before and after a set of equations. If equations are grouped, the spacing can be 1.5. If the equation has a specific name, it can be listed on the left. The units should be displayed as in Equation 1 below. If the unit symbols are explained, it could be shown as in Equation 2.

For example, if Ohm's Law was used in the documentation, the equation could be displayed

Ohm's Law	$V = IR$	(Volts) = (Amps) * (Ohms)	(1)
Ohm's Law	$V = IR$	(V) = (A) * (Ω)	(2)

Within the appendix, sample calculations should be given for any calculations made during the lab exercise and subsequent data analysis. Data can be presented in a table, in this case Table 1, with equations following (Equations 3-5). An example is below:

Current (Amps, A)	Resistance (Ohms, Ω)	Voltage (Volts, V)
0.1	100	10
0.2	150	30

$$V = IR \tag{3}$$

$$V = 0.2A \times 150\Omega \tag{4}$$

$$V = 30V \tag{5}$$

Choosing the right visuals helps you present results effectively and makes information available to your audience in multiple ways—you're reinforcing your conclusions with clear visual data, making your stance more believable.

Practice & Application: Exercise J – Interpreting Graphs in Context

Application: Sample from Technical Document Showing Use of Visuals

... [Excerpt] ...

At each concentration, the Arduino displayed a binary value through the LEDs, which was read by the team members and converted into a decimal value using

Equation 1 below. A sample calculation can be found in Appendix A.

$$N_d = d_7 \cdot 2^7 + d_6 \cdot 2^6 + d_5 \cdot 2^5 + d_4 \cdot 2^4 + d_3 \cdot 2^3 + d_2 \cdot 2^2 + d_1 \cdot 2^1 + d_0 \cdot 2^0 \quad (1)$$

Where N_d is the decimal number that corresponds to the binary number $N_b = d_7 d_6 d_5 d_4 d_3 d_2 d_1 d_0$

The values from the first trial are shown in Table 1. As the concentration increased, the value displayed by the Arduino increased.

Table 1. *Binary and decimal readings from varying concentrations of fluorescein*

Concentration	Binary Value	Decimal Value
0	110	6
5	101101	45
10	1100011	99
15	1111001	121
20	10110000	176
25	11001001	201
30	100001001	265
35	100101010	298
40	110100101	421
45	111110101	501

The values from both trials were plotted in Figure 1.

The data follows a roughly linear, positively correlated relationship.

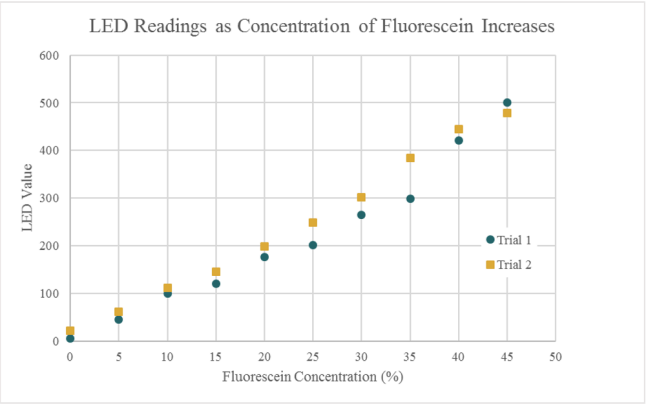


Figure 1. *Decimal LED readings from two trials with fluorescein concentrations from 0-45%*

More trials will allow the team to create a trend line that will serve as a calibration curve to determine the concentration of fluorescein in an unknown sample.

Key Takeaways

- Choose the visual that will most effectively convey the information to the reader.
- Introduce and explain each visual as it appears in the text. Visuals without descriptions are rarely helpful for an unfamiliar audience.
- Use good practices to make graphs clear and easy to read.
- Maintain consistent style and formatting throughout your visuals to avoid distracting from the message.

Additional Resources

UNC Writing Center: Figures and Charts
David McMurrey's "Tables, Charts, Graphs: Show Me the Data"

Chapter 5. Writing Common Technical Documents

In this Chapter

- Discussion of the purpose and audience for common types of technical documentation
- Suggestions for how to approach writing different types of documents in academic and professional settings
- Document guides that model the correct organization and content for the following documents:

This chapter will provide an overview of the types of **technical documentation** you will write in First Year Engineering and in your academic career.

The term "technical documents" often refers to writing that describe products (people often think about technical documentation as being limited to user manuals), but the focus here will be primarily on lab and project documentation. In lab- and project- related writing, the communicator must describe processes and results—the actions taken and the outcomes observed. The communicator will typically offer an interpretation of the results or recommendations for next steps, but those interpretations and recommendations must be clearly supported by the findings and data.

In this context, it is vital for the engineer to communicate information accurately, precisely, and to the required level of specificity and technicality for your audience. Even in technical documentation, you will find varying levels of detail and technical needed for different readers, so always consider your audience—what they need to know and what they will need to do with the information (e.g. replicate the experiment or make a business decision).

Purpose, Audience & Outline of Technical Documents

This chart provides an overview of the documents the serve a function in the lab and project activities you will be doing in First Year Engineering—lab report, lab memo, executive summary, abstract, and progress report. The guidelines here and in the sections that follow are intended to help you better understand the role(s) of these documents and provide practical guides to

assist you as you write in this new way. With that in mind, consider the following:

- There is no single, authoritative standard for these documents. Different subfields, industries, companies, and even individuals have different expectations, but you will find that even with variations in section titles or writing style, they share similar conceptual patterns. Following the guidelines offered in this chapter will familiarize you with those patterns, but you should know that you will encounter variations and will need to be willing and able to adapt.
- You may not be asked to produce every one of the documents on this list in your first year or even during your academic career—that is okay. Understanding how these documents are similar and different will improve your understanding of technical documentation as a whole and may be useful to you in the future.

Lab Report:

Purpose

Delivers complete, formal documentation of the experiment or process. Most detailed version of lab documentation.

Audience able to recreate the lab (and results) based on the information.

Audience

No assumed familiarity or background with the specific experiment.

Assume subject matter peer level unless otherwise instructed.

Content Outline

- Title Page
- Executive Summary
- Table of Contents
- Introduction
- Experimental Methodology
- Results (or Results & Description)
- Discussion
- Conclusion & Recommendations (or Summary & Conclusion)
- Appendix

Length: As long as needed, unless otherwise instructed.

Lab Memo:

Purpose	Audience	Content Outline
Delivers significant results and conclusions from the lab, but excludes detailed information about the experiment and methodology. More concise than the Lab Report as a result. Audience able to understand the key findings in a concise document focused on relevant results and conclusions.	Generally familiar with the experiment background and context. Most useful in "internal" reporting situations, where the audience understands the need for the lab/ experiment and wants to focus on results. Assume subject matter peer level unless otherwise instructed.	• Header • Introduction • Results & Discussion • Conclusion & Recommendations • Appendix Length: As long as needed, unless otherwise instructed.

Executive Summary:

Purpose	Audience	Content Outline
In one page, provides basic context, description of results, and conclusions. Efficiently delivers information to aid decision-making—focused results and recommendations rather than detailed methodologies or extensive data.	Project stakeholders—often thought of as the business audience (the "executive"), but might also be peers or other technical experts looking for a concise summary. Assumed familiar with the experiment background and context. Level of detail limited; level of technicality will be based on the audience's background, needs, and goals.	• Header • Introduction (Background & Purpose) • Results & Analysis • Conclusion & Recommendations • Appendix (if stand-alone document) Length: 1 page maximum

Abstract:

Purpose	Audience	Content Outline
Concise summary of a full report; high level description of object, methods, and findings; helps the reader determine if they want or need to read the full report	Subject matter peer level, but no assumed familiarity or background with the specific experiment. Scientific/technical expertise (cares about methods).	• Introduction • Experimental Methodology • Results • Discussion • Conclusion & Recommendations Length: 1 page maximum

Progress Report:

Purpose

Summarizes work completed and plans future work; may outline preliminary conclusions, but avoids drawing final conclusions because the project is still in progress.

Demonstrates competence and the ability to plan for and achieve project goals.

NOTE: Careful project documentation throughout makes it easier to produce terminal documentation.

Audience

Vested interest in the project or operation, but may approach from various perspectives (e.g. client vs. supervisor or business vs. technical).

Audience's subject matter knowledge should affect the level of technicality and detail included in the report.

Content Outline

- Report of progress (backward-looking)
  - Situation
  - Results & Analysis
  - Takeaways
- Future work (forward-looking)
  - Situation
  - Upcoming goals
  - Upcoming schedule
- Appendices

Length: Brevity valued; try to keep to 1 single-spaced page with additional information in appendices for First Year Engineering courses. May be longer in other contexts.

Key Takeaways

- Use these document guides to inform the content and style of your documents.
- Refer to assignment details or professional standards for specific requirements when developing a technical document.
- Keep audience and purpose in mind to create a useful and cohesive document.

5.1 Lab Report and Lab Memo

Within a **Lab Report**, data presentation, analysis, and explanation should be thorough and should make no assumptions about the reader's knowledge of the laboratory background or experiment. A **Lab Memo** assumes that the reader is familiar with the background and procedure of a specific lab, but includes what results were obtained, answers discussion questions, and provides general conclusions and recommendations.

Different instructors or even employers may ask for different content based on the situation and their specific needs or interests, but the organization and information outlined here will provide a solid foundation to build on and adapt in the future.

As always, defer to the specific assignment requirements and documentation for your class and instructor. Outlined in this chapter are the general guidelines, but there may be some variation in practice. For example, in some cases an instructor might ask that each team member write a Conclusion or Summary, but at other times a single Conclusion or Summary will be written by the group.

Lab Reports and Lab Memos should be written in paragraph form, using headings for main sections like Introduction, Experimental Methodology, etc. There is no length stipulation; however, a lab memo will be shorter than a lab report.

Lab Report

Wind Turbine Lab Report

Submitted to:
Inst. Name
GTA Name

Created by:
Team Letter

Team Member 1
Team Member 2
Team Member 3
Team Member 4

Engineering 1181
The Ohio State University
Columbus, OH
Date Month Year

Executive Summary

An executive summary is often provided at the beginning of a report to provide a summary to

readers who may or may not wish to read the full report. An executive summary might also be a standalone document, described here. The executive summary should be one page in length with no subheadings. When included with a Lab Report, the summary should not include or reference tables and figures within the report. It is acceptable to repeat information from the rest of the lab report, however the summary should not include any new information or conclusions that are not already stated elsewhere. For this reason, it is advisable to write the executive summary last.

See Executive Summary for a complete content and writing guide.

Table of Contents

Formal documents often contain a Table of Contents to help users find specific information or sections. Each major section should be listed in the ToC with the page number.

Introduction

The introduction should be a paragraph that contains the goals of the lab and an overview of what the reader can expect to find within the report.

- State the objective of the lab exercise. Though this is provided in the lab documents, the purpose should be restated in your own words.
- Provide a brief overview or "roadmap" of the report contents.

Experimental Methodology

This section should detail the procedure and equipment used in the lab.

- Describe the steps used in the experiment in paragraph form. The goal is for the reader to understand and be able to replicate the experiment.
- Explain how and where equipment is used in the experiment. It is not necessary to explain in detail how common equipment, such as a voltmeter or strain gage, functions, but the report should include what equipment would be needed in order to replicate the experiment. Images should be added to support the text when appropriate.

Results

The Results section should describe all observations and data that are relevant to the purpose of the lab.

- Provide objective observations from the lab. What was noticed throughout the course of the

experiment? Example: *As the AEV traveled along the track, it was noticed that the speed decreased on the sloped portion of the track. On trials 2 and 3, the AEV stopped forward motion near the top of the slope and began to roll backward.*

- Present the raw data from each major part of the experiment, followed by how this data was analyzed to reach the final results.
    - Provide results in the order of the experimental methodology.
    - Include any data that will be discussed later in the report. This is the only section in which results should be introduced.
    - Use a combination of text, figures, tables, and equations to present the data as clearly as possible. There should be enough descriptive text to guide the reader through the results and explain any assumptions or analysis performed in order to reach the results.
    - NOTE: Raw data can become overwhelming quickly and make it difficult to read the results. Some data, particularly large tables of values, can be placed in an appendix and referenced as needed to increase the readability of your report. If you are not discussing the

contents of a table or figure, it may belong in an appendix.

Note on using figures, tables, and equations

Figures are used to better describe something that is difficult to convey in text or in a table. Graphs are used to present data visually. Diagrams or images can be used to show results that would be difficult to describe in words. See Using Graphics & Visuals Effectively for more information.

Tables are typically used to display various data values that are not appropriate for a figure or for which a numerical value is important. A good indication that a table may be necessary is if a paragraph contains many data values.

Equations are needed whenever a calculation is part of the analysis unless it is a calculation where there is a universal

understanding of the associated equation, such as the average of a set of numbers.

Discussion

The Discussion should analyze the data presented in Results, compare it to expected values based on existing theory, and address potential error.

- Discuss what trends, or lack thereof, are present in the results that are relevant to the lab objectives. This section should answer the question, "What do the results clearly show?"
    - This section requires the most comprehension of the theory behind the experiment in order to give context to the results. Example: *The stress was greater when the knee was subjected to dynamic loads than when it was subjected to static loads.*
    - If needed, reference figures from the Results section by name; figures are not typically *introduced* in the Discussion.

- Address whether the trends you observed were expected based on theory.
    - This section should discuss whether the results "make sense." You would expect that running a motor at a higher speed would use more energy than at a lower speed. Is that what you saw in your results?
    - The results should be compared to theory quantitatively. Do relevant equations and the existing knowledge in this area support the results of the experiment?
- Disclose the limitations and delimitations of the experiment or sources of error. Why would your data not exactly match the theory? Potential errors should be mentioned whether or not it is believed that they affected the data.
    - Both systematic and random error should be discussed. What errors could have occurred and how would they affect the data? See "Addressing errors in lab documentation" in (Chapter 3).
    - If it is obvious that an error did affect the data, this should be acknowledged and the estimated effects reported.
    - The suggested modifications to the

experiment that would reduce or eliminate these errors should not be presented in the discussion.

Conclusions & Recommendations

This section should summarize the findings of the experiment and offer recommendations for the scenario, including methods for decreasing the effect of error.

- Summarize the experiment and results, and highlight key points from the discussion. This 1-2 paragraph section should contain no new data that is not already part of the other sections in the report, but should pull together ideas from the entire document.
- State your conclusions. Provide quantified, high level support from data where applicable. How do these ideas compare to the lab objectives and results? How do your conclusions relate to the objective of the lab? Example: *The synthetic material's tensile strength was higher than that of the natural material, requiring 5% more stress to cause failure.*
- Discuss potential solutions for all errors mentioned in the Discussion. Example: *Timing*

error could be minimized by using multiple timers for each run or adding an automatic sensor-based timer that does not rely on human reaction time.

- Provide recommendations for the scenario posed at the beginning of the lab procedure based on your conclusions.

References

A list of references cited in the report.

- Reference any sources used in creating or following the lab procedure. Ex. lab documents or guides for data interpretation.
- Include any resources used to write the background or discussion. These might be more theoretical sources like textbooks or journal articles.

See Citations and Citation Styles for more information.

Appendices

Create a new appendix for each category of content.

- Title each appendix using the format Appendix A: Descriptive Title. For example, a report might contain the appendices:
    - Appendix A: Circuit Diagrams
    - Appendix B: Experimental Data
    - Appendix C: Equations and Sample Calculations
- Arrange appendices in the order in which they are referenced within your report—each appendix should start on a new page. Every appendix must be referenced within the document.
- Start figure and table labels at 1 in each appendix. Each numeric label will be preceded by the appendix letter and a period with no spaces (e.g., A.1, or B.3) . Labels should be formatted as described in Using Graphics and Visuals Effectively.
- Organize and format each appendix neatly. Appendices should not be storage for messy or extraneous information.

- Do not repeat figures and tables between appendix and main text. Each item should appear only once in the report.

Lab Memo

Memo

Date:
To: Inst. Name & GTA Name
From: Group Letter – Team Member 1, Team Member 2, ...
Subject: Title of Lab

Introduction

The introduction should be a paragraph that

contains the goals of the lab and an overview of what the reader can expect to find within the report.

- State the objective of the lab exercise. Though this is provided in the lab documents, the purpose should be restated in your own words. Example: *In this lab, four types of beams were tested to determine which has the greatest strength-to-weight ratio (grams-pounds).*
- Provide a brief overview or "roadmap" of the report contents.

Results and Discussion

In a Lab Memo, the "results" and "discussion" are combined under a single heading, but it is helpful to distinguish between them during the writing process. Follow the guidelines for each section below as you draft the memo, but know that they will be combined under the single "Results and Discussion" heading in the final document.

[Results]

The Results section should be a concise report of all significant results—describe observations and data that were critical to the experiment's purpose and outcomes. Ask, *what information does my reader need so they can understand the final conclusions of the memo?*

- Provide objective observations from the lab. What was noticed throughout the course of the experiment? Example: *As the AEV traveled along the track, it was noticed that the speed decreased on the sloped portion of the track. On trials 2 and 3, the AEV stopped forward motion near the top of the slope and began to roll backward.*
    - This is the only section, besides the appendix, in which results should be introduced.
    - In general, a combination of text, figures, tables, and equations is most effective to present the data as clearly as possible. Not all are necessary in a lab memo, but consider carefully what is required to convey your results most clearly.
    - Equations should be used to show how key parameters were derived from the data.
    - There should be enough descriptive text to guide the reader through the results and explain any assumptions or analysis performed in order to reach the results.
    - NOTE: Raw data can become overwhelming quickly and make it difficult to read the results. Some data,

particularly large tables of values, can be placed in an appendix and referenced as needed to increase the readability of your report. If you are *not* discussing the contents of a table or figure, it may belong in an appendix.

Note on using figures, tables, and equations

Figures are used to better describe something that is difficult to convey in text or in a table. Graphs are used to present data visually. Diagrams or images can be used to show results that would be difficult to describe in words. See Using Graphics & Visuals Effectively for more information.

Tables are typically used to display various data values that are not appropriate for a figure or for which a numerical value is important. A good indication that a table may be necessary is if a paragraph contains many data values.

Equations are needed whenever a calculation is part of the analysis unless it is a calculation where there is a universal understanding of the associated equation, such as the average of a set of numbers.

[Discussion]

The Discussion should analyze the data presented in Results, compare it to expected values based on existing theory, and address potential error.

- Discuss what trends, or lack thereof, are present in the results that are relevant to the lab objectives. This section should answer the question, "What do the results clearly show?"
    - This section requires the most comprehension of the theory behind the experiment in order to give context to the results. Example: *The stress was greater when the knee was subjected to dynamic loads than when it was subjected to static loads.*
    - If needed, reference figures from the Results section by name; figures are not typically *introduced* in the Discussion.

- Address whether the trends you observed were expected based on theory.
    - This section should discuss whether the results "make sense." You would expect that running a motor at a higher speed would use more energy than at a lower speed. Is that what you saw in your results?
    - The results should be compared to theory quantitatively. Do relevant equations and the existing knowledge in this area support the results of the experiment?
- Disclose the limitations and delimitations of the experiment or sources of error. Why would your data not exactly match the theory? Potential errors should be mentioned whether or not it is believed that they affected the data.
    - Both systematic and random error should be discussed. What errors could have occurred and how would they affect the data? See "Addressing errors in lab documentation" in (Chapter 3).
    - If it is obvious that an error did affect the data, this should be acknowledged and the estimated effects reported.
    - The suggested modifications to the

experiment that would reduce or eliminate these errors should not be presented in the discussion.

Conclusions & Recommendations

This section should summarize the findings of the experiment and offer recommendations for the scenario, including methods for decreasing the effect of error.

- Summarize the experiment and results, and highlight key points from the discussion. This 1-2 paragraph section should contain no new data that is not already part of the other sections in the report, but should pull together ideas from the entire document.
- State your conclusions. Provide quantified, high level support from data where applicable. How do these ideas compare to the lab objectives and results? How do your conclusions relate to the objective of the lab? Example: *The synthetic material's tensile strength was higher than that of the natural material, requiring 5% more stress to cause failure.*
- Discuss potential solutions for all errors mentioned in the Discussion. Example: *Timing*

error could be minimized by using multiple timers for each run or adding an automatic sensor-based timer that does not rely on human reaction time.

- Provide recommendations for the scenario posed at the beginning of the lab procedure based on your conclusions.

References

A list of references cited in the memo.

- Reference any sources used in creating or following the lab procedure. Ex. lab documents or guides for data interpretation.
- Include any resources used to write the background or discussion. These might be more theoretical sources like textbooks or journal articles.

See Citations and Citation Styles for more information.

Appendices

Create a new appendix for each category of content.

- Title each appendix using the format Appendix A: Descriptive Title. For example, a report might contain the appendices:
    - Appendix A: Experimental Data
    - Appendix B: Equations and Sample Calculations
- Arrange appendices in the order in which they are referenced within your memo—each appendix should start on a new page. Every appendix must be referenced within the document.
- Start figure and table labels at 1 in each appendix. Each numeric label will be preceded by the appendix letter and a period with no spaces (e.g., A.1, or B.3) . Labels should be formatted as described in Using Graphics and Visuals Effectively.
- Organize and format each appendix neatly. Appendices should not be storage for messy or extraneous information.
- Do not repeat figures and tables between

appendix and main text. Each item should appear only once in the report.

Testing Log

Testing Log

When a testing log is required as part of a project, each team must track the exact amount of testing time and other relevant details about the test. Testing logs should be promptly updated and maintained in chronological order. Testing logs do not require specific formatting, but maintain a consistent format that includes all required elements.

Testing logs should include the following:

- When the test was run and how long (day/time, duration)
- Who ran the test (who conducted the test,

who observed)

- Where the test was performed (location)
- What specifically was being tested (methodology)
- Why the test was performed (purpose)
- What resulted

Additional Resources

Writing Guidelines for Engineering and Science: Laboratory Reports
USC Research Guides: Appendices

5.2 Executive Summary and Abstract

An **Executive Summary** is a short document that details the results of a laboratory experiment. It may appear as a stand-alone document or included within a longer report. The reader should be able to quickly read it and obtain important results and conclusions from an experiment.

Individual sections of an Executive Summary are not divided by subheadings. As a stand-alone document, the length of text should not exceed one page with an additional 1-2 pages for figures or tables.

When included as part of a Lab Report, the summary should *not* include or reference tables and figures.

It is acceptable to repeat information from the rest of the lab report; however, the summary should not include any new information or conclusions that are not already stated elsewhere. For this reason, it is advisable to write the executive summary *last*, after all other sections of the document are drafted.

Many technical reports include a short **abstract** at the beginning of the report. **Abstracts** are typically written to enable the reader to determine if they want to read the report in its entirety. They are extremely concise version of the full report. They do not present any information that is not included in the full report.

An abstract is written in *introduction–body–conclusion paragraph* form and should *not* include subsections. Abstracts should *not* include any images, graphs, tables, or sample

calculations. The parts of an abstract are related to their counterparts in the full lab report, but are abbreviated versions.

Executive Summary

Group Letter – Team Member 1, Team Member 2, ...

Title of Lab

Instructor – Name, GTA – Name

Date

Executive Summary

Background & Purpose: The background should be a paragraph that contains the goals of the lab and briefly explains what significance it has to the scientific community.

- State the objective of the lab exercise. Though this is provided in the lab documents, the purpose should be restated in your own words. The purpose should be specific and focus on scientific principles. Example: *In this lab, four types of beams were tested to determine which has the greatest strength-to-weight ratio (grams-pounds).*
- In a sentence or two, explain why the purpose of the lab is important to the scientific

community. What is the motivation behind performing this lab? Example: *ABC Company wants to determine whether lighting is better in parallel or in series. The results of the lab will allow the team to make a recommendation for the company.*

Results and Analysis: In 1-2 paragraphs, summarize the most important results and trends in the experiment. In a stand-alone document, figures and tables in an appendix can be referenced to support your analysis.

- State results and content independent of your own influence. These observations should be relevant to the purpose of the lab experiment.
- Describe trends and implications by referencing your results. What can you infer from your data? Example: *Increasing wind speeds caused the turbine to produce more power, as shown in Table 4. To maximize power production, turbines should be placed where they will receive the strongest winds.*
- Briefly describe possible errors and discuss potential solutions.

Conclusion & Recommendations: The final paragraph should emphasize the conclusions drawn from the results and how the results can be used in your scenario.

- State your conclusions based on the results of the lab.
- Provide recommendations for the scenario posed at the beginning of the lab procedure, based on the lab results. Example: *Based on the results of the procedure, the team recommends a tapered channel with a toothed check valve that leads to an oval detection well.*

Appendices: Create a new appendix for each category of content.

- Title each appendix using the format Appendix A: Descriptive Title. For example, an executive summary might contain the appendices:
    - Appendix A: Experimental Data
    - Appendix B: Equations and Sample Calculations
- Arrange appendices in the order in which they are referenced within your summary. Every appendix must be referenced within the document.
- Start figure and table labels at 1 in each appendix. Each numeric label will be preceded by the appendix letter and a period with no spaces (e.g., A.1, or B.3) . Labels should be formatted as described in Using Graphics and Visuals Effectively.

- Organize and format each appendix neatly. Appendices should not be storage for messy or extraneous information.
- Place any necessary figures and tables in an appendix. Executive summaries should not have figures and tables within the summary. It is acceptable to choose the most important content to limit the figures and tables to 1-2 pages.

Abstract

Introduction: Briefly describe the goals of the lab and explain its significance to the scientific community.

- State the objective of the lab exercise. Though this is provided in the lab documents, the purpose should be restated in your own words. The purpose should be specific and focus on scientific principles. Example: *In this lab, four*

types of beams were tested to determine which has the greatest strength-to-weight ratio (grams-pounds).

- In a sentence or two, explain why the purpose of the lab is important to the scientific community. What is the motivation behind performing this lab? Example: *ABC Company wants to determine whether lighting is better in parallel or in series. The results of the lab will allow the team to make a recommendation for the company.*

Experimental Methodology: An abstract will typically be read by someone who is not familiar with the experiment. Mention the methods used in your experiment.

- Include a brief description of the experiment. Example: *The efficiency of each design was measured by retrieving data from the Arduino and analyzing the energy usage in MATLAB*.
- Discuss what data was collected and how you collected it.
- Do not discuss specific equipment unless it is unique and vital to the purpose of the experiment.

Results: Provide a summary of the results of the experiment in a few sentences.

- Present the final, processed results and

observations of the experiment. Example: *A circular check valve with tapered channels leading to an ovalur detection well required the smallest fluid sample to fill the detection well.*

- State any possible sources of error.
- Do not include or reference any raw data, calculations, graphs, or tables.

Conclusion: Summarize the conclusions and recommendations from the experiment in 1-2 sentences.

- State the conclusions that can be drawn from the results of the experiment and connect these conclusions to the purpose as described in the introduction.
- Briefly describe possible solutions to the limitations of the experiment and suggest any further studies that may be meaningful.

Additional Resources

University of Toronto Engineering Communication Program: Abstracts and Executive Summaries
University of Waterloo: Executive Summaries
USC Research Guides: Appendices

5.3 Progress Report

A **Progress Report** captures the project progress made in the past week and outlines the plan for the upcoming week.

While there is no minimum or maximum length, *brevity is key*. An attempt should be made to keep the progress report to one single-spaced page (extras pages can be added for appendices).

Progress Report

Group Letter – Team Member 1, Team Member 2, ...

Progress Report #

Instructor – Name, GTA – Name

Date

Report of Progress

The Report of Progress informs the reader of what has been done since the last progress report, provides the results and analysis of the activities, and establishes the implications of those results on the rest of the project. Divide into three sections, labeled with subheadings as shown here:

Situation

- Describe what was completed, how, and why. Example: *Three different means of braking were tested: coasting to a complete stop, reversing the motors to produce a counter force, and manual braking using a servo motor.*

Results and Analysis

- Summarize and analyze completed work quantitatively and qualitatively.
- Support your summary with data (use tables and figures as needed).

Takeaways

- Apply the results to the overall project. Takeaways should be specific notes on how your results will affect your upcoming work.
    - Example: *Coasting to a stop is energy efficient, but inconsistent. This method of stopping should be used when the stopping location does not need to be precise.*
    - NOTE: It is acceptable to format Takeaways as a bulleted list.

Future Work

This section informs the reader of what will be done

in the upcoming phase and how it will be completed.

Situation

- Describe the next tasks to be completed. How and why will they be completed?

Upcoming Goals

- Discuss goals for the upcoming tasks. Goals should be complete, specific, measurable, and reasonable. Example: *Compare three different styles of check valves to minimize backflow and increase flow rate, determined by which design requires the smallest sample to fill the detection well.*

Upcoming Schedule

- Organize major tasks for the next phase. Who will complete specific tasks?
- See Managing Project Communications for more information about creating a project schedule

Appendices

Create a new appendix for each category of content.

- Title each appendix using the format

Appendix A: Descriptive Title. For example, a progress report might contain the appendices:

- Appendix A: Design Sketches
- Appendix B: Solidworks Drawings
- Appendix C: Code
- Appendix D: Team Meetings

- Arrange appendices in the order in which they are referenced within your summary. Every appendix must be referenced within the document.
- Start figure and table labels at 1 in each appendix. Each numeric label will be preceded by the appendix letter and a period with no spaces (e.g., A.1, or B.3) . Labels should be formatted as described in Using Graphics and Visuals Effectively.
- Organize and format each appendix neatly. Appendices should not be storage for messy or extraneous information.
- Place any necessary figures and tables in an appendix. Executive summaries should not have figures and tables within the summary. It is acceptable to choose the most important content to limit the figures and tables to 1-2 pages.

Additional Resources

The Mayfield Handbook of Technical and Scientific Writing: Progress Reports
USC Research Guides: Appendices

Chapter 6. Writing Common Professional Documents

In this Chapter

- Discussion of the importance of professional communication skills
- Standards and guidelines for writing emails in a formal, professional style
- Standards and guidelines for composing formal, professional business letters

While people working in engineering-related fields are asked to read and produce technical documentation somewhat regularly, you will certainly be reading and writing **professional communications** on a daily basis. The day-to-day work of any organization requires an immense amount of communication to make decisions and share information, most often via email, but also through letters and face-to-face meetings. These types of writing and communicating are essential in a productive

workplace and you should approach it thoughtfully and strategically, beginning to practice those skills now as a student.

Different workplaces and organizations will have different expectations and standards based on their business culture. Consider that conducting yourself professionally does not always mean adopting an exceedingly formal or highly technical writing style—it means being considerate, efficient, and working to meet the needs and expectations of your audience. As a student or as a member of the workforce, be observant and adaptable in your professional communication style.

Also consider that there is not always a strict division between these "professional" or operational communications and technical documentation. For instance, you might need to present initial findings from a study in a condensed format in an email for your supervisor. Always consider the needs and knowledge of your audience as you decide how best to communicate the information (see Understanding Your Audience).

This chapter presents strategies and best practices for communicating effectively and professionally in emails and formal letters. Professional settings commonly require other types of communications. See Managing Project Communications [Link] for information on documenting meetings and Designing and Delivering Presentations for tips on presentations.

Writing Formal, Professional Emails

Email is one of the most common forms of professional workplace communication. Knowing how to write a formal, professional email is a vital skill as you communicate with

colleagues, supervisors, professors, teaching associates, potential employers, clients, and others in a professional context. Poor email etiquette will reflect badly on your communication skills, so it is important to take time and care with how you present yourself.

Be thoughtful, responsible, and ethical about what goes "on your record" in the form of email communications.

Emails essentially go on your permanent record—as a student or in the workplace. Emails are undeniably sent by you and are date and time stamped. Emails you write as an employee are not your property, and you can't control what happens to them once they are sent (i.e. a person other than the recipient you intended might see it if it gets forwarded or shared). Even if the email only reaches your intended reader, it still can have a long-term impact, since many people maintain email archives. Consider about the scenario of asking a former professor for a letter of recommendation. They very well might might search their email for your name and look back at your past emails to refresh their memory. Be thoughtful, responsible, and ethical about what goes "on your record" in the form of email communications.

Use the guidelines provided here for any communication with the instructional team for FE and FEH and for any email in an academic or professional setting in the future.

Components of Formal Emails

Subject Line

Provide some insight into the topic and purpose of the email. Include useful keywords.

The subject line should be concise and easy to read—50-60 characters max.

Effective:

Question about ENGR 1181 Assignment 4
Introduction to New Product Intern
Request for travel expense information

Ineffective:

Hello
Information
<no subject>

This is the first part of the communication your reader will see, so it should be meaningful in establishing the purpose and importance of the message.

Greeting

Use a polite, appropriate greeting to begin the email followed by a comma or colon. The level of formality will depend on your relationship with the recipient and the context.

In an academic setting, address a professor in a way consistent with their communications to you—check the syllabus, Carmen, or their email signature for clues about their preferred title.

Acceptable:

Dear Dr. Kowalski,
Professor Jones:
Mr. / Ms. Thomas:
Hello Jack, [if on a first name basis]

Avoid:

Hey
Hello or Hi [without a name]
Mrs. Patrick, [unless the recipient has specifically stated they wish to be addressed as "Mrs.", use "Ms."]

In all cases, *spell names correctly!* Steven will notice if you address him as Stephen; Professor Li won't likely appreciate an email addressed to Professor Lee. It's a small thing that can make a big difference in how your message is received.

Opening: Thank You Statement & Purpose Statement

The first lines of an email should set a positive tone and set a clear purpose for the communication.

If appropriate, start with a brief statement of gratitude:

Thank you for your inquiry.
Thanks for your offer to hold additional office hours.
I appreciate your help with this project.

Then provide a clear statement of purpose for the email:

I am writing to request your assistance with my application.
I have questions about the sun umbrella project.
This email contains all of the project documentation you requested.
My revised Lab Report is attached, as requested.

Use the first lines of an email to establish the right tone (one that will make your reader inclined to do what you ask) and establish a clear reason for the communication. Be direct and straightforward, while still maintaining a polite, professional tone.

As always, consider audience and purpose—put yourself in the recipient's position and make the email as useful and efficient as possible for them.

Body (Main Content)

The body of an email will vary greatly, depending on the purpose and context, but it should always be concise and well organized.

The writing style should be clear and concise. If too much text is included in the email, people might miss important information so the aim should be clarity and brevity. Place important information at the beginning of paragraphs (topic sentences) and keep paragraphs short and focused.

Use these strategies to ensure that the main content of the email is effectively written:

Focus. Use an effective writing style without wordy phrases (see more about writing style here).

Format. Use headings, paragraph breaks, and lists to break up long blocks of text. Have three questions? Use a numbered list! Have a list of requirements? Use a bulleted list! Don't let your email become a long wall of text—use logical paragraph breaks (with space between paragraphs) to make sure it's easy to read.

Edit. Draft, revise, and perhaps even ask for an outside review in cases where the email is important or complex. Use correct spelling, grammar, capitalization and punctuation to present a professional image.

Remember that people often read emails very quickly—make sure that your tone, message, and request is direct and clear. You will likely spend far more time writing and editing the email than they will spend reading it, and that's how it should be.

Conclusion

Most importantly, the closing should echo the main purpose of the email and make next steps clear and specific. If you are asking the recipient of the email to do something, if you will be taking action, or if no response is required, state it clearly.

Effective:

The letter of recommendation will need to be uploaded by September 20th.
Please complete the attached form and return to me via email by the end of the week.
This email is just for your information—no response is required.

As with the opening, it is also important to end the email on a positive note. Express gratitude, a positive outlook, or an offer of help whenever possible and appropriate.

Effective:

I appreciate your help with this issue.
Thank you for your assistance.
Please let me know if you have any questions or need any additional information.
I look forward to working with you on this project.

Closing & Signature

To complete the email, use a formal closing and sign your name. If you haven't already, make sure that the recipient knows how best to reach you.

Appropriate closings:

Thank you,
Best regards,
Sincerely,

It is also a good idea to set up the "signature" in your email client. Include 3-5 lines of text. Options include full name, role(s), affiliation(s) (school, major, organizations), contact information (.#, phone number, office address), website URL.

Strategies for Effective Email Communication

Here are some additional tips and guidelines to help develop strong email communication skills:

1. **Adapt your approach to the environment or setting.** Different educational environments and workplaces have different cultures and expectations. Not every situation will demand fully formal email etiquette for every single email—it's ok to "blend in" and adapt to different norms, adopting the practices of your audience. For instance, some workplaces might use very informal greetings, or they might put emoticons in day-to-day communication. However, it is always best to start with a more formal style of communication and adjust later, when you are sure it will be acceptable to your audience.
2. **Don't project negative emotions.** Emails are typically written quickly and on the same day (or hour or minute) that they are delivered. For this reason, be especially cautious that you do not convey anger, frustration, or any other negative emotion to your audience that may affect how your message is received. If you find yourself writing an email in frustration, pause and give yourself time to carefully edit and consider the phrasing and its potential effect on your audience before hitting send.
3. **Respect your reader's time.** Busy people tend to receive a large number of emails every day; they will appreciate your communication skills if you are efficient with your emails. In addition to making the information in the email easily accessible, work to minimize the number of emails between you and your audience. Ask yourself, is email is the best way to communicate this message? (Perhaps a quick

meeting, a direct message, or a phone call would be more efficient.) Then ask, am I giving them everything they need? (Consider how providing dates and times of your availability for meetings, attaching documents that they will need to reference, or including links to helpful information might make it easier for your reader to do what you are asking.)

Writing Professional Business Letters

Formal business letters are far less common in the workplace than they used to be, but it is still important to know how to write an format a formal letter—you will often still need to produce a formal application letter and some industries might still use the formal letter as a means of communication with partners and clients.

The best practices for writing the content of an email and writing a formal letter are similar, but with a letter you are asked to do more formatting. You should envision and design it as a document (whether it is printed and mailed or delivered as a PDF).

Format and Components of Professional Business Letters

There are established standards and expectations for how a formal letter should be formatted. Here are the general formatting guidelines:

- Single spaced (1.15 is also acceptable)

- 11 or 12 point font
- White space between paragraphs (do not indent first line of new paragraphs) and elements (see below)

The annotated image below describes the different elements and sections of a formal business letter—click the plus signs to expand the descriptions.

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://ohiostate.pressbooks.pub/feptechcomm/?p=57

Key Takeaways

- Professional communications like emails, letters, presentations, and meetings will almost certainly be a daily part of any workplace—building those skills as a student will prepare you to thrive in the workplace.
- Use a formal approach to writing emails in professional or academic settings; include a subject line, greeting, well formatted and organized information, and polite closing.

- Take care to present information correctly and accurately in professional communications. Emails may be written quickly, but they can make a lasting impression.
- Letters will be less common, but it is important to follow the standards of the genre when they are required, including the sender's address/letterhead, date, inside address, salutation, body paragraphs, and closing, all with correct formatting.

Additional Resources

Email Etiquette (Purdue OWL)
Strategies for Writing Effective Emails (Engineering Career Services, Ohio State)
Email Signature Tool (Ohio State Brand Guidelines)
Writing the Basic Business Letter (Purdue OWL)

Chapter 7. Managing Project Communications

In this Chapter

- Discussion of the importance of effective communication in team projects
- Guidelines and tips for creating meeting notes, project schedules, and team working agreements

Communication plays a key role in allowing a group of people to function as a team with a common goal. To be effective, teams must share information by documenting plans, activities, and decisions (e.g., meeting notes, project schedules, or team agreements); or resolving problems and conflicts (e.g., writing emails or verbal communication).

Team Meeting Notes

During the course of a project, it is valuable to accurately document team meetings—the logistics (where and when they occurred, who was in attendance) and also the content (topics of discussion and decisions). This documentation benefits the team members by providing an record of project activities and documenting decisions and responsibilities—it provides a helpful benchmark to refresh memories and resolve questions or issues that arise. Meeting notes might also be provided to an external audience (supervisor, client, or instructor) to show that the team is making progress and fully engaged. Note that they may be required as part of a Progress Report.

The practice and policy of documenting decisions and discussion in meetings will follow you into the workplace. See here for a real-world example of minutes from a Minnesota Department of Transportation meeting.

Meeting notes should be written during and immediately after the meeting takes place. They will not be as accurate or useful if they are written too long after the event.

The notes should be informative of what the team discussed and what needs to be completed. Typical team meeting notes include the following elements:

- **Header**—date, time, method (e.g. physical location or Skype call), full names of the members who attended
- **Objective statement**—1-2 sentences that establish the goal or purpose of the meeting (e.g., to share findings and progress, to decide on a design, or to brainstorm)
- **Completed tasks** from previous week or last meeting, including:
    - Bulleted list of tasks

    - Person(s) assigned to each task ("task owner")
    - Short summary of status (e.g., completed and submitted on Carmen or in progress or pending group review)
- **Tasks to be completed** for the upcoming week, including:
    - Bulleted list of tasks
    - Person(s) assigned to the task ("task owner")
- **Project timeline** (may be presented as a Gantt chart) indicating major milestones and deadlines
- **Decisions** made by group with key information about how the decisions were made (e.g., group consensus, decided by project manager)

Project Schedule

A schedule helps the team stay on task and allocate enough time for tasks. It also allows the instructor or supervisor to see what the team has completed or needs to complete. The schedule should include the task that needs to be completed, start and finish dates, when the task is due, the teammates working on the task, and its percent completed at the end of due date.

Note, not all percent completion may be 100 percent. The team may have been unable to complete some tasks and will carry them forward. Occasionally, tasks will take longer than expected.

Two common methods for displaying the schedule are a **task list** and a **Gantt chart**. As you might guess from the name, the task list breaks the activities of a project down into a series of smaller steps and assigns deadlines and people to each task. See here for more information and an example of a task list project

schedule. A Gantt chart is a visual tool for displaying what is essentially the task list. By representing each task as a segment of a line, the chart is useful for emphasizing duration of activities and relationships between activities (e.g. design needing to be complete before beginning development). There are many different software options for creating Gantt charts, but you can also create one in Excel, as shown here.

Team Working Agreement

A **team working agreement** is a type of contract between team members that helps set expectations and ground rules for how the team will operate. They can take various forms, but the example below shows the type you may be asked to complete in First Year Engineering at Ohio State.

When completing an agreement, include all team members in the process and use the opportunity to discuss issues that can arise during group projects. Being able to think about possible conflicts or issues and talking about them as a group can help prevent some of those problems, and it will make it easier to address conflict later on, if needed.

Sample Team Working Agreement

Team Working Agreement
Term (Example: Autumn 201X)
Creation XX/XX/XXXX; Revised XX/XX/XXXX *(If revised)*

1) Group Identification

Lab section # –
Table # –
Instructor –
Team Name (Optional) –

Team member info:

	NAME:	EMAIL:	PHONE:	OTHER:
1	Teammate			
2	Teammate			
3	Teammate			
4	Teammate			

2) Primary Means of Communication and Expectations

State your team's agreed upon various means of communication and expectations for response. (Example: *All members will be expected to read emails from anyone in the group on a daily basis and respond in not more than 12 hours.*)

3) Scheduling Meetings (Schedule at least one meeting as part of constructing your team agreement.)

Agreed upon means of scheduling meetings. (Example: *Team will agree, at the end of each class, to set any meetings times and agenda needed before the next class and beyond if possible. Team members will take turns to send out a reminder of the meeting with an agenda within eight hours after the class.*)

4) General Responsibilities for All Team Members

This element of the team working agreement is the list of rules/agreements or the contract that all members agrees to live by.

5) Specific Team Member Responsibilities/ Deadlines *(Optional)*

This section may be used to record specific tasks or responsibilities particular team members have assumed.

6) Conflict Resolution

Each team should have an agreed-upon approach to addressing issues that may arise. *For example, if a*

team member is not meeting deadlines, the team agrees to do X [specific action decided by the team] to address the problem before bringing the issue to a TA or professor.

7) Expectations of Faculty and GTA's

Suggested Statement:
If a team member fails to live up to this agreement, the situation may be reported to the staff, but the team will still be responsible for submitting a completed assignment. Staff will be available to meet with teams to resolve issues.

8) Team Signatures

Include signature for each student.

Key Takeaways

- Prioritize effective communication strategies in group projects to ensure that work is distributed and completed in a way that is clear, fair, and efficient.
- Carefully document decisions and tasks in meeting notes to aid memory and keep group

members accountable.

- Project planning includes creating project schedules for the work and making sure the team members are in agreement about how the group will function (by completing a team working agreement, for example).

Additional Resources

Video: How to Create a Basic Gantt Chart in Excel
Group Work: Dealing With Conflicts (The Learning & Teaching Office – Ryerson University)

Chapter 8. Formatting Documents

In this Chapter

- Overview of the general standards for document formatting and the importance of using consistent, clear formatting.
- Tips and resources for how to use Microsoft Word styles and templates to simplify formatting.

Document formatting refers to the way a document is laid out on the page—the way it looks and is visually organized—and it addresses things like font selection, font size and presentation (like bold or italics), spacing, margins, alignment, columns, indentation, and lists. Basically, the mechanics of how the words appear on the page. A well formatting document is consistent, correct (in terms of meeting any stated requirements), and easy to read.

The **visual appeal** of a document has an effect on the reader and how they perceive the information, so it's important in any piece of writing or documentation to be concerned with its

formatting. Formatting also makes information more accessible to the reader by creating and labeling sections (headings), highlighting key words or ideas (bold, italics, or lists), and making a good impression (professional look and feel, appropriate font choice for the document type).

There are many ways to format a technical or professional document. Assignments may specify formatting requirements, but if a style is not dictated, maintain a clear and consistent format throughout the document.

Especially when combining work from multiple team members, details like slight differences in font size or line spacing are easy to miss, but these subtle inconsistencies detract from the overall professionalism of your document. Sloppy formatting will reflect poorly on your abilities, and your audience may lose confidence in your message.

Basic Formatting Standards for Lab Documents

A few standards that should be used in most lab documents, unless specified otherwise:

- 11-12 pt. font in a consistent style throughout, including headers, footers, and visual labels
- 14 pt font for section headings (and “Memo” or other document label within a header)
- A standard, professional font (e.g., Times New Roman, Cambria, Calibri)
- Single or 0.15 line spacing, with no indentation on the first line of the paragraph
- Additional line break between paragraphs

- Left-justified body text
- Page numbers at bottom right corner (starting the first page of the main text, i.e. not the cover page or Table of Contents)
- 1in. margins

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://ohiostate.pressbooks.pub/feptechcomm/?p=61

Writing Common Technical Documents details the content for documents you are likely to write in first-year engineering. You should review these for what information should be included in headers, title pages, etc. Each content guide demonstrates the general formatting you might see in a document of that type, but these are not complete templates for formatting.

Using Features in Word

Using the built-in features in Microsoft Word can help maintain proper formatting even when you need to make changes to your document.

- Word's Equation Editor should be used for all equations and calculations (see Using Graphics and Visuals Effectively for more information on formatting equations, figures, and tables).

- All page breaks should use the Page Break option within Word. This ensures that proper spacing will be maintained regardless of changes to the surrounding text or file type.
- Many citation styles use hanging indents in the reference list. Word has an option to indent all lines in a paragraph except the first line. This is accessible under Paragraph Options and should be used for all reference lists that require hanging indents. This option will maintain your hanging indent if the text or font size is changed.
- Use the list formatting feature to ensure that the spacing and alignment are consistent throughout the doc. Note that when lists extend to more than one line, the text remains vertically aligned.

Using Templates & Styles

If a Word**template** is provided by your instructor, use it to create your document. Templates can be applied later, but it may be more difficult. Save the template as a document using your desired file name, then begin editing and adding content. Templates will often use features to simplify adding tables, figures, and a table of contents.

If a template is not provided, you can use a **style** to format your document. Word has many built-in styles that can be modified and saved. A style is a set of formatting that is applied automatically to the document as you create and modify it. It is likely that there will not be a style with exactly the characteristics you are looking for, but spending a few minutes to update the style will likely save time later by allowing you to easily add a Table of Contents, adjust Figure and Table labels, and move easily from section to section using the Outline feature. It is not

mandatory to use these features, but you may find them helpful, particularly for lab reports.

How-To Geek created "Microsoft Word: Document Formatting Essentials," a series of lessons on creating documents in Word.

More information on using paragraphs, sections, and characters within styles is detailed in "Six Tips for Better Formatting in Microsoft Word."

See the **Additional Resources** box below for links to more information on using Word effectively for formatting. If you are unsure of how to use a feature or find yourself spending an excessive amount of time manually making formatting changes, don't be afraid to Google how to do something. Word is one of the most widely used programs in the world; there are many resources and tutorials online on how to use it. Know that many similar formatting features are also available in Google Docs.

Key Takeaways

- If formatting is not specified by your instructor, use the generally accepted standards for technical documents.
- Keep formatting consistent to minimize distractions and create a professional impression.
- Always use built-in tools like page breaks and indents to create documents.

- Consider using templates or styles to make consistent formatting easier.

Additional Resources

A Design Procedure for Routine Business Documents (OWL)
Customize or create new styles in Word (Microsoft)
How to Simplify Word Document Formatting With Styles (TutsPlus)
How to Use, Modify, and Create Templates in Word (PCWorld)

Chapter 10. Designing and Delivering Presentations

In this Chapter

- Strategies for developing professional oral presentations and designing clear, functional slides
- Discussion of what makes presentations challenging and practical advice for becoming a more engaging and effective presenter
- Tips for extending the concepts of high quality presentations to creating videos and posters

Presentations are one of the most visible forms of professional or technical communication you will have to do in your career. Because of that and the nature of being put "on the spot," presentations are often high pressure situations that make many people anxious. As with the other forms of

communication described in this guide, the ability to present well is a skill that can be practiced and honed.

The skills that make you a strong presenter in that setting are incredibly valuable in many other situations.

When we think of presentations, we typically imagine standing in front of a room (or auditorium) full of people, delivering information verbally with slides projected on a screen. Variations of that scene are common. Keep in mind, though, that the skills that make you a strong presenter in that setting are incredibly valuable in many other situations, and they are worth studying and practicing.

Effective presentation skills are the ability to use your voice confidently to communicate in "live" situations—delivering information verbally and "physically," being able to engage your audience, and thinking on your feet. It also translates to things like videos, which are a more and more common form of communication in professional spheres. You will have a number of opportunities during your academic career to practice your presentation skills, and it is worth it to put effort into developing these skills. They will serve you well in myriad situations beyond traditional presentations, such as interviews, meetings, networking, and public relations.

This chapter describes best practices and tips for becoming an effective presenter in the traditional sense, and also describes how best practices for presentation skills and visuals apply to creating videos and posters.

Process for Planning, Organizing, and

Writing Presentations

Similar to any other piece of writing or communication, to design a successful presentation, you must follow a thoughtful writing process (see Engineering Your Writing Process) that includes planning, drafting, and getting feedback on the presentation content, visuals, and delivery (more on that in the following section).Following is a simple and comprehensive way to approach "writing" a presentation:

Step 1: Identify and state the purpose of the presentation. Find focus by being able to clearly and simply articulate the goal of the presentation—what are you trying to achieve? This is helpful for you and your audience—you will use it in your introduction and conclusion, and it will help you draft the rest of the presentation content.

Step 2: Outline major sections. Next, break the presentation content into sections. Visualizing sections will also help you assess organization and consider transitions from one idea to the next. Plan for an introduction, main content sections that help you achieve the purpose of the presentation, and a conclusion.

Step 3: Draft content. Once you have an outline, it's time to fill in the details and plan what you are actually going to say. Include an introduction that gives you a chance to greet the audience, state the purpose of the presentation, and provide a brief overview of the rest of the presentation (e.g. "First, we will describe the results of our study, then we'll outline our recommendations and take your questions"). Help your audience follow the main content of the presentation by telling them as you move from one section of your outline to the next—use the structure you created to keep yourself and your audience on track.

End with a summary, restating the main ideas (purpose) from the presentation and concluding the presentation smoothly (typically thanking your audience and offering to answering any questions from your audience). Ending a presentation can be tricky, but it's important because it will make a lasting impression with your audience—don't neglect to plan out the conclusion carefully.

Step 4: Write presentation notes. For a more effective presentation style, write key ideas, data, and information as lists and notes (not a complete, word-for-word script). This allows you to ensure you are including all the vital information without getting stuck reading a script. Your presentation notes should allow you to look down, quickly reference important information or reminders, and then look back up at your audience.

Step 5: Design supporting visuals. Now it's time to consider what types of visuals will best help your audience understand the information in your presentation. Typically, presentations include a title slide, an overview or advance organizer, visual support for each major content section, and a conclusion slide. Use the visuals to reinforce the organization of your presentation and help your audience see the information in new ways.

Don't just put your notes on the slides or use visuals that will be overwhelming or distracting—your audience doesn't need to read everything you're saying, they need help focusing on and really understanding the most important information. See Designing Effective Visuals.

At each step of the way, *assess audience and purpose* and let them affect the tone and style of your presentation. *What does your audience already know? What do you want them to*

remember or do with the information? Use the introduction and conclusion in particular to make that clear.

For in-class presentations, look at the assignment or ask the instructor to make sure you're clear on who your audience is supposed to be. As with written assignments, you may be asked to address an imagined audience or design a presentation for a specific situation, not the real people who might be in the room.

In summary, successful presentations

- have a stated purpose and focus;
- are clearly organized, with a beginning, middle, and end;
- guide the audience from one idea to the next, clearly explaining how ideas are connected and building on the previous section; and
- provide multiple ways for the audience to absorb the most important information (aurally and visually).

Developing a Strong Presentation Style

Since presentation are delivered to the audience "live," review and revise it as a verbal and visual presentation, not as a piece of writing. As part of the "writing" process, give yourself time to practice delivering your presentation *out loud with the visuals*. This might mean practicing in front of a mirror or asking someone else to listen to your presentation and give you feedback (or both!). Even if you have a solid plan for the presentation and a strong script, unexpected things will happen when you actually say the words—timing will feel different, you will find transitions that need to be smoothed out, slides will need to be moved.

More importantly, you will be better able to reach your audience if you are able to look up from your notes and really talk to them—this will take practice.

Characteristics of a Strong Presentation Style

When it comes time to practice delivery, think about what has made a presentation and a presenter more or less effective in your past experiences in the audience. What presenters impressed you? Or bored you? What types of presentation visuals keep your attention? Or are more useful?

One of the keys to an effective presentation is to keep your audience focused on what matters—the information—and avoid distracting them or losing their attention with things like overly complicated visuals, monotone delivery, or disinterested body language.

As a presenter, you must also bring your own energy and show the audience that you are interested in the topic—nothing is more boring than a bored presenter, and if your audience is bored, you will not be successful in delivering your message.

Verbal communication should be clear and easy to listen to; non-verbal communication (or body language) should be natural and not distracting to your audience. The chart below outlines qualities of both verbal and non-verbal communication that impact presentation style. Use it as a sort of "rubric" as you assess and practice your own presentation skills.

Verbal

- **Volume:** Project your voice appropriately for the room. Make sure everyone can hear easily, but avoid yelling or straining your voice. If using a microphone, test it (if possible), check in with your audience, and be willing to adjust.
- **Pace:** Don't rush! Many people speak too quickly when they are nervous. Remind yourself to speak clearly and deliberately, with reasonable pauses between phrases and ideas, and enunciate carefully (especially words or concepts that are new to your audience).
- **Dynamics & tone:** Speak with a natural rise and fall in your voice. Monotone speaking is difficult to listen to, but it is easy to do if you're nervous or reading from a script. Remember that you are speaking to your audience, not at them, and try to use a conversational tone of voice.
- **Filler words:** Limit the number of "filler" words in your speech—"uh," "um," "like," "you know," "so," etc. These are words that creep in and take up space. You might not be able to eliminate them completely, but with awareness, preparation, and practice, you can keep them from being excessively distracting.

Non-verbal

- **Location:** Position yourself where your audience can see you, but do not block their view of the visuals.
- **Eye contact:** Look at your audience. You should have practiced the presentation enough that you can look up from your notes and make them feel as though you're talking to them.
- **Posture:** Stand comfortably (do not lean on the wall or podium). Depending on the setting, you might move around during the presentation, but avoid too much swaying or rocking back and forth while standing—stay grounded.
- **Gestures:** Use natural, conversational gestures; avoid nervous fidgeting (e.g., pulling at clothing, touching face or hair).

As you plan and practice a presentation, be aware of time constraints. If you are given a time limit (say, 15 minutes to deliver a presentation in class or 30 minutes for a conference

presentation), respect that time limit and plan the right amount of content. As mentioned above, timing must be practiced "live"—without timing yourself, it's difficult to know how long a presentation will actually take to deliver.

Finally, remember that presentations are "live" and you need to stay alert and flexible to deal with the unexpected:

- **Check in with your audience.** Ask questions to make sure everything is working ("Can everyone hear me ok?" or "Can you see the screen if I stand here?") and be willing to adapt to fix any issues.
- **Don't get so locked into a script that you can't improvise.** You might need to respond to a question, take more time to explain a concept if you see that you're losing your audience, or move through a planned section more quickly for the sake of time. Have a plan and be able to underscore the main purpose and message of your presentation clearly, even if you end up deviating from the plan.
- **Expect technical difficulties.** Presentation equipment fails all the time—the slide advancer won't work, your laptop won't connect to the podium, a video won't play, etc. Obviously, you should do everything you can to avoid this by checking and planning, but if it does, stay calm, try to fix it, and be willing to adjust your plans. You might need to manually advance slides or speak louder to compensate for a faulty microphone. Also, have multiple ways to access your presentation visuals (e.g., opening Google Slides from another machine or having a flash drive).

Developing Strong Group Presentations

Group presentations come with unique challenges. You might

be a confident presenter individually, but as a member of a group, you are dealing with different presentation styles and levels of comfort.

Here are some techniques and things to consider to help groups work through the planning and practicing process together:

- **Transitions and hand-off points.** Be conscious of and plan for smooth transitions between group members as one person takes over the presentation from another. Awkward or abrupt transitions can become distracting for an audience, so help them shift their attention from one speaker to the next. You can acknowledge the person who is speaking next ("I'll hand it over to Sam who will tell you about the results") or the person who's stepping in can acknowledge the previous speaker ("So, I will build on what you just heard and explain our findings in more detail"). Don't spend too much time on transitions—that can also become distracting. Work to make them smooth and natural.
- **Table reads.** When the presentation is outlined and written, sit around a table together and talk through the presentation—actually say what you will say during the presentation, but in a more casual way. This will help you check the real timing (keep an eye on the clock) and work through transitions and hand-off points. (Table reads are what actors do with scripts as part of the rehearsal process.)
- **Body language.** Remember that you are still part of the presentation even when you're not speaking. Consider non-verbal communication cues—pay attention to your fellow group members, don't block the visuals, and look alert and interested.

Designing Effective Visuals

Presentation visuals (typically slides, but could be videos, props, handouts, etc.) help presenters reinforce important information by giving the audience a way to *see* as well as hear the message. As with all other aspects of presentations, the goal of visuals is to aid your audience's understanding, not overwhelm or distract them. One of the most common ways visuals get distracting is by using too much text. Plan and select visuals aids carefully—don't just put your notes on the screen, but use the visuals to reinforce important information and explain difficult concepts.

The slides below outline useful strategies for designing professional, effective presentation slides.

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://ohiostate.pressbooks.pub/feptechcomm/?p=65

- **Write concise text.** Minimize the amount of reading you ask your audience to do by using only meaningful keywords, essential data and information, and short phrases. Long blocks of text or full paragraphs are almost never useful.
- **Use meaningful titles.** The title should reveal the purpose of the slide. Its position on the slide is highly visible—use it to make a claim or assertion, identify the specific focus of the slide, or ask a framing question.
- **Use images and graphics.** Wherever possible, replace

wordy descriptions with visuals. Well chosen images and graphics will add another dimension to the message you are trying to communicate. Make sure images are clear and large enough for your audience to see and understand in the context of the presentation.

- **Keep design consistent.** The visual style of the slides should be cohesive. Use the same fonts, colors, borders, backgrounds for similar items (e.g., all titles should be styled the same way, all photos should have the same size and color border). This does not mean every slide needs to look identical, but they should be a recognizable set.
- **Use appropriate contrast.** Pay attention to how easy it is to see elements on the screen. Whatever colors you choose, backgrounds and overlaid text need to be some version of light/dark. Avoid positioning text over a patterned or "busy" background—it is easy for the text to get lost and become unreadable. Know that what looks ok on your computer screen might not be as clear when projected.

Key Takeaway

- Create a structure for your presentation or video that clearly supports your goal.
- Practice effective verbal and non-verbal communication to become comfortable with

your content and timing. If you are presenting as a group, practice together.

- Use visuals that support your message without distracting your audience.

Additional Resources

Appendix A: Technical Design Review Writing Guide

This appendix provides additional information and support for students as they work on the **ENGR 1182 Technical Design Review** document. Use this page as a reference and guide during all stages of the writing process.

Report Components

- **Cover page:** Must include project title, submission date, team member names, and logo (see note about design under Document Formatting Tips & Requirements)
- **Executive Summary**
- **Problem Definition Review**
- **Conceptual Design Review**
- **Final Design Review**

Writing & Editing Tips

To produce a clean, clear, and professional final document, you must spend time reviewing and revising for writing style. The content is obviously of the highest importance, but *how* it is written has a significant impact on whether the document is ultimately successful for your reader.

Achieving "Tech Comm" writing style

- Content and word choice used are appropriate for a technical supervisor who has had limited involvement with the project, but who will have to justify all decisions to company CEO or Vice President. *Therefore, your goal should be to give them a clear understanding of the process and reasoning that led to the final product.*
- Writing is concise, precise, direct, and well organized (review these sections for more information and examples).
- Grammar and mechanics are correct; there are few to no errors, and none that create confusion for the reader.

Creating cohesion across sections

- Transition phrases and words are used to connect ideas within and across paragraphs in sections (see the list of transition words and phrases under "Well Organized")
- Conceptual transitions are made across sections to clarify the relationship between them. *For example, using a sentence at the beginning of the design requirements*

section that demonstrates their relationship to user needs.

- Voice, tone, level of technical language, and paragraph length used across the document are consistent (i.e., it's not obvious that each section has a different author). Read more about writing as a team here.

Document Formatting Tips & Requirements

For this type of professional document, ensure that the final product is cohesive and consistent in its visual design.

Design a Cover Page that makes a good first impression on the reader—it should be professional, consistent with the design of the rest of the document (in terms of typeface, for example), but can also represent the team's personality or "brand."

Document Formatting

Adhere to the standard formatting guidelines described for lab documents in as you finalize the Technical Design Review document:

- Standard, professional font (e.g., Times New Roman, Arial, Calibri, Cambria)
- 11-12 pt. for body text
- Headings are used to clearly label the components and required sections of the documentation and their format should be consistent throughout the document
  - 14 pt **bolded** font for main headings (i.e., Heading 1): **Executive Summary, Problem Definition Review, Conceptual Design Review, Final Design Review**
  - 12 pt. ALL CAPS for subheadings (i.e. Heading 2): DESIGN 1 REVIEW
- Table titles and figure captions are 1 pt. smaller than the body text
- Single or 1.15 line spacing, without indenting the first line of the paragraph
- Additional line break (space) between paragraphs
- Left-justified body text; centered tables, figures, and corresponding titles and captions
- Page numbers at bottom right corner (starting the first page of the main text, i.e. not the cover page or Table of Contents)
- 1in. margins on all sides
- Use IEEE format for citing secondary sources in text

Tables & Figures

Tables are used to present data or information in a grid of rows and columns and **figures** are generally any other visuals, such as graphs, charts, illustrations, or photographs.

To create a polished final document, use well-designed, professional graphics. With the exception of hand-drawn concept sketches, the graphics, tables, renderings, etc. should

be created with appropriate software, legible (i.e., not too small to read or poorly reproduced), and with appropriate legend/ units.

> **NOTE:**
> The rules for labeling presented here apply generally to both **APA** and **IEEE** citation styles; however, the graphic citation guidelines are based on APA guidelines to provide more thorough citation information for copyright purposes. *Even when you are unsure of the correct format or if you don't have all of the required information, it is better to credit your source material as thoroughly as you can rather than risk violating copyright or ethical rules.*

Positioning tables and figures in the document

For both tables and figures, the first step is to position them where they will be meaningful to the reader as they review the document. *Ideally this will be directly after the first reference to the information in the text*, but it is more important that the entire figure and its caption appear on the same page.

They should be centered on the page and appropriately sized so the information is legible. Although it is not always possible, the graphic should be oriented on the page in the same direction as the layout of the text—ideally, your reader should *not* have to turn the page sideways to read the table or figure.

Labeling and citing tables and figures

Tables

- Place "title" text above the table—*you can do this manually or use the "insert caption" feature in Word, but note that you may have to override Word's default settings to achieve the required format*.
    - Include a table number and a descriptive title.
    - Reduce font size by at least 1 point to distinguish it from the body text.
    - Center the title text over the table.
- Number all tables in the document in consecutive order (Table 1, Table 2, etc.). *NOTE: Tables and figures are numbered independently of one another*.
- Write a concise, descriptive caption that explains what table shows—*without reading anything else on the page, your reader should understand what information the table contains*.
- Provide a source citation *only if*
    - you are reproducing the table from secondary source (use "Reprinted") or
    - you sourced the data in the table from a secondary source (use "Adapted").
- If the table requires a citation, below the table, preceded by "*Note*." as shown: *Note.* Reprinted [or Adapted] from Title of Work, by Author. Retrieved from URL. Date of Copyright by Copyright Holder.

Table 1.
Blank table to demonstrate correct formatting and labeling.

Note. Reprinted [or Adapted] from Title of Work, by Author. Retrieved from URL. Date of Copyright by Copyright Holder.

Figures

- Place a "caption" below the figure—*you can do this manually or use the "insert caption" feature in Word, but note that you may have to override Word's default settings to achieve the required format*.
    - Add a figure number, description, and, when needed, a citation to the caption.
    - Reduce font size by at least 1 point to distinguish it from the body text.
    - Center the caption text under the figure.
- Number figures in order in the document (e.g., *Figure 1*, *Figure 2*, etc.) and italicize as shown. *NOTE: Tables and figures are numbered independently of one another.*
- Write a concise, descriptive caption that identifies the type of figure and the information it presents (e.g., *Line drawing of the final robot storage concept*.)
    - Without reading anything else on the page, your reader should be able to understand what information the figure contains.
    - For clarity, the caption should also identify the type of graphic (e.g., line drawing, photograph, bar graph, etc.).

- Provide a source citation *only if*
  - you are directly copying the figure from an outside source (use "Reprinted"), or
  - the data in the figure come from an external source (use "Adapted").
- If the figure requires a citation, add it after the period at the end of the descriptive caption as shown: Reprinted [or Adapted] from Title of Work, by Author. Retrieved from URL. Date of Copyright by Copyright Holder.

Figure 1. Gray box placeholder to demonstrate how to caption a figure. Reprinted [or Adapted] from Title of Work, by Author. Retrieved from URL. Date of Copyright by Copyright Holder.

Explaining tables and figures

Figures and tables are useful clarifications, illustrations, and augmentations of written content; with few exceptions, *they must be referenced and explained in the surrounding body text*.

First, consider how and why you want to present the figure or table to your audience (beyond "the assignment requires that I do")—what aspects of the data do you want your audience to pay attention to? What conclusions do you want them to draw?

Here are some guidelines for writing about figures and tables:

- Directly reference the table or figure in the written text before it appears in the document, if possible; capitalize "Table" or "Figure" as with a proper noun: *Table 1 shows*... or *As seen in Figure 2*...

... Table 1 compares design criteria used to evaluate vehicle Designs 1 and 2; it shows that while Design 1 was more fuel efficient, Design 2 better met both efficiency and cost requirements. ...

... As seen in Figure 2, users rated backlighting and sound criteria as the most important factors in device usability. ...

- In the written explanation of the figure or table, explain the figure or table and its data in a way appropriate for the audience, and which emphasizes the key takeaway that you want to make with the figure or table.
    - Use **precise** language to describe the conclusions you are drawing about the information in the figure; do not just describe the figure (read more about precise language usage here)

IMPRECISE: "...the chart compares user preferences..."

Since all charts make comparisons, tell your reader instead what this specific comparison shows about the users' preferences—what conclusions did you draw or decisions did you make based on these preferences?

MORE PRECISE: "...the chart in Figure 2 demonstrates that backlighting was significantly more valued by users than any other criterion..."

- If there are outliers, or data that would be surprising or confusing for your reader, be sure to explain how you are interpreting or understanding them in context.
- Be ethical and honest with your representation of the data;

when needed, explain contradictory information or data that doesn't obviously support your final conclusion (don't ignore these issues—your reader won't).

Exercise A: Audience and Purpose

Considering the context in which your vehicle will operate to explain why your innovation matters

Background

The public facing page of your team's website—the AEV project introduction—provides an overview of the project for commuters in the city of Columbus. The purpose of this section is therefore primarily to **inform—**you want to inform commuters that there will be a new transportation system available that addresses SMART city goals, as well as your readers' individual goals and interests (i.e., access to groceries, healthcare, or other services).

As you craft your team's website introduction, consider what questions Linden residents might have about a new system like this, and how those questions and concerns align with your design choices for the AEV. Key questions your readers might have include:

- How will it change the way I get around Columbus?
- Can I get to the places I need to go?

- When can I use it?
- How much will it cost me?
- Is this more efficient than using the bus (both in terms of my time as well as in terms of fuel costs)?

Because this is an overview for commuters interested in using public transportation, this is not the place to talk in technical detail about all aspects of your AEV design, unless those aspects improve the public transportation experience of commuters in some way. You'll want to consider how your design choices relating to efficiency, safety, etc. can be connected to **where** the AEV system will run in Columbus to make your design choices meaningful and relatable to Linden commuters' interests and needs.

A note about style:

You can see that most of this information is not overtly technical in nature (i.e., we're not asking you to describe how the AEV's reflectance sensors operate, or its design specifications). As such, you should choose **words and content that are appropriate to your audience**, and use a style that is **accurate and precise**, focusing on reader interests and concerns.

Practice

Write your team's introduction to the AEV project following guidelines for the project outlined in the assignment description on Carmen.

Discussion:

1. Exchange your introduction with another team and read each others' documents.
2. With your partner team, discuss responses to the below questions for 5 mins:
    a. How does the purpose and audience of the website introduction differ from your R&D documentation? What choices about writing style, content, or structure did you make about the introduction that were different from the R&D documentation? Why did you make those choices?
    b. Did considering the needs and interests of the audience for your project website influence your ideas about design priorities for the AEV? Why or why not?
    c. How does thinking about the context in which a device or product will be used influence the design process? How can integrating consideration of context become a regular part of the Plan and Evaluate steps of your engineering DR PIE process?
3. With the entire class, discuss responses to questions 2a-2c above.

Exercise B: Adapting Word Choice for Audience and Purpose

Background

It's rare that we behave and speak identically from social situation to social situation. Consider the ways that we behave and speak differently in the following interactions:

- Asking the teacher questions to clarify a concept in a math class
- Encouraging your teammate to pass you the ball during a soccer game
- Explaining your experience to a manager for a job opportunity

In each of these situations, we adapt both what we say and how we say it for multiple reasons: to achieve our purpose (understand the concept, get the ball to score, receive the job offer) and to maintain our relationships (the teacher understands you are trying to learn, your teammate knows you are open, the manager views you as a talented worker). In short, the person we speak with (our audience), our goal in speaking with them (purpose), and the topic itself all influence what we choose to say and emphasize as well as how we choose to say it. To successfully achieve your purpose with your audience, you need to consider (among other questions, which will come up

later in the semester) which words are most appropriate (word choice).

Practice

In this activity, you'll write for three different audiences, including:

1. Your 1181 Lab TA,
2. Students at your high school considering an engineering major, and
3. A first grader.

First, reflect on what you did to complete the Buckeye Challenge Lab. Next, for each audience listed above, write one paragraph explaining what you did and why you did it when you completed the lab.

Considerations

On the one hand, your TA already knows what you did, so rehashing the activities themselves in detail is probably unnecessary. Instead, they're probably more interested in how you solved the problem, what you learned about teamwork, how your outcomes were influenced by your approach, etc. On the other hand, high school students might want to know more of the details of the process, the concepts involved, and a sense of whether this is the kind of activity they might look forward to doing next year; finally, first graders are probably more interested in hearing what you did and why this was fun.

It should be clear that you cannot use the exact same words or content to describe the lab for these three differing audiences. Similarly, their interest in and attention to what you did differs based on their experience with the lab and with their knowledge (or lack of knowledge) of engineering. They won't listen if it's too technical/doesn't match their interests. Your goal is to explain the what and why of the lab by balancing appropriate levels of technicality (word choice) and content/information that will appeal to your audience, but will still inform them about the lab itself in a meaningful way.

Discussion

Discussion Board Posting and Response: Trade your responses with another member of your lab group; read their responses and write a response to their discussion post, responding to the following:

1. Identify where the writer made strong, clear choices about how to explain the content using words appropriate for the given audience in each instance, given their knowledge level, interests, and concerns.
2. Are there any places where the writer could have more clearly or precisely explained what was done?
3. In terms of the audience's knowledge, interests, and concerns, does the description seem accurate? Does it attempt to make the content compelling for each audience? How so? If not, what could have made it more compelling?

In Class: Discuss your responses with your partner; then discuss as a whole class.

Exercise C: Articulating Problems and Problem Scope in Context

Framing Problems for Multiple Stakeholders

Background

Part of the challenge of the SMART City initiative and—under the umbrella of that initiative, the AEV project—is that there are many, interrelated issues to be addressed and many stakeholders with varying interests and backgrounds.

As an engineer, a significant part of your work will involve defining a specific problem (or defining multiple problems) to be addressed within a context where there are multiple, interrelated issues. To limit the scope and clarify your purpose, a problem definition should articulate the issues your engineering solution will address, as well as identify issues outside the scope of your proposed solution. To put it another way, you must choose content and words that frame the problem to clarify why it is relevant and significant for your audience. In addition, the AEV project allows for many different problems to be solved—by

creating the AEV, you aim to solve a transportation problem for the citizens of city of Columbus.

In addition, by creating a design that is safe, efficient, cost-effective (whatever you've decided) you solve a problem for your company. Finally, by creating a custom part for your AEV, you solve a problem for your team.

It follows that when you're defining an engineering problem in writing, it matters that you consider the scope and parameters of the problem, as well your audience, since they have different concerns and interests.

Practice

1. Write a paragraph to the CEO of your company, explaining how your design solves problems of efficiency, cost, or safety that you identified through your research and development process. Be precise and concise, using exact figures and accurate descriptions (e.g., instead of indicating that your chosen design is "best", explain what makes it "best": For example, "our final design solves the energy efficiency problem presented in our original designs. Specifically, the modifications to the motor increase efficiency by 75%, reducing energy use per run from 1500 joules to 375 joules.")
2. Write a paragraph to a public investor, explaining the main problem for the community of Columbus that is solved (or opportunity that is created) by your AEV **and** its location on a path from Linden to Easton. Possible ways of framing the benefits of the AEV could include discussion of the following (among others):
    a. Opportunities created for Columbus residents,

b. Access issues for Linden residents that would be solved (e.g., better ability to use public transportation to get to doctor's appointments and grocery stores), and
c. Return on investment (probably the investor's main concern), as well as any additional investment/development opportunities at other stops along the path the AEV would travel.

Be precise and concise, but consider the balance of information when determining what an investor would want to know about the vehicle design versus logistics questions such as where and how the vehicle would operate, its passenger capacity and time required to travel, return on investment, etc.

Discussion

1. Exchange your paragraphs with a partner on your AEV team, and read their response.
2. After reading your partner's response, take brief notes on the differences in how they framed the problems solved/opportunities created by the AEV project for the CEO versus for the outside investor.
3. With your entire group, discuss the responses—which response was most effective in framing the problem for the CEO? For the public investor? What made each response particularly effective?

Exercise D: Software Design Pitch Video Prep

User Interview Analysis Pitch

Background

The SDP requires that you create a pitch video 'selling' your game to the public, or to a potential investor. While these two audiences have differing concerns, both will want to see evidence that you can explain how your game appeals to its intended audience—specifically, how you've taken user input into account when designing and producing your game.

To convince either audience—the public or an investor—you'll need a **compelling** pitch explaining how your pitch video will 'sell' your game. In addition, your audience attention span and time is a key concern, so you will want to create an explanation that is both **precise and concise**, as well as **informative**.

Purpose

The purpose of the user interview analysis is to examine the

ways in which your interviews influenced the development of your game to help shape the best possible pitch video for potential game users/investors.

Practice

1. Review the results of your two user interviews, and write a paragraph summarizing the key takeaways from each interview that have influenced the development of your game(s).
2. Next, with your team, create a mini pitch (2 mins or less) for another group, analyzing your interview results and explaining how you plan to address this user input through **content/style choices** as your team crafts the pitch video for your video game (For example, if you noted that your user is interested in games that are fast paced and challenging, how will you capture/convey those qualities of your game in the pitch? Visually? Verbally? Be specific).
3. Pitch your video content and style to another group. Group members watching the presentation should take notes and provide feedback and suggestions based on whether content/style seems appropriate, given the audience for the pitch video and its purpose.
4. With your group, review the feedback you received and determine how you will use it to produce your pitch video.

Suggestions

Your user interview analysis should be precise and concise: For example, instead of saying you'll use visuals to 'catch the viewer's attention,' try, 'to address the user's interest in fast paced and challenging games, we will use rapid cuts between shots of users playing the game, as well as an exciting description of the key challenges users have to accomplish to win')Finally, pay careful attention to transitions and repetition of key terms so that your reader understands which strategies will be used to addressed which elements of your game that were influenced by the interviews.

Exercise E: Making Data Meaningful

Can the Numbers Speak for Themselves?: Managing Writing Style, Audience Expectations, and Context to Make AEV R&D Data Meaningful

Background

Engineering is founded on developing procedures and processes that generate data, which is then collected through a variety of means (software, equipment and instruments, paper and pen, photographs and sketches, etc.). We in STEM value the reliable and valid production of data, and depend on it to make decisions needed to develop innovations and maintain existing engineered systems and products.

While you may have heard the adage "the numbers speak for themselves," professional engineers understand that data, particularly "raw" data, should always be interpreted in context. The meaning one engineer understand from a data set may not align with what another engineer–even an engineer from the same discipline–sees. This is because contextual factors influence how we make meaning from data. Our interpretations

of data are influenced by our prior experiences with similar data, our understanding of the limitations of the data collection method or experimental design, or our knowledge of how the client wishes the data to be used.

What does this mean for writing and speaking about data? Simply that we must precisely and directly articulate what the data mean, as well as acknowledge the key contextual factors that contribute to that meaning and affect our interpretations and comparisons.

Practice

1. You have now run some preliminary tests of your AEV and collected data on its performance criteria. Now, **write an email** directed to the company CEO, explaining precisely and directly the results of your tests. **Explain what conclusions** you have made from these data (and how you came to those conclusion) as well as decisions for next steps in AEV development. Conclusions may range from insights about the efficacy of your code, the choice of braking system, the need to balance the weight distribution, or any other criterion on which your group has chosen to focus. You may use graphs of your AEV energy expenditure tests to support your conclusions and illustrate key points.
2. With your team, **present the results of your tests and your conclusions** to another team, using your energy expenditure graphs as visual aids.
3. Once both teams have presented, discuss your results together and determine the key differences between your designs and tests results.

Your email should not only describe what your conclusions and decisions are, but why/how you came to those conclusions and decisions. For example, "Based on an average stopping error of 30.5 cm per trial, we concluded that coasting is not a precise enough method to reduce the AEV's speed…"

Considerations:

- You may express raw data results (e.g., the AEV sample expended 120 joules to travel the course, while our AEV#1 expended 100 joules), but a comparison of the raw numbers is not useful for understanding the significance of your improvement. **How you can process and interpret the data to make it more meaningful**—and make the benefit to your innovation clearer—to the CEO (e.g., "AEV#1 was 16.67% more efficient than the AEV sample")?
- If you refer to your energy expenditure graphs to help support your explanation to the CEO, consider that graphs **can** help us visualize the raw data in a way that can make our interpretations easier to understand, but also they require interpretation. Explain your graphs of the energy expenditure data in terms of **direct comparison among prototypes**, using **precise units**, but also carefully **consider which units of comparison** are most useful for highlighting your most significant innovations to the initial model (e.g., perhaps your AEV is 15g lighter than the prototype, but the most significant difference is that your use of the motor reduces energy usage by 56% (100 joules)).

Discussion:

- How does listening to another team's presentation of tests results influence your team's ideas and conclusions about your design? Did it make you rethink any aspects of your design?
- Did the other team process and explain their data similarly to how your team did? What kind of comparisons best highlighted the AEV innovations that a team had made?
- Were there any instances where the presenting team could have interpreted or 'processed' the data to make it more meaningful or compelling? If they used them, were the graphs effectively used to support their claims? How so?

Exercise F: Precision and Paragraph Organization

Emphasizing the bottom line with precise (and appropriate) comparisons

Background

When comparing multiple variables in engineering it is tempting to write documents for readers that emphasize the key variables you—the engineer—worked with to derive your solution. But good technical communication is reader-oriented, meaning that it should precisely articulate your solution using key terms and ideas that your reader values and expects to find. You can achieve reader-oriented precision by focusing on your reader's key concerns and framing the solution to foreground that solution in those terms up front, as your reader begins reading.

In engineering, emphasizing the key idea in terms that concern your audience is often achieved through writing BLUF paragraphs; BLUF paragraphs are simply those that begin with a topic sentence that puts the most important information (to your reader, not to you!) at the fore. Put another way, it gets the

Bottom **L**ine **U**p **F**ront (BLUF!). The remainder of the paragraph is developed to support the bottom line from the topic sentence.

Practice

Your supervisor has asked you to analyze two recycling processes to reduce costs over 12 months. Using information about the processes provided below, write one or two paragraphs to your supervisor comparing them and recommending one that your supervisor should implement.

As you craft your paragraph(s) and your BLUF topic sentence, consider the following:

- What key concerns and priorities does your supervisor have?
- How can you organize your paragraph to ensure that your recommendation is framed to address those concerns and

priorities, specifically?

Discussion

1. Discuss with your team how your topic sentence clarifies the bottom line–the most important idea–and what information you chose to support that bottom line in the rest of the paragraph.
2. With what granularity did you break down savings (By month? By year?)? Why?
3. The variables provided by the supervisor include tons of recyclables processed, and dollars per ton of recyclables that remain unprocessed. You can compare the difference in these processes by comparing only tons of recyclables or only dollars saved. Considering your supervisor's concerns and priorities, what variables did you choose to address and why?

Exercise G: Logic, Cohesion, and the Bottom Line

Extension of MSE Economics Analysis

Background

Writing about concepts that are related, but where the relationship is not immediately obvious, requires particular attention to strategies for enhancing cohesion and clarifying the logical connections. Strategies for cohesion include the use of **transitions, threading words, and the repetition of key terms** [See Mechanics and Grammar if these terms are confusing to you]

Purpose

The purpose of this exercise is two-fold: 1.) you will practice writing well-organized, cohesive paragraphs with clear, bottom line topic sentences, and 2.) you will clearly interpret charts and data.

Practice

1. Use the Bureau of Labor Statistics page here to view average hours and earnings of production employees on manufacturing payrolls, by State.
2. Add two new columns on your table, and compare how costs of wages and office space could influence the overall cost of spring production based on locating your spring business in two different states. Create a chart that best represents the data for a prospective investor, including how each of the two states compares with the national average.
3. Addressing a prospective investor, write two paragraphs that contain the following contents:
    a. Summarize the data comparison done in #2 above, and
    b. Make a recommendation for where the spring business should be located and why, given your estimated total costs by location.

    In the paragraphs, you should refer to and explain the chart you created. Craft an **effective bottom line** for each paragraph that expresses the main takeaway and persuades your investor to continue reading; include **clear transitions, threading words, and repeated terms between ideas** in each sentence and paragraph (for example, what's the relationship you want to highlight between the cost of office space and the cost of wages?). When you're finished, review each sentence to ensure that you have expressed **only one main idea** in each sentence.

Discussion

1. Exchange your response with another member of your team. Identify the places where they incorporated strategies for cohesion (repeated terminology, demonstratives, pronouns, etc.). Return their response to them and discuss: What was challenging (or not) about incorporating the cohesion and logic strategies into writing your paragraph?
2. In what ways did the additional information about average hours and earnings of production employees on manufacturing payrolls influence your decision about where to locate your spring business? Did seeing the state by state breakdown change your ideas?
3. What choices did you make when designing your chart to best support your recommendation, visually, for an investor? (i.e., What type of chart did you choose and why? What about this format helps visualize the information most effectively?)

Exercise H: Telling a Story with Numbers

Creating Charts and Interpreting Data

Background

Data captured in tables can be used to support a variety of claims and for a variety of purposes. For example, a table representing vehicle engine reliability, electronics reliability, and body integrity across models and years can be used by an individual to support a decision to purchase (or not purchase) a particular vehicle. That same table might be used by engineers to prioritize areas for development in subsequent designs of that vehicle model. Essentially, how you use the data depends on your background, context, and purpose (Are you an engineer or a car buyer? Are you making a purchasing decision or working on a professional project?).

To succeed in engineering work and communication, we should recognize that context matters when determining what a data set or data representation means. In the case below, knowing that cost of living is often significantly higher outside of Ohio might change one's interpretation of the information. Context will matter for all interpretations of data, including

consideration of who is interested in the interpretation, and how they will be using it.

Purpose

The purpose of this activity is to help you practice writing claims about data for a particular audience and purpose, as well as to demonstrate how adding additional contextual data can change a claim that was well-supported by the initial set of data.

Practice

1. Review the data in the Table 1, entitled, "Average Annual Salaries for Bachelor of Science Graduates, Summer 2016-Spring 2017".
2. Using this data, create a chart (with a title, labeled axes, and a legend) comparing the average salaries that you could use to guide high school students who want salary influence the type of engineering major that they will choose. Consider, which fields tend to make the most money?
3. Write a paragraph addressed to a high school student who wants to select an engineering field based on the salary; using a comparison of the data, recommend which majors they should most closely consider.

Table 1: Average Annual Salaries & Hourly Wages for Undergraduate by Program, Summer 2016-Spring 2017

Engineering - Average Annual Salaries & Hourly Wages for Undergraduates by Program, Summer 2016-Spring 2017

Average Annual Salaries for Bachelor of Science Graduates, Summer 2016-Spring 2017						
Program	All Offers/Acceptances	Offers/Acceptances with Salary Information	Average Annual Salaries	25th Percentile	50th Percentile	75th Percentile
Aeronautical & Astronautical Engineering	46	31	$66,356	$60,750	$68,000	$69,900
Aviation	6	0	-	-	-	-
Biomedical Engineering	23	14	$60,201	$50,500	$60,000	$68,000
Chemical Engineering	192	112	$67,853	$63,000	$68,000	$74,000
Civil Engineering	151	78	$55,787	$50,000	$56,000	$60,000
Computer Science & Engineering	237	153	$75,488	$62,000	$70,000	$90,000
Electrical & Computer Engineering	162	112	$69,008	$63,351	$68,000	$73,125
Engineering Physics	9	*	$62,775	N/A	N/A	N/A
Environmental Engineering	30	16	$55,444	$50,990	$55,750	$62,000
Food Agricultural & Biological Engineering	23	12	$57,604	$51,500	$53,000	$66,625
Industrial & Systems Engineering	165	95	$65,411	$60,850	$65,000	$69,600
Materials Science & Engineering	48	35	$63,286	$61,500	$65,000	$66,950
Mechanical Engineering	181	120	$66,190	$62,000	$65,000	$69,000
Welding Engineering	53	30	$66,505	$62,500	$67,000	$71,344
Total	*1,326*	*812*	*$66,904*	*$60,000*	*$65,000*	*$71,500*

Discussion

1. Which majors did you initially recommend that students investigating salary might pursue? What were the key data points that supported that recommendation?
2. Now, review the data in the Table 2, entitled, "Reported Employment Location by Program for BS, MS, & PhD Graduates, Summer 2016-Spring 2017" ; consider that the cost of living varies significantly between Ohio and other states. **According to cityrating.com, the cost of living in Ohio is 8.16% lower than the national US average.** Consider, also, that some engineering fields tend to be located in rural areas (ChemE) while others are concentrated in urban centers with higher cost of living (CSE, for example).

   In what ways does this new contextual information influence your understanding of the data? In what ways could it lead you to alter your recommendation?

Table 2: Reported Employment Location by Program for BS, MS, & PhD Graduates, Summer 2016-Spring 2017

Reported Employment Location by Program for BS, MS, & PhD Graduates, Summer 2016-Spring 2017		
Program	**Ohio**	**Outside Ohio**
Aeronautical & Astronautical Engineering	46%	54%
Aviation	67%	33%
Biomedical Engineering	35%	65%
Chemical Engineering	57%	43%
Civil Engineering	68%	32%
Computer Science & Engineering	37%	63%
Electrical & Computer Engineering	39%	61%
Engineering Physics	71%	29%
Environmental Engineering	76%	24%
Food Agricultural & Biological Engineering	62%	38%
Industrial & Systems Engineering	50%	50%
Materials Science & Engineering	55%	45%
Mechanical Engineering	49%	51%
Nuclear Engineering	40%	60%
Welding Engineering	47%	53%
Total	***49%***	***51%***

1. Finally, is there any additional data that you could use to further nuance your understanding of this information and further modify your initial claim?
    a. *e.g., civil engineers earn slightly more than environmental engineers, on average, upon graduation; does that difference persist after 5 years of industry experience? How do salary outcomes compare between environmental engineers and civil engineers with a master's degree? How significantly does the 'weight' of the student's interest in salary influence the interpretation of the data? Are there any non-fiscal benefits that could influence the high school student's decision (e.g., interest in/passion for the subject; family pressure/identity associated with engineering discipline; benefits/vacation/flextime of various employers in each field; average number of*

hours worked/week by discipline, etc.)?

Exercise I: Using and Explaining Graphics

Explaining screening and scoring charts verbally to peers

Background

The purpose of this exercise is to help you practice delivering verbal interpretations of graphics, in particular, tables. From your work with hand drawing and designing AEV components in Solidworks, you already understand how much a drawing can communicate without any accompanying written or oral explanation. However, you can also see how much training is needed to accurately and meaningfully interpret these drawings.

Other graphs and charts are similar, in that they can convey a great deal of meaning, but don't translate seamlessly across audiences who differ in terms of interest, need, and background. Even graphics produced by different AEV teams may be interpreted differently because of different value judgments made by each team (e.g., Team K values stability over energy costs, but Team G values speed and energy efficiency above all other factors). Graphics that seem simple to us once we

understand their context and purpose may still be completely opaque to those who don't share our same situational context.

The screening and scoring charts you created in your performance tests helped you make decisions based on quantifiable differences among various modifications to your AEV. These same tables can usefully provide an outsider with a technical background with a way to compare your designs' performance across a number of criteria quickly and easily. However, missing from their interpretations are important, value-based decisions you made about criteria to evaluate and how to weight those criteria. Providing that information to an external audience can clarify the role of those decisions in your design process, as well as help you practice explaining your design process to an outside audience.

The goal of this exercise is to help you practice verbally presenting the content of your screening and scoring charts, as well as the design-and thought-processes behind their creation. You will practice creating, delivering, and providing feedback on verbal presentations, and also practice thinking and speaking critically about your choices for evaluating your AEV designs.

Practice

1. Write a title and a caption for each of your screening and scoring charts.
2. Next, with your group, prepare a 2 minute presentation addressing the following topics:
    a. Explain how you developed and used the screening and scoring charts—how did you decide what criteria to compare? How did you decide what criteria *not* to compare?

   b. Explain the conclusions the charts helped you to derive about your AEV designs; be sure to explain your rationale for criteria chosen to be evaluated, as well as your rationale for weighting criteria (in the scoring chart).
3. Now, each group should choose two presenters to deliver the presentation to two different groups, using the screening and scoring charts as visual aids.
4. Group members *listening* to presentations should take notes on the following:
   a. Why did they choose the criteria compared on their scoring charts?
   b. Do you agree with their rationale for weighting each criterion? Why or why not?
   c. What, if anything, could this presenter do to **clarify the presentation's content** or **strengthen their physical delivery of the content** (e.g., more explanation of the rationale behind the criteria compared OR more eye contact and less mumbling).
5. When all presenters are finished, listening team members will verbally deliver their feedback and provide notes to presenters.
6. Presenters will return to their groups and verbally present to their groups the feedback they received. This information should be taken into account in further writing about the rationale for the team's design decisions, and should be used to influence how teams discuss their choices during the AEV competition.

Exercise J: Interpreting Graphs in Context

Prompt

You are working with a client as a financial advisor, and you have produced a graph to help your client understand how each of the investment accounts will behave over time. Write your client a paragraph outlining an investment forecast and recommending in which type of account they should invest.

Considerations

In your paragraph, to support your claims you should use comparisons of the data and an explanation of the chart trendlines on the next tab. Address whether the client is looking to invest short term (five years or less) or long term (longer than five years).

Discussion

1. With your teammates, and then with the whole class, discuss: Which type of account did you recommend? How was your recommendation influenced by the duration of the investment? (i.e., why does the contextual information about the client's investment duration matter, and how

does it influence your recommendation?)

2. Which of the chart types on the following Excel page, titled "Chart Types" will be most useful for supporting your recommendations? Why?