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Guidelines for Technical Communication Department Guidance

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FOREWORD

The purpose of this guide is to spell out what "right" looks like in technical writing and presenting. As you compose your papers and presentations in your math, science, and engineering classes, refer to these pages for advice on communicating like a professional. The audience for this guide is West Point cadets, and feedback from West Point cadets helped to shape and improve it. The guide's main body outlines the fundamental principles of good technical writing and presenting. Because West Point cadets are often short on time, this main body was kept as short as possible, but it is supplemented by appendices containing examples and advice on special topics.

This is a living document; feedback is encouraged! If you have ideas for how this guide could be improved, please send an email to the address below:

Please send feedback to setcfeedback@westpoint.edu.

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1 INTRODUCTION

Communicating technical information is a critical skill for Army officers. Your ability to inform, explain, clarify, and persuade will help you to be a good leader and a good team member. One day, your communication skills could even help save billions of dollars or the lives of others.

Whatever your current communication ability, you can improve. This is as true of a first-semester cadet as a four-star general. This document is meant to guide you in this process. It is an introduction to basic principles of good technical writing and presenting. Its intended audience consists of West Point cadets enrolled in science, math, and engineering courses, although cadets in other departments should also find the information useful. By the time you have finished reading, you should:

- Understand the basic principles of good technical writing and presenting.
- Be able to use those principles to assess and improve your papers and presentations.
- Understand how your ability to communicate will be assessed in your technical classes.

1.1 What is Technical Communication?

Technical communication is the exchange of *technical information*, coming from topics such as science, technology, defense, and medicine. Technical communicators often speak in a "language" of jargon and other concepts known by members of their specific profession. For an example, think of all the terms, acronyms, and diagrams unique to the Army that you have been exposed to at West Point. Technical communication includes the papers, presentations, and problem sets that you will work on in your classes. The term is also used in the professional world to refer to technical manuals or communicating using technology,[1] but these are not the focus of this guide.

1.2 Motivation

The way we communicate influences how others think of us and our work. When we communicate poorly, we frustrate and bore our audience, making it hard for them to take us seriously. But when we write and present seriously, professionally, and with pride, we encourage and inspire our audience, and they will be more likely to listen to us and even trust us.

1.3 Scope

The advice in this document is meant to get you started improving your communication, to get you noticing and practicing new things, and to steer you in the right direction. It is not an exhaustive style guide, a textbook, or a replacement for a course in technical communication. If you would like to learn more about technical communication and communication in general, these books are a good place to start:

1. *The Elements of Style*, by William Strunk Jr. and E.B. White.
2. *The Sense of Style*, by Steven Pinker.
3. *Handbook of Technical Writing*, by Gerald J. Alred, Charles T. Brusaw, and Walter E. Oliu.
4. *A Guide to Writing as an Engineer*, by David F. Beer and David A. McMurrey.
5. *Pocket Book of Technical Writing for Engineers and Scientists*, by Leo Finkelstein, Jr.

1.4 West Point Writing Program

The West Point Writing Program (WPWP) is another resource for learning about and improving your technical communication. A primary goal of the WPWP is to help you to develop your writing ability so that you

can succeed both at West Point and as an Army officer. Use the WPWP to help you assess and improve your work. You can find more information about the WPWP in the Resources section (Appendix C).

1.5 Document Outline

This guide consists of a main body followed by appendices, which contain supplemental guidance on specific topics. In the main body, Section 2 describes three models meant to help you understand the basics of good communication, which are described in Section 3; Section 4 describes principles of good writing specifically, while Section 5 does the same for presenting; Section 6 discusses how your communication will be assessed in your classes; and Section 7 concludes. In the appendix, Appendix A contains supplementary guidance on a myriad of topics, including emails, abstracts, executive summaries, quad charts, and technical posters; Appendix B contains examples of good technical writing; Appendix C outlines useful external resources; Appendix D contains checklists to help you complete your assignments; and Appendices E and F contain this guide's citations and references, respectively.

A final note: to avoid the awkward constructions of gender neutrality—*he or she*, *his or hers*, and so on—a gender was assigned to various hypothetical people in this guide with no intent except for brevity.

2 MODELS

Scientists and engineers spend a lot of time using models to think about their work and the world. Below are three communication-related models that will help you to think about your papers and presentations.

2.1 The Communication Model

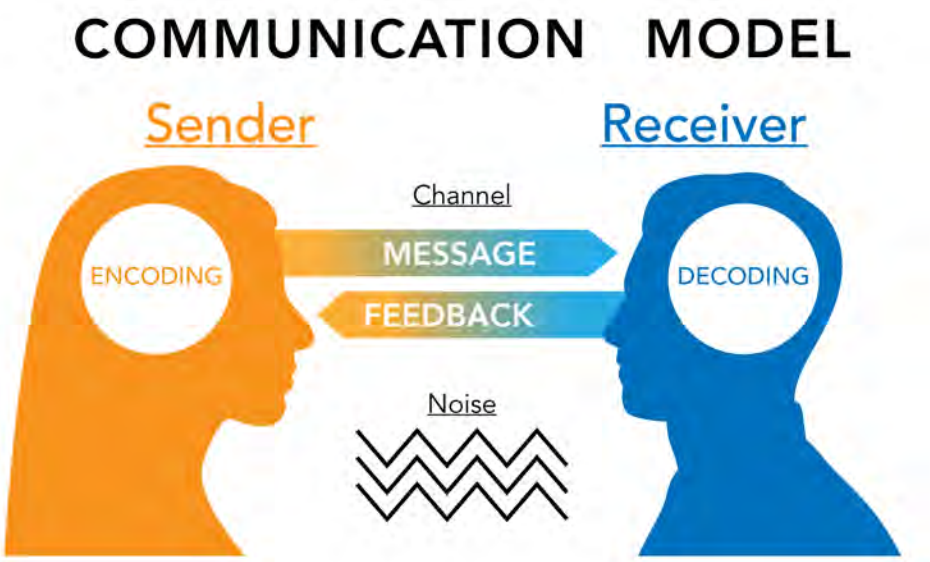


Figure 1: A classic model of two-way communication.

When we communicate, our goal is to share information and understand one another. Say that you want to communicate something to a friend. First, you have to decide how—you might send a text, use social media, talk over the phone or in person, or even sketch a picture. Whatever your choice, you have to convert the information from how it exists in your mind into some *message* that your friend can sense, usually through vision or hearing. Crafting the message is often the hardest part of the process, especially when we are restricted in our method of communication. To experience this yourself, try to explain to someone how to tie their shoes using words only—no pictures, no demonstrations.

As your friend receives your message, he will try to understand it. Hopefully, you will end up on the same page, meaning your understanding and your friend's are close. If they are not, it could be for a variety of reasons: your words were not clear, Autocorrect mangled your text, your friend could not hear you, or he did not have some necessary background knowledge. Whatever the outcome, he can tell you how well he understood you so that you can adjust your message accordingly, although it is often up to the person sending the message to ask for this feedback.

This process is depicted in Figure 1: a classic model of two-way communication. Although it shows a conversation between two people, you can extend it to any number of people and any form of communication.

In this model, you are the *sender*, who wants to share information with your friend, the *receiver*. Your choice of medium—words, a picture, etc.—is called the *channel*. You convert the information in your head into a *message*—a process called *encoding*—that you communicate along the channel. Anything that interferes with the message is called *noise*. Your friend then *decodes* the message and forms his own understanding. He might then offer *feedback*, which is also subject to noise.

Your papers and presentations follow the same process: you are the sender, your audience is the receiver, and your words and pictures are your message. Communicating well is about creating a message that is well suited to your audience, adjusting your message based on feedback, and minimizing noise, which you can think of in two groups:

- Physical noise: visual or audio interference like poor lighting, distracting sounds in the room, hard-to-read text or figures, and, importantly, unnecessary words and pictures in the message.
- Perceptive noise: distractions related to the sender or receiver. For example, while watching a presentation, you might be distracted by a presenter who cannot stand still or by a bad font or color choice. You might also be distracted for personal reasons, such as a test in your next class or hunger and tiredness.

2.2 The System Model

Scientists and engineers spend a lot of time thinking about *systems*. A *system* is "an integrated set of elements that accomplishes a defined objective."[2] Systems are made up of parts (elements) that work together. Each part serves a purpose, and together the parts serve some greater purpose—the system's objective—that they could not achieve on their own. A car, an airplane, and the Army are all systems.

You can adapt the system model to help you create good papers and presentations. Like systems, all papers and presentations have a purpose and are made up of parts that work together to achieve that purpose. Each part also serves its own purpose within the greater whole. For example, in a standard five-paragraph essay, each paragraph is a subsystem of the overall essay, each supports the overall objective of the essay—to inform and perhaps persuade, and each has its own individual purpose—for example, one purpose of the introduction is to present a thesis statement.

For systems to work, they must be *integrated*, meaning their parts must be connected and work together. The same applies to the parts of your papers and presentations: they should build on each other logically and transition into one another. Integrating can help you avoid the classic mediocre paper or presentation: one in which the required components are there (i.e., the "boxes are checked") but there is no logical flow between those components. Communicating without logical flow is like piling a bunch of spark plugs, valves, pistons, and cylinders into a big heap and calling it a working car engine.

Communicating with logical flow means presenting information so that it builds on itself in a way that makes sense to people who are unfamiliar with that information. This means several things, including providing background to ensure the audience can understand your work, starting general before getting specific, explaining how the parts of your work relate to each other as you move through them (known as *transitioning*), and only including information that serves a purpose.

2.3 The Technical Communication Model

Technical communication is often used to explain complex and high-stakes topics that are not easy to understand. Technical communication should be:

- **Clear.** Good technical communication is direct, accurate, factually correct, and simple. It is not ambiguous (multiple interpretations), vague (no clear interpretation), or redundant (unnecessary interpretations).
- **Concise.** Good technical communication contains only the content necessary to get its message across. It also uses figures and tables to help the audience understand the message with fewer written or spoken words.
- **Precise.** Good technical communication uses technical terms correctly. Using the wrong terms confuses and distracts the audience.
- **Purposeful.** Good technical communication is driven by a purpose involving the audience and the effect the work is meant to have on them.
- **Consistent.** Good technical communication uses a single voice and tone and is consistent in the use of tense, lists, punctuation, captions, and capitalization.

In short, ensure that your assignments are:

CLEAR – CONCISE – PRECISE – PURPOSEFUL – CONSISTENT

2.4 Conclusion

As you work on your papers and presentations, keep these models in mind. They will help you to keep the ultimate purpose of your work in mind: to communicate a well-crafted, cohesive message that your audience can understand. The advice in the next few sections will help you achieve this.

3 BASIC PRINCIPLES

This section outlines nine principles of good communication that apply to both writing and presenting. Afterwards, Section 4 goes into more detail for writing and Section 5 does the same for presenting.

3.1 Communicate with Purpose

All engineered systems require a purpose. A system's purpose drives its design and is the basis for judging its quality. You can improve your papers and presentations by making them purpose driven. For this to work, make your purposes **specific** to your content and your audience; **attainable**, given your constraints (e.g., time and page limits); **relevant** to your project and its stakeholders; and **impactful** to the audience, meaning your goal should be to affect the audience, not just make information available to them.

For example, say that you need to recommend a course of action (COA) to your senior leadership based on an analysis that you have run, and you have been given 10 minutes to brief your recommendation. The purpose of your briefing might be something such as "Brief my senior leadership on the situation requiring action, the available COAs, and my recommended COA such that they can make an informed decision." The impact of this purpose is in the last phrase: *such that they can make an informed decision*. This element of the purpose—combined with your knowledge of the audience, your knowledge of the material, and your time constraints—will drive what gets put into the briefing, what gets left out of it, and how it all fits together.

You can extend this approach to lower levels by considering the purpose of individual sections and slides. At times, you may want to consider the purpose of individual words to help you decide if you should keep or delete them.

3.2 Use the Right Format

Format refers to the appearance and high-level contents of your work, including everything from your margins to your fonts to your slide template to your cover sheet. The right format is important because using the wrong one can make it hard or impossible for your message to reach its audience. This is because:

- It makes the audience think that you cannot follow directions.
- It makes it harder for the audience to understand your work.
- Publications that call for a specific format will not accept the wrong one.

When a specific format is required in class, you will be informed which one to use. In the Army, formatting guidelines for many types of documents are described in Army Regulation 25-50 (see Appendix C for a link). Sometimes, you will be required to use a specific *style guide* that defines your formatting rules, as described in Section 4.7.

3.3 Omit Needless Words

In communication, less is more: write or say only what is necessary to fulfill the purpose of your work. As Strunk & White put it, you should "omit needless words,"[3] but you can extend that principle to omitting needless figures, tables, and anything else that does not serve a purpose. Writing or saying too much distracts the audience, gives them more to criticize, dilutes your necessary content, and makes it harder to edit your work. It is like designing a machine with unnecessary parts: all they do is make the machine overly complicated, more likely to fail, and harder to fix.

3.4 Make it Professional

Professionals take their jobs seriously. When you apply the same philosophy to your papers and presentations, then your audience will take you and your message seriously. To be a professional communicator:

- **Be consistent** in your style to avoid distracting the audience. Consistency is especially important in group work, where you and your teammates have to combine your contributions into a single product. Even minor things can distract an audience, such as ending some bullets with periods and others without.

- **Be honest** about the state of your work. Not knowing everything, having only preliminary results or an incomplete design, and having unresolved questions are necessary parts of technical work and should be discussed openly.
- **Own your work** by understanding and working towards the point of the assignment, not just the elements of the rubric. If you are not sure what the point of the assignment is, ask your instructor.
- **Be on time.** To help you meet your deadlines, have a plan to deal with printer and email problems and other last-minute issues.
- **Serve the audience.** Make your work pleasing to look at by using high-quality images, clean tables, an easy-to-read font, and an appropriate template. Also, *know your audience* and tailor your work to them. More on knowing your audience in the next section.

3.5 Know your Audience

Imagine that you have been asked to describe what your life is like at West Point. Consider how you might respond differently to each of these people: your five-year-old nephew, your cousin around the same age as you, a stranger at the airport, your tactical officer (TAC), a grandparent, your career Navy aunt, a friend from childhood, a prospective cadet in high school, and the Superintendent.

You would probably give a wide range of responses. Your nephew, for example, has less life experience than your cousin, and so he will not be able to understand as much, and the prospective cadet in high school is going to care about different things than your grandparent.

These are elements of *knowing your audience*. To know your audience means having answers to the following questions:

1. What does your audience know before seeing your work?
2. What does your audience need to know to understand your work?
3. What is your audience hoping to get out of your work (i.e., what do they care about)?

By tailoring your work to your audience, you will help them to understand it. They will also be grateful to you for not speaking above or below their understanding. Tailoring your work involves two elements: *content* and *level*. *Content* refers to what information you communicate, while *level* refers to the detail and scope of that content. Thinking back to your two relatives, say that you gave the following answers:

- To your five-year-old nephew: “Being a cadet is hard, but I am learning a lot, and so it’s worth it!”
- To your cousin around the same age: “Being a cadet is hard at times, especially when I get a lot of work all at once. It reminds me a bit of high school in that way. But I’m learning a lot of valuable leadership skills that will help as an officer. I’m also looking forward to my capstone project.”

The content of these messages is similar, but you went into more detail with your cousin, explaining more about why being a cadet is hard and the sorts of things you are learning. You also came to a conclusion with your nephew—*it’s worth it!*—whereas you did not with your cousin.

We would call your answer to your nephew *high-level* and your answer to your cousin *low-level*. High-level communication is focused on breadth, conclusions, impacts, take-aways, answering *so what?*, the bird’s eye view, and the forest (not the trees). Low-level communication is in the weeds, focusing on depth, details, processes, rigor, answering *how did you figure this out?*, the worm’s eye view, and the trees (not the forest).

Different levels are appropriate for different audiences. For example, an audience of engineers is more likely to care about the lower-level technical details of your work, whereas an audience of non-technical decision makers is more likely to care about the higher-level impact of your work on their project goals. Different levels are also appropriate for different settings. For example, a written report has much more room for low-level details than, say, a ten-minute presentation. Your choice of level also depends on the state of your work—the further along it is, the more low-level details you might have to communicate.

Explaining a topic at a high level does not make the message incomplete or wrong any more than viewing your house from an airplane makes the picture less accurate than viewing it from the street. In fact, explaining at a high level is critical when you are briefing an audience that is either short on time or not as technically knowledgeable as you.

Sports, with their arcane rules and devoted fans, are a good setting for understanding leveling. Below are three explanations for baseball's *infield fly rule*, each at a different level.

- **Low Level:** Baseball's *infield fly rule* is enacted when there are zero or one outs, runners on first and second base or the bases are loaded, and the batter hits a fly ball to the infield that, in the umpire's estimation, is catchable with ordinary effort. When this situation occurs, the batter is called out and the runners may advance at their own risk. This rule prevents infielders from automatically acquiring multiple outs by intentionally dropping the ball and then forcing out two or more runners who, because of the pop fly, have remained close to their respective bases.

- **Medium Level:** Baseball's *infield fly rule* is meant to prevent an automatic double or triple play whenever a catchable pop fly to the infield is hit. It is enacted in circumstances where this could take place and results in the batter being immediately called out.

- **High Level:** Baseball's *infield fly rule* is enacted under special circumstances to prevent giving an unfair advantage to the defensive team.

Notice that the high-level explanation is not wrong; it is just less detailed than the other two explanations. However, for certain audiences, this explanation may be well tailored to what they know and what they want to know.

3.6 Lay a Foundation

Start your papers and presentations with a clear, strong introduction. Introductions prepare the audience for the material to come, motivate them to read or listen to it, and give them the background they need to understand it. They also set the audience's expectations, helping them to mentally organize your message. As you might be thinking, creating good introductions is strongly tied to knowing your audience.

Think of an introduction like the foundation of a house. Just as a foundation anchors a house to the ground below, good introductions anchor your work to what the audience already knows about your subject area. They do this by providing the background information that your audience might not yet have but requires to understand and appreciate your work.* Without it, they will have no place upon which to "build" their understanding.

For example, say that you were briefing a senior Army audience on a new unmanned aerial vehicle (UAV) that will be used by the Corps of Engineers for surveying bridges and roads. You could be confident that this audience knows about the Corps of Engineers and its role in the Army ("what the audience already knows"), but they might not be familiar with the particulars of the surveying missions that the UAV will be used for and why they are important. For them to understand and appreciate your UAV, you would first provide background on these missions. This information would also equalize your audience, who might have different backgrounds and familiarity with your technical area.

Other important components of introductions include:

- The **purpose**, including what your audience should come away with and potentially what you wish to learn from your audience (Section 1 is an example).

- The **scope**, including what your work does and does not address (Section 1.3 is an example).

- An **outline** of the major sections and their contents (Section 1.5 is an example).

- An early **summary** of critical takeaways, as in a *bottom line up front* (BLUF) statement.

*In this context, *appreciate your work* means to understand its importance and implications.

3.7 Prepare Well

There is an old saying: "Give me five minutes to chop down a tree, and I will spend the first three sharpening my axe." In other words, to do a job well, you must prepare well.

You can prepare well and save time in your papers and presentations by understanding their purpose and then creating an outline. Outlines do not need to be complex, they can just be a list of the major sections of your paper or presentation, but you can also expand them to include the purpose and high-level contents of each section as well as the transitions between them. Using outlines helps you to keep the intended end state of your work in mind as you are working towards it. Remember the motto of the International Honor Society for Systems Engineering: "Think about the end before the beginning."[4]

3.8 Proofread and Peer Review

Proofreading means reviewing your work to correct mistakes and refine your words and graphics. *Peer review* means having others (i.e., your peers) review your work.

You should proofread not only to correct typos and other obvious errors, but also to refine your message. However, sometimes you will get so familiar with your own work that you will not be able to tell if it needs refining or how well others will understand it—a phenomenon called the *curse of knowledge*.[5] That is the value of peer review: someone unfamiliar with the work can give you a better sense of how understandable it will be to your audience.[†]

It can be tempting to bypass these steps in an effort to save time, but do not. Remember, it is usually better to have less to say but to say it well than to have more to say but to say it poorly. Proofread your work and have it peer reviewed to make sure that you say it well.

3.9 Pay Attention and Practice

No matter your current ability, you can become a better technical communicator. Fortunately, you are surrounded by others trying to do the same thing. This means you are in the perfect place to *pay attention* and *practice*.

To *pay attention* means to observe and assess your communication style and those of others, including your classmates and instructors. For example, when you watch presentations, notice what the presenters do well and what they could do better. Learn from their examples and apply those lessons in your presentations. Apply the same principles when you are peer reviewing others' work.

To *practice* means to present and write often and to mindfully incorporate your lessons learned into each presentation or paper. As with any skill, the more you practice, the better you will become, but if you practice well, then you will improve by leaps and bounds instead of by baby steps.

3.10 Conclusion

The principles outlined above are the place to start as you work to improve your papers and presentations. The next section goes into further detail for creating good papers, while Section 5 does the same for presentations.

[†] As you make revisions, save old versions of your work along the way. Sometimes you will want to reintroduce work that you had thought you no longer needed.

4 TECHNICAL WRITING

Writing will be one of your primary modes of communication as an officer. This section introduces a few basic concepts that apply to written technical communication, shortened to just *papers* below.

Papers are a static form of communication; they are completed before the reader sees them and then can be read at any time and for as much time as the reader likes. This mode of communication is unlike presentations, which require some real-time improvisation and last a limited amount of time. Because they are static, papers are well suited to communicating detail, especially low-level detail. Writing also lets you choose and refine your words carefully, as opposed to improvised speaking. You will encounter many kinds of written technical communication at West Point: reports, essays, orders, white papers, memoranda, and even some emails. This section concentrates on technical reports, although the principles outlined below can be generalized to other types of written communication. You can also find guidance on writing good emails in Appendix A.

4.1 Software

You will write most of your formal papers using word processing software, for which there are two major categories:

- **WYSIWYG.** Pronounced "WIZ-ee-wig," WYSIWYG stands for "what you see is what you get." In WYSIWYG programs, the appearance of the text on screen closely resembles how it will look printed or made into a Portable Document Format (PDF) file. Microsoft Word, Google Docs, and Apple's Pages are all WYSIWYG software.
- **Markup Languages.** Markup languages are like coding for documents. The markup language LaTeX (pronounced "lah-TEK")[‡] is widely used in technical fields. It is often required for technical reports and dissertations in the professional world, and it is especially useful for writing math. This document, for example, was written in LaTeX. R Markdown, which converts analyses created in R into "high-quality documents, reports, presentations, and dashboards,"[6] is another example. To learn more about LaTeX and R Markdown, see Appendix C.

Each choice has advantages and disadvantages. LaTeX, for example, is highly configurable and handles graphics and mathematics well, but it is harder to learn than a WYSIWYG program such as Microsoft Word.

All of these software packages can automate parts of the writing process for you. For example, Microsoft Word can automatically manage your table of contents, citations, and figure and table captions. Check the Internet for instructions on how to use these tools. Also, be aware that instructors may require you to use specific software for some assignments.

4.2 Technical Reports

Technical reports are among the longest and most detailed papers that you will write. They tend to have several main body sections, a table of contents, an executive summary or abstract, several figures and tables, and one or more appendices. However, their most important parts are the introduction, main body, and conclusion, which are the focus of the guidance below. You can find more guidance on abstracts and executive summaries in Appendix A.

4.2.1 More on Introductions

The importance of good introductions was mentioned back in Section 3.6. Introductions are especially important in papers, which may contain a lot of low-level detail that cannot be understood without the right background knowledge. Your audience needs this background knowledge to decode your message, as described in Section 2.1.

To help your audience appreciate your work, discuss its **motivation** by introducing your topic and why it is worth studying. The motivation often includes an extended problem statement, such as the following made-up paragraph:

[‡] Although this pronunciation is common, in reality, there is no one universally accepted pronunciation of LaTeX. However, to avoid sounding like a newbie, do not pronounce it like the clothing fiber.

> *Flood models are used by insurance companies to determine the likelihood of catastrophic flooding in a given year. For the Beatnavy River of Upstate New York, most flood models were created between 1930 and 1945 and do not take into account recent shifts in flood patterns caused by climate change. As a result, flood insurance rates in the Beatnavy River Valley no longer reflect actual probabilities of catastrophic flooding. To prevent costly mismatches between insurance rates and flood rates, new flood models are required.*

Notice that the problem statement introduces a "gap," or the problem that needs to be solved—in this case, the mismatch between insurance rates and rates of flooding, which is followed by how the work will fill that gap—by introducing new flood models.

A **background** section contains information the reader needs to understand and think critically about your work. For the example above, the background might include a brief history of flood modeling, a description of the hydrology of the Beatnavy River Valley, a description of recent changes in flood patterns, or an introduction to the modeling techniques used in your study.

In your paper's **scope**, describe what the paper is and is not about and the topics that it does and does not cover. Scopes set your readers' expectations. For the example above, you might state that the work addresses current changes in flood patterns but does not anticipate future changes: a topic that readers might reasonably expect to see. It is these sorts of topics that are close to yet outside of a paper's subject area that are important to address in the "does not cover" part of the scope. This guide contains a scope in Section 1.3.

In the **outline**, you give the reader a road map of your paper, briefly explaining the contents of each section. This guide contains an outline in Section 1.5.

Finally, **literature reviews** are surveys of the current state of research for your topic. They serve three purposes:[7]

1. To give your readers relevant background information regarding your research.

2. To demonstrate your familiarity with the research in your field.

3. To show how your work contributes to that field.

Literature reviews are important to both researchers and their audience—for the researchers, literature reviews help define the unresolved questions in their subject area, and for their audience, literature reviews help establish the impact and validity of the researchers' work. At West Point, literature reviews are an important element of capstone projects. To complete one, first consider the purpose of your work. Then, find research that relates to yours. For the flood model problem described above, you might identify research on climate change and the Beatnavy River Valley; however, because establishing new flood models is the purpose of the work, flood models are where you would concentrate, including their history and current status. Next, summarize the research, establishing for your audience how it relates to yours and how your work contributes to the subject area. This last part is key—it is not enough to just list the research and describe it, you must show how each example is connected to the others and to your own work.

4.2.2 The Main Body

The main body has two goals. The first is to describe the approach that you followed to get your results, including your methods, processes, experimental setup, models, assumptions, limitations, and constraints. You should include enough detail so that someone reading your paper could replicate your work.

The second goal is to present the results themselves. Your results might include the outcome of a simulation or physical experiment; your system's proposed design; your stakeholder findings, conclusions, and recommendations; and a myriad of other information. Be sure to discuss this information to help your reader understand it and its significance.

Cadets are often curious about whether a particular piece of information belongs in the main body or in an appendix. The following rule of thumb may help: if the information is necessary for the audience to understand your work or it supports a necessary explanation, it belongs in the main body; if the information

may be of interest to some readers but is not necessary, put it in an appendix.

4.2.3 Conclusions

The conclusion is your last interaction with most readers. Use it to summarize the key points and significance of your work. Depending on the paper, you might also describe your next steps. Regardless, do not introduce any new technical information in the conclusion.

Some papers, such as this one, end each section with a conclusion. When this is the case, use the mid-paper conclusions to transition to the next section.

After your conclusions come your appendices, if any. Appendices should have the same quality of language and presentation as the rest of your document. Avoid the temptation to use your appendices as an information junkyard!

4.3 Figures and Tables

Figures and tables are *display items*, which help you to make your message more concise and understandable. They condense information, make your work more appealing to the audience, focus your main points, and support discussion. Figures can be pictures, plots, schematics, and other graphics. All figures require a caption containing a label (e.g., Figure 1) and a short description. Tables are grids of text arranged into horizontal rows and vertical columns. Like figures, they require a caption with a label and description. The first row of a table is called the *header row*. Note that captions typically go below figures and above tables.

Display items convey information more efficiently than blocks of text if the display items are appropriate, readable, and clean. Good tables have row heights, column widths, cell padding, and borders that make the text easy to read. One common problem is for a table's column widths to be too narrow, breaking individual words in the header into multiple lines, as in the example below:

Project Descriptio n

Avoid this by adjusting the column widths, adding hyphens between syllables (e.g., Descrip-tion) and line breaking, or by rotating the header words 90 degrees counterclockwise so that they read bottom to top instead of left to right. All three of these solutions are shown below:

Project Description

Project Descrip- tion

Project Description

Also, never use screenshots from Excel in your papers (or presentations). Instead, either remake your Excel tables in your word processing software or, if you are using compatible software such as Word, copy and paste the tables into your paper and then adjust their styles so that they match the rest of it.

All display items must be addressed in your text, as in, "Table 10.2 is a sample of the system performance data." In many cases, you will also have to describe the display item's contents or explain to the reader how to interpret them. You may also wish to call out specific aspects of the display item to help the reader follow your logic, as in, "Observe that the most common score was between 85% and 90%."

Here are more tips for working with display items:

- Because your figures and tables may "float" as you write your paper, meaning their positions may change, reference them by their label, not by their position. For example, write, "See Figure 2" as opposed to, "See the figure below."
- Write captions clearly, descriptively, and with punctuation.
- Make sure that audiences can understand your figures even if they are not in color.

For examples showing how to use figures and tables, see Appendix B.2.

4.4 Equations and Other Technical Matter

Most technical work is quantitative, including elements such as mathematical models, data, equations, units, dimensions, uncertainty, and error analysis. As described in Section 2.3, clarity, conciseness, precision, purpose, and consistency are especially important to this kind of written work. The advice outlined below will help you to ensure that your technical writing has these qualities.

4.4.1 Equations

Mathematics is a common element of technical writing that you will use to both explain your approach and, in some assignments, show your work. Like figures and tables, math can be used to condense and enhance your papers. When including math, be sure to number your equations sequentially, define all terms, and use the right number of significant digits.

You should also use proper symbols. For example, write $\geq$, $\leq$, and x^2, not $>=$, $<=$, and $x\hat{}2$. If you are using WYSIWYG software, then following these two suggestions may help: (1) learn the hotkeys for subscript and superscript, and (2) maintain a separate document containing common mathematical symbols that you can copy and paste from.

Regarding significant digits: the more that you include in a result, the more precision you are ascribing to it. For example, imagine that a person told you that it took them 30 minutes to get ready in the morning, while another person told you that it took them 30.05 minutes. The numerical difference between these two amounts is small, but the difference in their meanings is large: the first case implies much more variability than the second. Your calculator has no sense of this and will output answers at maximum precision, so it is up to you to round those answers to a number of digits that makes sense for your work.

Italicize variables in equations, as in $E = mc^2$. Equations that are short or do not require a number, such as the one just written, can be written in-line with your text, but you should separate important or long equations, as in the following:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}. \tag{1}$$

Note that this equation has an equation number and ends with a period—it has been punctuated so that it reads like it is part of a sentence, which is good practice. See Appendices B.3 and B.4 for more examples of equations in technical writing.

4.4.2 Other Technical Matter

The following advice may also be helpful to you.

- **Terms and terminology.** To ensure that your work is clear and understood, always use correct and precise terms. For example, *availability* and *reliability* are related but not the same, just as *fluid mechanics* and *fluid dynamics* are related but not the same.
- **Glossary of Variables.** If your paper contains many variables, then include a glossary of variables before the introduction.
- **Abbreviations.** Abbreviations, including acronyms, are often used in technical communication for brevity. Use them correctly by doing the following:
  - Identify and define abbreviations in parentheses the first time you use them, as in, “computational fluid dynamics (CFD).”
  - Before abbreviations, use the indefinite article (*a* or *an*) corresponding to the pronunciation of the first letter, not the word that the first letter stands for. For example, “an LCD screen” is correct, even though you would write “a liquid crystal display screen” if you were not using the abbreviation.
  - Pluralize abbreviations by adding a lowercase *s*, as in “LCDs.” Do not use an apostrophe unless you want to indicate possession or if the plural construction is confusing without the apostrophe, as in, “The student earned four A’s this semester.”

- **Numbers.** Numbers can be written as numerals (1, 2, 3) or words (one, two, three), and they can be cardinal (one, two three) or ordinal (first, second, third). Here are some essentials to keep your numbers straight:
  - Generally speaking, write whole cardinal numbers as words up to nine and as numerals beyond. For example, "The girl had three toy spaceships," and, "The dog was 14 years old."
  - Write numerals if they are accompanied by units of measure, as in $5 and 12.4 m.
  - Write numbers as words when they begin a sentence.
  - Add a lowercase *s* to numerals to form a plural.
  - Add a zero before a decimal point for numbers less than one, as in 0.5 (as opposed to .5).
  - Mixed numerals—a whole number and a fraction—should be connected by a hyphen, as in 3-1/2 m.
  - Use scientific notation for large or small numbers, as in 6.02×10^{23} and 5.2×10^{-21} m/s.

  You may encounter situations that call for modifying some of these rules or for rules not captured above. When in doubt, consult the style guide governing your work (see Section 4.7 for more on style guides).

- **Units of measure.** The command "Cadets, take charge of your UNITS!" is important in the classroom as well as on the parade field. Label your units and use the correct symbols. Do not italicize them, unlike variables in equations or algorithms, which should be italicized. For example the "m" representing mass in $E = mc^2$ is italicized, but the "m" representing meters in "The building was 10 m high" is not.

- **Data collection and reporting.** Mathematical uncertainty is an unavoidable part of technical work and is especially important for measurements taken from laboratory instruments. See the Science Laboratory Analysis Manual (SLAM) for a full treatment of this topic, including components of a measurement, types of uncertainty, reporting measurements appropriately, uncertainty propagation, types of error, error reduction methods, statistical evaluation of results, and more. A link is available in Appendix C.

4.5 Writing Style

Although some aspects of technical communication are hard and fast rules of best practice, others are a matter of personal style. This subsection describes a few stylistic choices that you may encounter as you compose papers.

4.5.1 Passive and Active Voice

The most basic components of an English sentence are the *subject* and the *predicate*. The subject is the thing about which the predicate makes an assertion, and the predicate is the assertion that is made about the subject. Note that the predicate is usually a verb and the words that come after it. For example, in "The cadet wrote the paper," "The cadet" is the subject and "wrote the paper" is the predicate.[8]

When the subject is doing the acting in a sentence, we call it the *active voice*. When the subject is being acted on, we call it the *passive voice*. For example:

- "The cadet wrote the paper" is active voice and "The cadet" is the subject.
- "The paper was written by the cadet" is passive voice and "The paper" is the subject.

Importantly, with passive voice, we do not have to name the person or thing doing the acting (the *actor*), and so we can shorten the second example above to:

- "The paper was written."

Conventional wisdom holds that active voice is strong and passive voice is weak. Indeed, active voice is more direct and concise and is how people usually talk in conversation. But there are times when passive voice is necessary, especially in technical writing. For example, sometimes the actor is irrelevant and distracting:[9]

- Active voice: "Steve analyzed the blood samples."
- Passive voice, with actor: "The blood samples were analyzed by Steve."
- Passive voice, without actor: "The blood samples were analyzed."

It probably does not matter that Steve in particular did the analysis; what matters is that the blood was analyzed. This is often the case in technical writing: the action is important and the actor is not. When this is true, passive voice is appropriate.

Passive voice is also appropriate when you want to change the emphasis of a sentence by changing its subject. In the example above, the active voice construction emphasized "Steve" as the subject and the passive voice construction emphasized "The blood samples" as the subject.

Although passive voice is appropriate at times, it is commonly overused in technical writing. As you write and review your papers, consider whether or not each use of passive voice can be changed to the active, especially if you have named the actor. Table 1 contains sentences naming the actor in both passive and active voice. For each one, consider how the directness and emphasis of the sentences change as you go from passive to active.

Table 1: Example sentences in passive and active voice.

Passive Voice	**Active Voice**
The surveys were filled out by the stakeholders.	The stakeholders filled out the surveys.
The brigade was led by COL J. Doe.	COL J. Doe led the brigade.
These truths are held by us to be self-evident...	We hold these truths to be self-evident...
The physical fitness test was passed by all cadets.	All cadets passed the physical fitness test.
The highest honors were earned by Matt.	Matt earned the highest honors.
A fixed-wing design was recommended by the design team.	The design team recommended a fixed-wing design.
The Commander-in-Chief's Trophy was won by Army.	Army won the Commander-in-Chief's Trophy.

Things get interesting when the choice between active and passive voice is not obvious. This may happen, for example, when it is not clear if the actor should be named. When you are not sure, err on the side of the active voice for its directness and conciseness. But be aware that the choice between active and passive voice is not purely stylistic; when we use passive voice to avoid naming actors, then those actors become dissociated from their actions. This might shield the actors from blame, which can be a diplomatic act, a pernicious one, or both. The phrase "mistakes were made," for example, is infamous for its use by politicians to admit wrongdoing while evading personal responsibility.[10] As an officer, you must be guided by your personal and professional ethics when making these choices.

4.5.2 Nominalization and "Zombie Nouns"

English verbs and adjectives can be transformed into nouns, often by adding suffixes such as "-ion," "-ity," "-ment," and "-ness." For example, you can transform the verb "discuss" into the noun "discussion" and the adjective "equal" into the noun "equality." We call this transformation *nominalization*. Note that the noun "nominalization" is, itself, a nominalization of the verb "nominalize," just as "transformation" is a nominalization of the verb "transform."

In terms of their effects on your writing and speaking, nominalization is similar to passive voice in some key ways:

- Both are frequently necessary yet commonly overused elements of technical communication.
- Both can weaken your words when used inappropriately.
- Both can be used to dissociate actors from their actions.

Consider the sentence, "The cadet presented the results." Nominalize the verb "present" into "presentation" and you might obtain, "The cadet's presentation was about the results." But thanks to this transformation, we no longer need to name the original actor of "present," meaning we can just write, "The presentation was about the results."

There is nothing inherently bad about this process. Nominalization, like passive voice, is simply a tool that English speakers can use to help express their thoughts. For example, if your intent is to emphasize what the cadet presented rather than who did the presenting, then the last sentence in the example above may be appropriate. (You could communicate a similar message in passive voice by writing, "The results were presented.") Nobody would argue that we should do away with necessary words such as *transformation*, *presentation*, and *equality*. But just as physical tools can be used inappropriately, so can linguistic tools such as nominalization and passive voice.

When we nominalize inappropriately, the result is often referred to as a *zombie noun*, because it can "suck the lifeblood" from your words by making the actors and their actions less clear.[11] These enervating words tend to follow vague verbs such as *use*, *make*, *do*, *give*, *perform*, *issue* and *provide*.[12] In the following examples, taking out the nominalization (struck-through text) in favor of the corresponding verb (bold text) strengthens the language:

- The staff should ~~perform an evaluation of~~ **evaluate** the new classroom design.
- The GPS readout will ~~give an indication of~~ **indicate** the airplane's location.
- The instructor will ~~issue a response~~ **respond** to the cadet's question.
- When we ~~use nominalization~~ **nominalize** inappropriately, the result is often referred to as a *zombie noun*.

Finally, remember the power of nominalization to dissociate actors from their actions and the role of your own personal and professional ethics in choosing to use this power.

4.5.3 First, Second, and Third Person

Person, in this context, refers to the individuals or things that a speaker is referring to ("speaker" is used metaphorically here and includes written words):

- If the speaker is referring to him or herself, we call it *first person*, as in, "I like to swim."
- If the speaker is referring to the persons or things being spoken to, we call it *second person*, as in, "You like to swim."
- If the speaker is referring to someone or something else, we call it *third person*, as in, "He likes to swim."

You can differentiate first, second, and third person based on the personal pronouns being used, as outlined in Table 2.[13] However, be aware that "they" and its related forms are also commonly used as singular pronouns in casual conversation and even in some formal writing. "They" has a long history of being used to refer to someone whose gender is unknown or unimportant, and more recently, it has been used to refer to someone who does not identify as male or female.[14]

A common question in technical writing is whether or not to use the first person. A sentence in first person such as "We interviewed the stakeholders" would instead be something such as "The research team interviewed the stakeholders" or "The stakeholders were interviewed" if you were avoiding it. Notice the passive construction of the last sentence, which is a common, but not inevitable, consequence of avoiding first person.

Table 2: Personal pronouns in first, second, and third person.

Person	Singular	Plural
First	I, me, my, mine	we, us, our, ours
Second	you, your, yours	you, your, yours
Third	he, him, his, she, her, hers, it, its	they, them, their, theirs

First person results in a more personal and perhaps less formal style of writing. It attaches you to your work by making you the actor in your descriptions, as in, "We analyzed the results," instead of, "The results were analyzed." It also results in more direct, active constructions. However, first person can also make your writing seem less objective, and it can divert focus from your work to you. For example, compare "From our analysis of the data, we obtained the following results," to, "From an analysis of the data, the following results were obtained." The first person statement emphasizes that you performed the analysis, making the results seem less like fact and more like opinion.

Some technical professionals and publications will insist that you avoid first person, while others will be fine with it. When you can choose, it is a matter of personal preference. You can also mix the use of first person with other styles to emphasize first person's strengths and avoid its weaknesses.

What about second person? Second person is aimed squarely at the reader and is sometimes so direct that it comes across as accusatory and unsettling. It is rare in technical writing, especially reports and journal articles, but it can be a good choice when your paper contains instructions or advice. This guide, for example, uses second person frequently. The reason why is because sentences such as "You can also mix the use of first person..." are more direct than alternatives such as "Cadets can also mix the use of first person..." or "First person and other styles can also be mixed..."

Because of its directness, second person is sometimes the most effective way to communicate danger. For example, compare the following notional warnings about gasoline-powered generators:[15]

1. Using a generator indoors can be fatal.
2. Using a generator indoors can kill you.

Which do you find more compelling?

4.5.4 Other Matters of Style

There are many other stylistic decisions that you will make as you write your papers, including the following:

- **Sentence Lengths.** Shorter sentences are direct, matter-of-fact, urgent, and serious. Longer sentences are slower-paced and can be useful when you want to linger on a description and take your time expressing a thought.
- **Lists.** Some lists work well in-line with your text (e.g., "apples, oranges, and bananas"), while others work well bulleted or enumerated. Enumerated lists are numbered, whereas bulleted lists (such as this one) are not; using an enumerated lists implies that the order of the elements matters, which is not true for bulleted lists.
- **Sectioning.** You will usually decide how to partition your content into sections and subsections. Try to do so in a way that puts equally important blocks of thought into the same levels of the hierarchy. You may also need to decide how to name your sections; using short, standard names such as *Introduction*, *Methodology*, and *Conclusion* is good practice. And finally, you may have to choose the depth of your hierarchy. For example, this document numbers down to the sub-subsection level (e.g., Section 4.5.4). Although numbering at lower levels can help you to organize a paper, going down too far can be distracting.
- **Tense.** It is not always clear when a document should be written in future, present, or past tense, and sometimes a writer must change tense depending on the section of the document. Like with

other matters of style where the choice is not clear, the most important thing is to be consistent with whatever choice you make.

4.6 Common Issues

The following guidance addresses some common writing issues that you may run into.

4.6.1 Write Like You Speak, then Clean it Up

Unfortunately, academic and technical writing are full of bad examples: unclear descriptions, wordy prose, unnecessary jargon, and overused passive voice and nominalization. This style is common enough that some technical writers try to imitate it, leading to bad habits.

To avoid those habits, try explaining your topic out loud. Talking comes more naturally to some people than writing, and speaking out loud can help you explain the topic more clearly. Pretend that you are speaking to your TAC, an instructor that you like, or an older family member—someone you are familiar with but might speak to more formally than a sibling or friend. Afterwards, write down what you said, then clean up the result. To make this technique easier, you could record what you say and then transcribe it.

Talking out loud is also a good technique when you are proofreading your work. If your work sounds good spoken aloud, it will probably "sound" good on the page.

As you follow this guidance, keep in mind that technical writing should not include slang or other common elements of spoken (but not written) language. The goal is to write naturally, not informally.

4.6.2 Quantify, Avoid Meaningless Words

Imagine that you read the following sentence about astronomy: "The surface of this star is hot." Compare that to the sentence, "The surface of this star is very hot." What difference does *very* make in this case? Does it change ten thousand degrees to twenty thousand? Ten million to twenty million? On its own, *very* adds nothing.

Two important principles come from this example:

1. **When you can, quantify.** Instead of saying "hot" or "very hot," the sentence would have been clearer if it had just stated the temperature of the star. Numbers are specific where words are often vague. Use numbers wherever you can.

2. **Avoid meaningless words.** As stated, the word *very* in the star example is meaningless. *Very* and similar intensifiers[§] add no value when there are no numbers offering context. These words can also weaken your message by turning an absolute into something not. For example, "The cadet is honest" is more powerful than "The cadet is very honest," which makes it seem as if the cadet could maybe be more honest than he or she already is.[16]

Terms such as *very* are appropriate when you combine them with a number to show that the number is remarkable. For example, you could write, "The cadet earned a very high score on the test: 94.9%." Without the number, you have no idea how well the cadet scored, and without the word *very*, you might not get the sense that 94.9% is noteworthy.[17]

4.6.3 When Working in Groups, Integrate

Writing in a group has particular challenges. For one thing, it adds the extra step of integrating the work done by each group member into a single product. Integration is an important phase of systems design; it is the step where the parts of the system are put together. Connecting the parts usually creates unexpected problems that must be fixed to get the system working the way it should. Integration is also an important phase of group writing. As you work on your group assignments, make sure that you program in enough time to combine each cadet's work into a seamless product. The result should read as if one person wrote it.

4.6.4 Other Issues

The following are other common issues that you should be aware of:

[§]Similar words include *extremely*, *entirely*, *completely*, *incredibly*, *exceedingly*, *slightly*, *rather*, *somewhat*, *immensely*, and *hugely*.

- **Page numbers.** Always number the pages of your papers. You may also want to include the total number of pages (e.g., "Page 7 of 9"), especially if you expect the pages to be separated.
- **Use one font.** Unless you have a good reason to do otherwise, use a single font throughout your paper, including on your headers, footers, and page numbers. Good reasons to switch fonts include writing code, math, or pull quotes.
- **Capitalization.** Know and follow the rules of English capitalization. Abbreviations such as GPS, for example, must be capitalized. Also, you are a member of the US Army, a proper noun that must also be capitalized.
- **Contractions.** Contractions are shortened versions of words created by omitting or altering sounds and letters. For example, "don't" is a contraction of "do not." Do not use contractions in technical writing.

4.7 Style Guides

A *style guide* is a list of rules dictating, among other things, how to format your paper, how to write certain words, and how to cite sources. One of the most common style guides in technical publications is the Institute of Electrical and Electronics Engineers (IEEE) standard. The American Psychological Association (APA) style, which this guide uses for its citations, is another example. The Army has its own style guides, such as the aforementioned Army Regulation 25-50.

The purpose of style guides is to encourage consistency, which is key to communication. If you are not told a particular style guide to use, then pick a common one such as IEEE or APA for the practice.

4.8 Conclusion

Writing technical papers is a satisfying challenge. It is not easy to translate the details of your work into something concise and understandable, but once you have done it, the result is a permanent exhibition of your accomplishments. However, technical papers are not the only way in which you share your work with an audience. They are often accompanied by a presentation where you stand before the audience and explain what you have done. This is the subject of the next section.

5 TECHNICAL PRESENTING

Presentations accompany papers for good reason: they complement each other. Although papers are well suited to conveying detail, they do not support the kind of face-to-face interaction that is crucial to working in groups. This is the role of presentations.

When you present, you interact with the audience in person and in real time. Because the audience can see and hear you, you can not only answer their questions but also show them enthusiasm, confidence, and empathy—all important qualities of leadership.[¶] But presentations are time constrained, which makes it critical to explain your ideas clearly.

In the technical world, presentations usually consist of one or more speakers (the presenters) accompanied by prepared slides. Although the presenters might use notes to help guide their words, they typically do not read from a script—this differentiates presentations from formal speeches. This semi-improvised style is flexible, letting the presenter change her words and emphasis based on the needs of the audience. It also requires preparation—the presenter must understand her subject matter well enough to be able to speak about it without a script.

This is the type of presentation you will most often give, and so it is the focus of this guide. However, you can generalize the advice given below to other forms of presentations, including those without slides.

5.1 Good Presenters are Leaders

As the presenter, you are in charge, you provide the information, you are the subject matter expert, and you lead the discussion. The audience looks to you to guide their focus and attention, and the better you lead them, the better they will understand and appreciate your work.

This kind of leadership is in many ways analogous to military leadership; presenters and officers are both in positions of power and knowledge, and they inspire trust through their professional demeanor, preparation, empathy, enthusiasm, and confidence. As you learn to lead during your time at West Point, use those leadership skills in your presentations.

5.2 Slide Rules

Slides are important tools for presenters. Used correctly, they help you to communicate your message. To ensure that your slides are helpful, keep the following guidance in mind:

1. **The focus of the audience is the presenter; the focus of the presenter is the audience.** As the presenter, you should be the focus of the audience's attention, not your slides. Similarly, you should focus on your audience. Your slides are there to support your message, not to control it.
2. **The slides must be able to stand on their own.** Craft your slides so that they make sense, are accurate, and get your essential points across even if you are not there to present them.

You can think of these rules like a pair of opposing forces, with the first encouraging sparse slides with few words and graphics and the second encouraging dense slides with many words and graphics. Too far in one direction and the slides will make little sense on their own,[‖] but too far in the other direction and the slides will read like documents, making the presenter unnecessary or, even worse, a distraction.

A generic slide that balances these two rules is built as follows: a title, a few bullet points, a graphic, and a takeaway statement (see Section 5.4.5). The bullets should be short and direct, like news headlines for what you will say out loud. Returning to the Beatnavy River example, your bullets for the work's motivation might be as follows:

- Flood models estimate probability of catastrophic flood.
- Insurance companies use models to set rates.

[¶] Conveying enthusiasm, confidence, and empathy becomes more difficult, but not impossible, in presentations given via teleconference. See Section 5.7 for more.

[‖] Sparse slides are okay in some types of presentations. The slides in TED talks, for example, tend to be built this way (https://www.ted.com/).

- Models for Beatnavy River are out of date.
- New models are required to ensure rates are fair.

Notice that these bullets are a condensed, high-level version of the problem statement on page 11.

These kinds of slides fill a double role. When you are not there to present them, they still convey your high-level points. This satisfies a practical concern: slides are often emailed to people who will not see you present. When you are there, then the audience will read your slides as you present them, making them a written supplement to what you will say out loud. This combination of written and spoken presentation helps your audience to follow your logic and retain your message.

There will be times when you want to make your slides sparser or denser than the example described above. This is fine—different situations call for different solutions. However, no matter your approach, you should not read directly from your slides; most of the time this is a crutch that will make the audience think you do not know your material, and it takes your focus away from your audience. Keeping your bullet points short will help you to avoid reading from them.

Finally, take advantage of the visual nature of presentations by including relevant graphics, such as pictures and figures, in your slides. Graphics break up the monotony of words on slides and can make the difference between a boring presentation and an engaging one. For the example described above, a relevant graphic might be a topographical map of the Beatnavy River Valley or perhaps a historical photo of the valley while it was flooded.

5.3 The Parts of a Presentation

Much of the advice for papers in the previous section applies well to presentations. After all, presentations also contain an introduction, main body, conclusion, words, figures, tables, and equations. But the audience of a presentation spends much less time with its material than the reader of a paper, and so their components are handled differently.**

5.3.1 Even More on Introductions

Title Slide

Your first interaction with most audiences is your title slide, which might be displayed for several minutes before you start talking. Make a good first impression by including the right elements: the presentation date, the venue (if appropriate), your name and those of your teammates, a picture or graphic (if appropriate), and a descriptive title. For class assignments, the title should reflect the contents of the presentation, not the name of the assignment. For example, “UAV Design for Corps of Engineers Surveys” is much better than “Final Project.”

Begin your introduction on the title slide by introducing yourself and your topic. Tell your audience the motivation for your work and preview your results. All of this should be done before moving on to your second slide. Doing this accomplishes the following:

1. It immediately focuses the audience’s attention on you and not your slides.
2. It immediately focuses your attention on the audience and not your slides.
3. It demonstrates your knowledge of the material.

Summary

A summary makes a good second slide. Use it to tell your audience your high-level takeaways before you present them. A summary sets your audience’s expectations and makes it easier for them to understand your work. For military audiences, calling the summary a BLUF slide is appropriate.

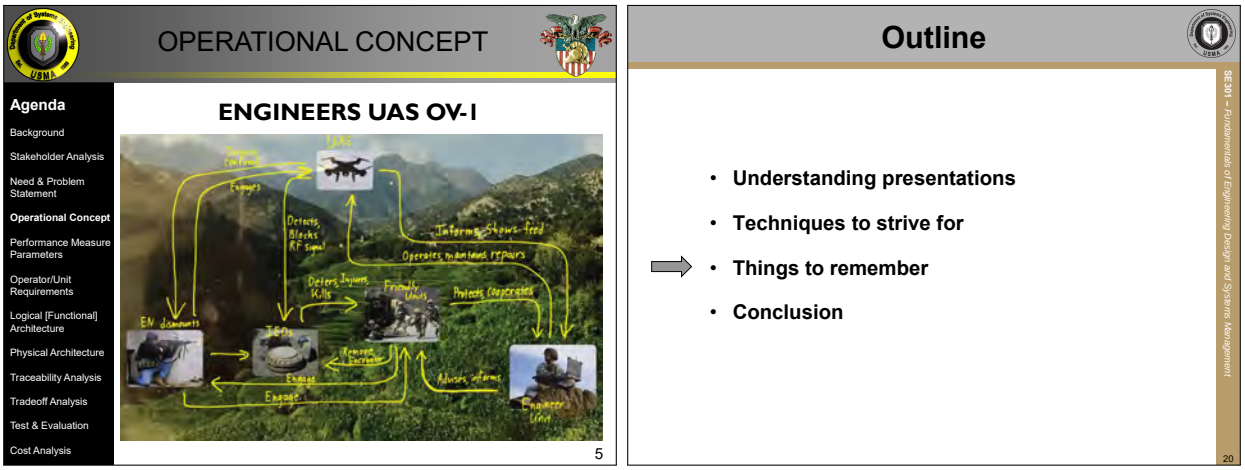
**Especially short presentations might not contain all of the parts outlined below. For example, a two-minute status update briefing will probably not need an agenda slide.

Agenda
Your agenda slide is an outline of the major sections of your presentation—it is often called the "Outline" slide for this reason. Many presenters rush past this slide, taking only enough time to name each section, which the audience could just read on their own. A better idea is to briefly describe each section and what you will discuss in it. This more-detailed agenda further prepares the audience for what you will be discussing.

Your agenda is the audience's road map; use it to regularly remind them of where they are in your presentation. There are two common ways to handle this, both of which are depicted in Figure 2:[18]

1. Show the agenda on every slide of your presentation, not including the title, in some unobtrusive place, noting the current section in bold or with some other obvious sign (Figure 2a).

2. Return to the agenda slide between sections, noting the one coming up next with an arrow or in bold (Figure 2b).



(a) Agenda shown on all slides (current section bolded). (b) Agenda shown between sections.

Figure 2: Two ways to remind the audience of the agenda.

Other Parts of the Introduction
The rest of your introduction should contain your motivation, background, and scope, as described in Section 4.2.1. Literature reviews are not typically part of technical presentations.

5.3.2 Main Body
The main body contains the bulk of your material. If you are presenting the results of an experiment or system design, then explain how you obtained the results and describe them, just as with papers. However, because presentations are time limited, your descriptions will usually need to be higher level than in a corresponding paper. Sometimes your audience will be interested in lower-level detail, which you can anticipate with backup slides (see below).

5.3.3 Conclusion and Backup Slides
Use your conclusion to remind your audience of the key takeaways of your work. As with papers, do not introduce any new technical information in the conclusion. You may also want to mention your next steps.

After the conclusion, include a slide thanking the audience for their attention and asking if they have any questions, if appropriate. This slide is an opportunity to post your contact information (usually your email address), which should be included in your presentation.

Your backup slides come next. Like appendices, they consist of noncritical material that may be of interest to some of your audience. Give the same care to your backup slides that you give to the rest of your

presentation; it will impress the audience when you respond to one of their questions with a well-crafted backup slide.

5.3.4 The Three T's

Your introduction, main body, and conclusion satisfy a classic piece of communication advice: *tell them what you're going to tell them, tell them, then tell them what you told them*. In other words, introduce the topic, explain the topic, then summarize the topic. This technique helps the audience to understand your material while you are explaining it and remember it once you are done.

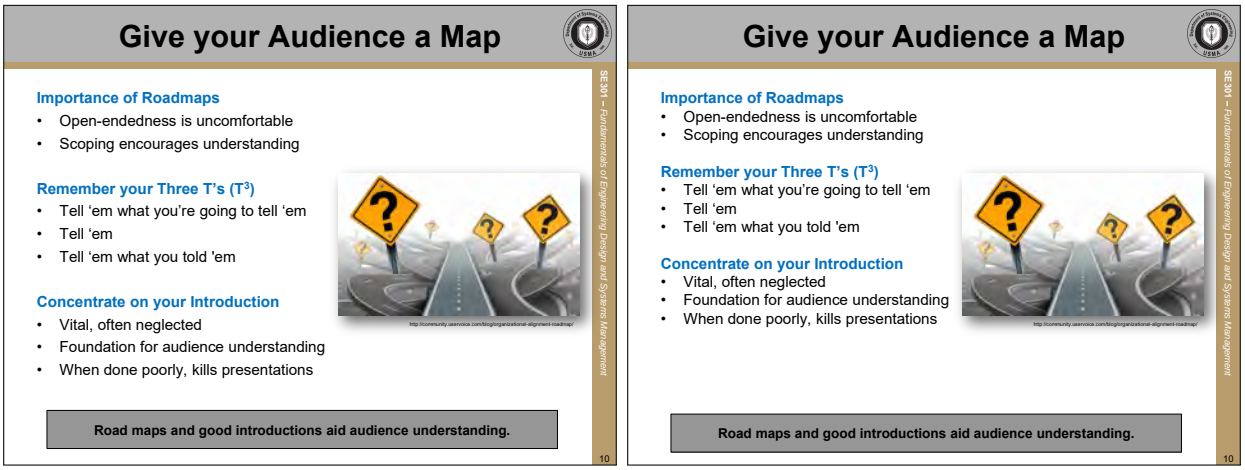
5.4 Helping Your Audience

The audience of a presentation needs to take in a lot of information quickly. With good slide design, you can make their job easier.

5.4.1 Aesthetics

First and foremost, your slides should be easy to read and aesthetically pleasing. Use font sizes between 14 and 20 points, including in your figures and tables, although titles can be larger and footnotes can be smaller. Spread out your text and figures so they are balanced on the slide, as in Figure 3a. Use a white background—they make your slides easier to print and are more compatible with most graphics than a dark background.

Remember that the colors in your slides will contrast much more on your computer monitor than when they are projected. If your content depends on color to be understood, use colors that are easy to distinguish and print your slides in color. Also, be familiar with the different types of color blindness and their prevalence.[††]



(a) Good balance.

(b) Poor balance.

Figure 3: A good and poor example of balancing white space.

5.4.2 Figures and Tables

Figures and tables, collectively *display items*, are useful in presentations for the same reason as in papers: they convey information quickly and concisely. However, depending on your audience's background, some of your display items may need explanation to be understood. You can do this out loud, though to help your slides stand on their own, you should also annotate them. Example annotations include:

- Highlighted table cells pointing out important results.

[††]For example, the most common type of color blindness—red-green—affects up to 8% of men and 0.5% of women of northern European ancestry.[19]

- Colored text differentiating desirable and undesirable results—often green and red, respectively.
- Explanatory arrows and text next to the axes of a graph. For example, you might include a vertical arrow next to the *y*-axis of a graph with text stating, "More is better."
- Text next to the curve of a plot explaining a trend or noteworthy feature, such as, "As time passes, system failure probability increases," "Values diverge for large values of *x*," or "Lift decreases for larger angles of attack."

Be careful not to add so many annotations that the slide gets bogged down—a few are helpful, too many are distracting.

Labeling your display items (Figure 1, Table 1, etc.) is optional in most presentations; usually your audience will reference them by slide number and not by figure or table number. However, there is nothing wrong with doing so if that is your preference. You may also want to label display items that share a slide with others to help differentiate them.

5.4.3 Ordering and Transitions

Order your slides so that they build on each other logically. To help yourself and your audience understand the logic, use transitions. Transitions are verbal cues showing the audience how the parts of your presentation are connected. For example: "Now that we've seen how the simulation was set up, let's take a look at some preliminary results."

Develop your transitions as you develop your slides. Doing so will help you to organize your slides and your thoughts, making it that much easier to present them.

One effective way to transition is to ask a question that you immediately answer. You can even write the question at the top of a slide. For example, you could begin a slide with "What functions must the UAV perform to accomplish its mission?" and then go on to answer the question.[20]

5.4.4 Animation

Only animate your slides if doing so supports your message. (In this context, *animation* refers to PowerPoint animations, not embedded movies.) For example, you might reveal groups of words or graphics on successive mouse clicks to help you explain a topic. If you do, keep the animations subtle: use simple appearances or fades, not flashy fly-ins, wheels, or grow & turns.

An alternative to using animations is to make small changes across a group of similar slides, much like a flip book. For example, if you wanted to reveal three groups of words sequentially, then your first slide would show the first group, your second slide would show the first and second, and your third slide would show all three. This technique is a way to preserve your "animation" even when you print the slides or convert them to PDF, but it will also inflate your slide count.

5.4.5 Bumpers

Members of your audience will get distracted from time to time. To help them stay up to speed as you present, use slide bumpers. A bumper is a short statement that explains a slide's takeaway. It is generally one or two sentences long and appears at the bottom of the slide. Someone who reads the bumper should understand enough of the slide's message to keep following your presentation, which is useful even when no one is distracted. Bumpers are especially useful for complicated slides where the takeaway is not obvious or requires some explanation. Figure 3 contains bumpers, as does Figure 4.[21]

5.5 Designing for Time

Presentations all have time limits, ranging from a few minutes to a few hours. The best way to judge your presentation's duration is to rehearse it, but for the early stages of slide development, a good rule of thumb is to allocate a minute per slide. For example, for a 20-minute presentation, target 20 slides, then adjust as necessary.

5.6 Getting Ready

The best way to present well is to rehearse. Rehearsing helps you to set your pace, transition between slides, switch between group members, and work out complicated explanations ahead of time. The audi-

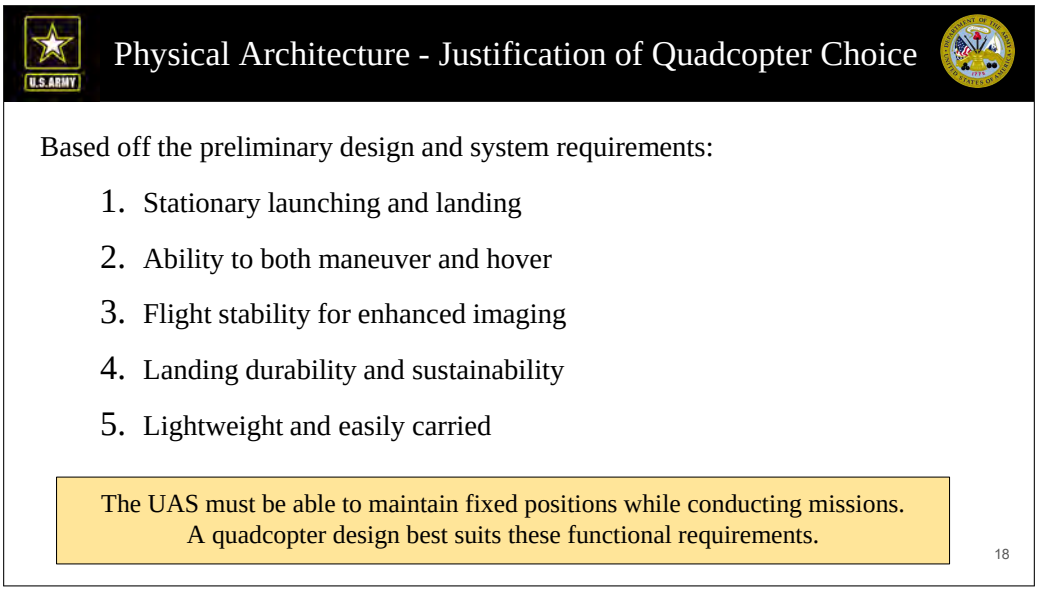


Figure 4: A slide with a bumper.

ence can easily tell when a presentation has been rehearsed—it is smoother and the presenters are more confident.

Introductions are often the hardest part of a presentation to present. During the introduction, you are still finding your rhythm and building your energy, and the content of the introduction may make it the most difficult part to explain. The introduction should be your priority when you rehearse. Next, prioritize your conclusion, your transitions, and finally your main body content.

When you can, rehearse in the same room that you will present in. Doing so will help you to be less nervous and lets you see how readable your slides will be.

Finally, have a plan for when the projector breaks, the Internet does not work, a group member is sick, or something else does not go according to plan. You will be expected to present even when things go wrong, and it looks good when you can take unexpected problems in stride.

5.7 During the Presentation

Bearing

When you are not confined to a podium, stand close to but not in front of your projected slides in a confident stance. You do not need to stand still, but be aware that the more you move during the presentation, the more energy you will add to it. A small amount of energy helps keep the audience interested, but too much can distract them and make them nervous.

Sometimes presenters move more than they intend because they themselves are nervous. A good practice is to have someone record you as you present so that you can observe your habits and make any necessary changes for your next presentation.

Pay attention to your tone of voice, volume, enunciation, and rate of speech. Your goal should be to project confidence while being easy to understand throughout the room, although be careful to not project so much confidence that you come across as aggressive or arrogant. Often presenters need to speak louder and slower than they typically do in conversation, but this is not true of everyone.

Maintain eye contact with the audience as much as possible and keep your hands out of your pockets. It is fine to gesture with your hands, but like moving around, gesturing too much can distract the audience and make them nervous.

Tools
You may wish to use the following tools during your presentations:

- **Remote clickers/laser pointers.** These devices let you control your slides without being confined to the computer keyboard and they let you direct the audience's focus without having to stand in front of your slides to point to them. A manual pointer (e.g., a stick) also works in a pinch.
- **Light switches.** Control the light in the room to help your audience see the projector screen. Many classrooms have extra light switches right next to the projector screen.
- **Note cards.** Note cards are useful to remind you of important talking points. Try to use them as little as possible, however, and do not read directly from them. It can also be helpful to have a printout of your slides to help you transition between them. Some cadets use tablets during presentations instead of printouts.[22] One advantage of tablets is that you can use them to reference your files and notes to help answer audience questions.
- **Printouts.** When feasible, print out your slides and hand them out to the audience, or at least the most important members of the audience. Aside from being classy, printing your slides demonstrates your preparation and helps the audience follow along. You should also retain a copy for yourself as a backup in case the projector breaks.

Group Presentations
When presenting in a group, decide who will brief each slide ahead of time and make sure that each group member is prepared to present his slides—it looks amateurish when presenters fumble between slides or correct their fellow group members during the presentation. Also, have each group member present a few slides before switching to the next one—any more frequent and the audience will be distracted.

Answering Questions
As you receive questions from the audience, restate the questions out loud before you answer them. Doing so accomplishes two things:

1. When you are the only one on a microphone, it ensures that everyone in the audience hears each question.
2. It ensures that you understand the question before you start answering it.

When you do not know the answer to a question, be honest about it and offer to follow up with the audience member who asked the question.

Teleconferences
Presenting via teleconference is cheaper and easier than traveling to meet face-to-face, but it also comes with challenges: you might not be able to see your audience, your audience might not be able to see the slides on your screen as you present them, and regardless, there will always be some lag on the line.

To help your teleconference presentations go smoothly, do the following:

- Email your slides ahead of time.[‡‡] Doing so ensures that your audience can view them even if you are not sharing your screen.
- Regularly remind the audience of the current slide number, especially if they cannot see your screen.
- Regularly pause to ask for questions.
- Inform the audience of who is in the room with you as you present.
- If your presentation results in action items, review those action items at the end of the call and then email them out to the group.

[‡‡] It is usually best to email a PDF version of your slides so they cannot be altered before being distributed further.

5.8 Common Issues

The following are common issues that cadets encounter in their presentations:

- **Slide numbers.** Number every slide except the title slide. Your audience will use the slide numbers in their questions and comments.
- **Transferring from Google Slides.** Google Slides is a great way to build a presentation in a group, but if you later migrate the slides into PowerPoint, look out for the formatting errors that often result.
- **West Point template.** Unless you have good reason to do otherwise, always present using a West Point template while you are a cadet.
- **Image sources.** If you need to cite an image source, do so on the slide that the image is embedded in. You can make the citation small and unobtrusive so long as it is readable on a printout.

5.9 Conclusion

Technical papers are important, but it is during your presentations that you make your strongest impressions on people. It takes courage to stand in front of a room and show an audience the work you have done, and in some situations, your presentations will be your only interactions with important people in your chain of command. All of this can make presenting a daunting experience. But if you approach it methodically and seriously, then you will do it well, which will carry you and your career forward.

6 ASSESSMENT

Your instructors will let you know how well you are writing and presenting and where you can improve. Nobody is a perfect communicator, so no instructor expects perfection from you. However, your instructors do expect that you will do your best to communicate well and strive to improve. Here are the three most basic ways to show your effort:

1. **Take care of the simple stuff,** including correct spelling, correct formatting, and labeling your figures and tables. These concerns are so easy to address that it looks bad when they are not.
2. **Use the system approach.** Make your assignments purpose driven, audience driven, integrated, and logical.
3. **Avoid making the same mistake twice.** When your instructors give you feedback, incorporate that feedback into your subsequent assignments.

These fundamentals will take you most of the way there. To help get you the rest of the way, there is a checklist in Appendix D that summarizes much of the advice in this document.

You can expect different instructors to pay special attention to different elements of communication based on their backgrounds. For example, some might focus on your demeanor during presentations while others might focus on your use of passive voice in writing. Although this might seem like an inconsistent standard, it is a realistic one: your bosses will also focus on different elements of their subordinates' communication, just as you will when you are in charge.

7 CONCLUSION

As an Army officer, the things you will one day say and write could start wars or stop them, spend lives or save them. This is why it is so important that you communicate well.

Like so many seemingly complicated phenomena, good communication is governed by a few simple rules:

1. **Tailor to your audience.** Know whom you are presenting to or writing for. For them to understand you, you must first understand them.
2. **Work with purpose.** Know where you want to end up as you prepare your papers and presentations. A purpose is a goal, and a goal gives you direction.
3. **Minimize noise.** Say only what you need to say and say it as clearly and briefly as possible.

The devil is in the details, of course, and being able to implement these rules and communicate well takes attention and practice. Hopefully, this guide has helped you to learn the things to pay attention to and what to practice. However, it is by no means your only resource. Talk to your fellow cadets, your instructors, and your TACs about communication. We all need to write and speak well, and we can learn from each other's ideas, mistakes, and triumphs. That, in the end, is what communication is all about.

A SUPPLEMENTARY MATERIAL

This section contains supplementary guidance about writing emails, abstracts, executive summaries, BLUF statements, quad charts, and posters.

A.1 Emails

At West Point and in the Army, we correspond via email daily. Emails are often the primary method of communicating with individuals outside of your organization and must be written carefully. The guidance below is a starting point. It is specific to cadets, but it will also serve you well when you become Second Lieutenants.[23]

A.1.1 About Emails

Emails are easy to create and impossible to truly delete. In a professional setting, they run the gamut of uses from informal notes to formal business letters. They can be sent to a single recipient or to an entire organization. They can be forwarded without the original sender's knowledge. They can be used as evidence in a court of law.

Give your emails the same care and attention that you would give to a formal document: write with purpose, proofread, know your audience, and omit needless words.

A.1.2 Parts of an Email

Subject Line

Some people get a lot of emails. For example, many of your instructors, peers, and supervisors receive 50 or more emails every day. Help your recipients prioritize your email with a concise subject line that clearly conveys the email's topic and any action that the recipient needs to take. For example, if you were to email your professor requesting additional instruction (AI), a subject line of "Help" is less effective than "CDT Smith AI Request for 10SEP19." Keep in mind that your subject line is also your email's first impression, so proofread it as well.

It can be helpful to include a prominent keyword at the start of your subject line that tells the recipient how they should respond to it. Example keywords and their meanings include:[24]

- ACTION – Compulsory for the recipient to take some action
- SIGN – Requires the signature of the recipient
- INFO – For informational purposes only, and there is no response or action required
- DECISION – Requires a decision by the recipient
- REQUEST – Seeks permission from or approval by the recipient
- COORD – Coordination by or with the recipient is needed

Greeting

A proper greeting at the start of an email consists of the recipient's rank or title following by their last name. For military ranks, it is appropriate to use the three-letter abbreviation, so "COL Jones" and "Colonel Jones" are both acceptable. For civilians, use their appropriate title, such as "Dr. Jones" for someone who has earned a PhD or other appropriate degree; "Mr.," "Ms.," or "Mrs. Jones" for someone who has not; and "Professor" for either case, assuming the recipient is an instructor. Although it is not necessary, you can begin your message with a cordial greeting such as "Good Morning, Dr. Smith" or "Good Afternoon, CPT Jackson." Follow your greeting with a comma* and then start the main message of your email two lines below the greeting (see the examples at the end of this section).

*Some formal emails should instead use a colon.

Content
After the greeting, immediately address the purpose of your message—for example: "I am writing to request additional instruction on 10SEP19." For more detailed messages, treat your first sentence as the topic sentence for your message, as in, "I am writing to address issues our capstone team is having in crafting the value hierarchy for our project." Omit needless words to provide only the information that your readers require, keeping in mind that they may be reading your message on a phone or between meetings. A short, well-crafted note helps them to understand the information quickly and then prioritize their response. If you are attaching a file to your message, orient your recipients to the attachment. For example: "... as you can see in the attached document, 'Value Hierarchy_Version1,' our group has struggled to develop a value measure for our third objective." Be sure to reference specific attachments when you have included more than one.

Closing
End your email with a sign off. In the military, we traditionally use "Respectfully," "Very Respectfully," "Sincerely," or "Thank You." Follow your sign off with a comma and insert your signature block two lines below.

Signature Block
Your signature block should include a few key pieces of contact information and nothing else. Do not include quotes, scripture, or other extraneous information in your signature block. Do include your rank and full name, organization, phone number, and email address. Your recipient and anyone they forwarded your email to can use this information to contact you, which saves them the step of looking through their records to find your contact information. Example signature blocks include:

Jane Doe
Cadet Sergeant, Company A1
United States Corps of Cadets
Email: Jane.Doe@westpoint.edu
Cell Phone: 845-555-0001

John Smith
2LT, IN
Platoon Leader, A/1-508th PIR
Email: John.Smith.mil@mail.mil
Work Phone: 910-555-5555
Cell Phone: 910-555-5556

A.1.3 Other Email Guidance
The following advice may also be helpful:

- To avoid accidentally sending an email before it is ready, leave the address lines blank until just before hitting *Send*.
- Courtesy copy (cc) recipients who should be informed about the email but are not its primary audience. The primary audience should be written on the *To:* line.
- The recipients of your email cannot see who was written on the blind courtesy copy (bcc) line. You can use this to send an email to a large group while respecting the privacy of individual recipients and avoiding accidental uses of *Reply All*. However, do not use the bcc line to send sensitive information to a third party without the primary recipient's knowledge; this is unethical.
- When you need a few days to respond to an email, send a courtesy response informing the sender when you will get back to them.
- Email is not your only choice. If you find that an email is becoming overly complicated or lengthy, it may be appropriate to schedule a meeting or conference call with the recipient.
- Use an appropriate and consistent font throughout the message, including in your signature block.
- Many email programs do not support certain types of formatting, including bulleted lists, bold and italic text, and embedded tables. Avoid this type of formatting in your emails unless you are confident that your recipient will be able to view it.
- Do not include emoji or slang in professional emails.
- In emails to multiple military recipients, put the recipients in descending rank order in your greeting.

A.1.4 Example Emails

Below are three model emails that follow the guidance offered above.

MAJ Washington,

I am writing to discuss the board problem you covered in class on Lesson 12. As I reviewed my notes from class, I found that the equation for the exponential smoothing forecast may have been incorrectly annotated on the boards. On page 137 of the text book, the equation utilizes an "α" however in class you used a "β." Can you please clarify this for me?

Respectfully,

Jane Doe
Cadet Sergeant, Company A1
United States Corps of Cadets
Email: Jane.Doe@westpoint.edu
Cell Phone: 845-555-0001

Professor Adams,

I will not be in class on 15SEP due to a trip section that I am attending as a member of the Sprint Football Team. I will ensure that I complete the assigned reading and homework problems as well as review any material posted on Blackboard.

Thank you,

Cadet John Doe
Cadet Corporal, Company E1
Email: John.Doe@westpoint.edu
Cell Phone: 845-555-0002

COL Miller, LTC Jones, and MAJ Thomas,

I am writing to follow up from the meeting we had with your team on 12JUN regarding our capstone project. My team and I are available for a conference call on 13SEP from 0900–1100 or 1300–1600 as well as on 14SEP from 1130–1430. Please let me know which time works best for your team.

Thank you gentlemen,

Cadet James Doe
Cadet Captain, Company D3
Email: James.Doe@westpoint.edu
Cell Phone: 845-555-0003

A.2 Abstracts, Executive Summaries, and BLUFs

An *abstract* is a short statement—on the order of 250 words—summarizing the key elements of a document. Abstracts appear at the beginning of documents, and their purpose is to give the reader enough information to decide if they want to read the rest of the document. There are two types of abstracts: the *descriptive abstract* and the *informational abstract*. Both types cover the motivation, significance, scope, and methods of the work, but informational abstracts go on to cover key findings, conclusions, and sometimes recommendations. The choice of abstract type depends on the state of the work when the abstract is written

and the requirements of the publication or assignment. Because of their content, descriptive abstracts tend to be completed early in the work, while informational abstracts tend to be completed near the end of the work and are often the last section to be written.

Below are three examples of informational abstracts.

> *Abstract—To assist a stakeholder in a house-purchasing decision, value modeling techniques were used to compare six for-sale houses along six variables of interest: number of bedrooms, number of bathrooms, attic storage, lot size, square footage, and neighborhood quality. A single overall score was calculated for each house based on value functions and weights reflecting the stakeholder's preferences. Based on the resulting scores and prices of each house, two were recommended to the stakeholder: The Burrow, which had the highest value and the second-highest price, and Commonwealth, which had a middling value and price but a maximized neighborhood quality, which was of high importance to the stakeholder. The techniques used in this analysis can serve as an illustrative example for undergraduates learning value modeling techniques.*

> *Abstract—An experimental apparatus was designed, built, tested, and implemented as a laboratory experience in an undergraduate heat transfer course at the United States Military Academy at West Point. Four different tube configurations demonstrate internal flow convection heat transfer fundamentals using straight and coiled thin-walled, circular tubes with valves and a large ice bath tank. The apparatus is instrumented with thermocouples and a data acquisition system. As part of the laboratory experience, students measure, collect and analyze data; compare experimental results to theory; and assess error and uncertainty. This simple laboratory provides realistic, hands-on experience with an experimental apparatus, a laboratory procedure, instrumentation, and engineering technicians, all of which help students develop professionally and gain physical understanding of thermal-fluids concepts.*

> *Abstract—Computational fluid dynamics (CFD) simulations struggle to predict the Magnus moment for spin-stabilized projectiles decelerating into the transonic flight regime. To investigate this phenomenon, Magnetic Resonance Velocimetry (MRV) techniques were extended to obtain high-fidelity, sub-millimeter resolution, three-dimensional velocity field data sets around a modified M193 5.56 mm projectile spinning with constant rotation. This projectile was designed to thicken the hydrodynamic boundary layer, allowing for the investigation of dynamic instabilities attributable to transient fluctuations in the Magnus moment during deceleration into the transonic regime. The experimental apparatus rotated the projectile at uniform spin rates in a constant flow of copper-sulfate solution as part of a test section placed within a 3.0 Tesla MRI magnet. The velocity fields for several spin rates and projectile angles of attack were analyzed and compared to Reynolds Averaged Navier-Stokes (RANS) CFD simulations to identify proposed causes of the Magnus moment, namely boundary layer asymmetries and attached lee side vortices. The experimental MRV data revealed notable lateral boundary layer asymmetries for some combinations of spin rate and angle of attack, while comparable RANS simulations showed no boundary layer effects due to spin or angle of attack. Experimental uncertainty was assessed and found to be similar to comparable methods for measuring velocity field data.*

Executive summaries are condensed versions of their corresponding documents. As the name implies, they are intended for *executives*, meaning high-ranking personnel who are typically short on time and require only a high-level understanding of the material. Unlike abstracts, executive summaries are not used to decide whether to read the rest of the document. They are often the only part of the document that their intended audience will read, and they should be written such that the reader comes away with a complete, though less detailed, understanding of the work, allowing them to make informed decisions. A good rule of thumb is for executive summaries to be about 10% as long as their corresponding documents.[25] It can be difficult to compress a document to such small proportions while keeping it informative and useful. To help

guide you in this process, consider the original purpose of the report (see Section 3.1). In your executive summary, include those parts of your report that contribute the most to the purpose and that can be reasonably incorporated into a summary.[26] To keep the process simple, write your executive summary such that it summarizes the document in the same order that the document is presented (i.e., summarize the first section, then the second, and so on).

By regulation, Army writing must be "concise, organized, and to the point," and should put "the main point at the beginning of the correspondence."[27] This being so, you will commonly find and use *bottom line up front* (BLUF) statements in military documents. BLUF statements capture the essential ideas of the document in a short summary. Their purpose is to make it easy for decision makers to digest the material and come to conclusions.

A.3 Quad Charts

A *quad chart* is a single slide, divided into four equal quadrants, with each highlighting a different aspect of your project (e.g., a system, idea, design, or product). You can think of a quad chart like the printed equivalent of an elevator pitch: a short summary of your work capturing its essential elements and takeaways. Although some departments at West Point and institutions beyond have prescribed quad chart formats, it will sometimes be up to you to decide on a design. One effective design divides the four quadrants in the following way:

1. A problem statement, challenge, or motivation
2. Key features or aspects of your work
3. A picture or drawing
4. Other relevant information such as budgeting or scheduling

Figure 5 contains a pair of example quad charts produced by cadets in AY2019. Your design should be based, as always, on your audience.

United States Military Academy at West Point

Turbine Vane Cooling Analysis

Cadets David Bindon, Mattias Cooper, Benjamin Duhaime, and Robert Woodings
Advisors: Dr. David Helmer, CPT Briana Fisk, COL Michael Benson, COL Bret Van Poppel, Dr. Chris Elkins

Department of Civil and Mechanical Engineering

Project Background

What: Design a rig to test and analyze the Advanced Recirculation Total Impingement Cooling (ARTIC) insert for the Air Force Research Laboratories (AFRL) to validate computation fluid dynamics (CFD) models

Why: Increased gas turbine efficiency reduces costs and environmental impacts. Experiments provide high quality data.

How: Model the ARTIC insert, maintain similarity to actual design, conduct Magnetic Resonance Velocimetry (MRV) and steady-state infrared imaging (IR) tests

Experimental Setup

Figure 1: Heat Transfer Schematic

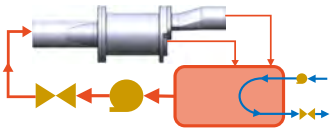


Figure 2: MRV Setup Schematic

Results

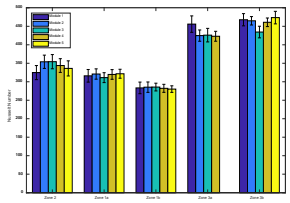


Figure 3: Peak Nu in All Sections

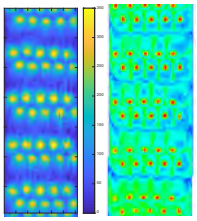


Figure 4: Nusselt Number vs. Fluid Velocity Comparison

Achievements and Future Work

- Both experimental techniques provide robust datasets that will further inform design
- Little module-to-module variation
- Proved in-house manufacturing and experimentation capabilities
- Future Work: Compare to CFD models, further combine MRV & IR data, and investigate film cooling

(a) Team Cool Vanes.

Team Hermes

Autonomous Drone Delivery via Airdrop Systems

Nena Riccoboni, Seth Jackson, Ronald Tobin, Abdul Halim Abdul Rahim

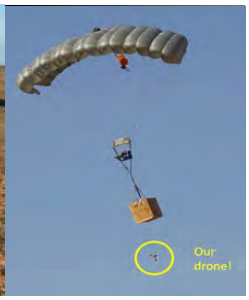
SOLDIER PROBLEM / CHALLENGE

Motivation Current capability gap: there is no way to deliver **small, high-value** payloads to the soldier from the air with **pinpoint accuracy**.

Problem Statement Design and build a scale model system that carries, dispenses, and initializes multiple Unmanned Aerial Vehicles (UAVs) from a Joint Precision Airdrop System (JPADS). Key tasks include:

- **Dynamic retasking** of small payloads.
- **Autonomous release** of UAVs to target points.
- **Fully autonomous flight** of UAVs to target points with **releasable payload bay**

Team Hermes after a successful test flight.



Drone releases from dispenser during first test.

FLIGHT TEST RESULTS

- Dispenser: successful test flights under JPADS system
  - Survived canopy opening: **100% success**
  - Detected location and altitude: **100% success**
  - Released door: **50% success**
  - Released dummy drones: **95% success**
- Temperature testing
- Drone testing "Throw" and "Mission" modes: **80% success**
- Payload release
  - Proximity sensor activates cargo latch at 4ft: **100% success**
  - Cargo bay survives 4ft drop: **100% success**
- Dynamic retasking ability to facilitate change of mission: **validated**

DRONE AND DISPENSER DESIGN HIGHLIGHTS

- Autonomous
  - Completely unmanned from launch
  - Piloted by Pixhawk and commanded by Raspberry Pi
- Improved Rail System
  - Allows drones to drop smoothly
  - Any drone fits inside any dispenser
- Detachable Payload
  - Released via proximity sensor relay to cargo latch
  - Facilitates dynamic retasking
- Environmentally hardened dispenser
  - Insulation with heating system
  - Door activated by mechanical latch release

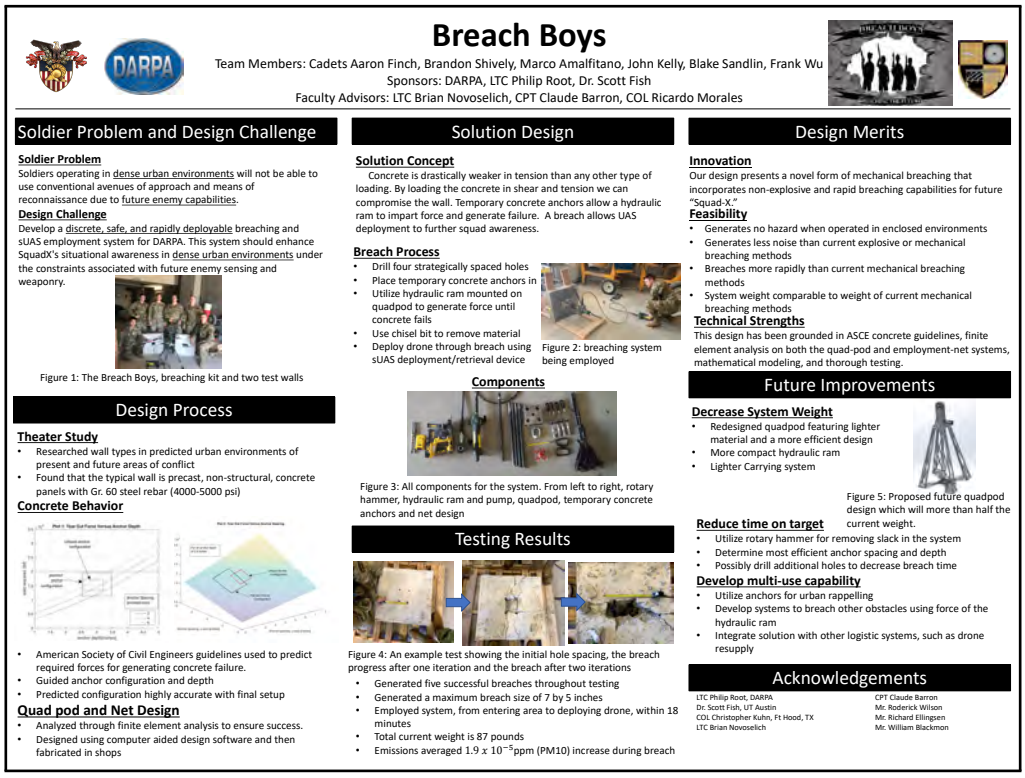
(b) Team ADDAS.

Figure 5: Example quad charts.

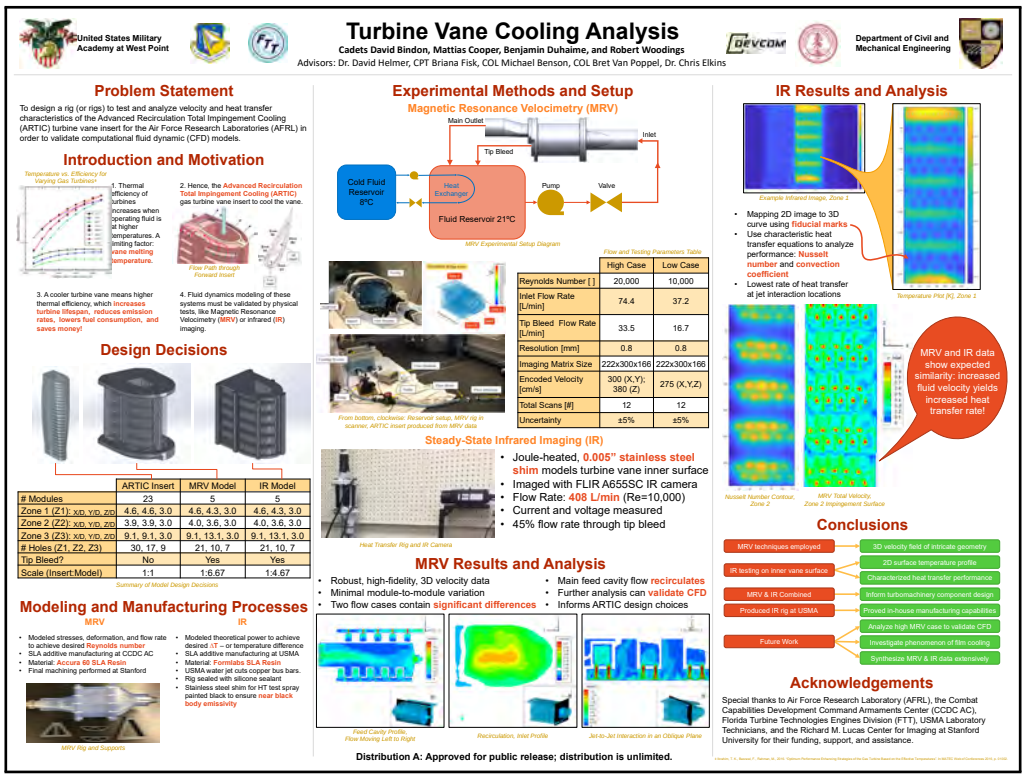
A.4 Technical Posters

Many conferences call for participants to create a poster to highlight their work, and some departments at West Point require cadets to create a poster for their capstone projects on Projects Day. A good poster concisely describes the project, including its motivation, methods, results, conclusions, and recommendations. Posters should be laid out such that a reader can understand the highlights of your work after a minute of reading and can fully read the poster after roughly five minutes.

Figure 6 contains a pair of example posters, also produced by cadets during AY2019.



(a) Team Breach Boys.



(b) Team Cool Vanes.

Figure 6: Example technical posters.

B EXAMPLES

This section contains several examples meant to help you understand the guidance in this document.

B.1 Proofing and Refining

This communication guide was proofread and peer reviewed just as you should do with your own assignments. For example, below are two descriptions of the Communication Model introduced in Section 2.1. One of these descriptions is identical to the one in that section, while the other is an early draft of the same information. Notice that the final draft is higher level, develops the explanation more slowly, offers more examples, and is more in line with the purpose of the paragraph: *to introduce readers to the Communication Model such that they can use it to help them understand the rest of this document*.

- **Early Draft:** Communication begins at the *sender*, who wishes to impart information to the *receiver*. That information exists initially within the sender's brain as neural connections. To communicate it to the receiver, the sender must convert the information into something transmittable, a process known as *encoding*. Once the information is encoded, it is transmitted as a *message* using some medium, called the *channel*. Along the way, *noise* interferes with the message. The message is then heard or seen by the receiver, who *decodes* it into his or her own brain as neural connections. The receiver may then reverse the process by providing *feedback* to the sender, which is also subject to noise.

- **Final Draft:** When we communicate, our goal is to share information and understand one another. Say that you want to communicate something to a friend. First, you have to decide how—you might send a text, use social media, talk over the phone or in person, or even sketch a picture. Whatever your choice, you have to convert the information from how it exists in your mind into some *message* that your friend can sense, usually through vision or hearing. Crafting the message is often the hardest part of the process, especially when we are restricted in our method of communication. To experience this yourself, try to explain to someone how to tie their shoes using words only—no pictures, no demonstrations.

  As your friend receives your message, he will try to understand it. Hopefully, you will end up on the same page, meaning your understanding and your friend's are close. If they are not, it could be for a variety of reasons: your words were not clear, Autocorrect mangled your text, your friend could not hear you, or he did not have some necessary background knowledge. Whatever the outcome, he can tell you how well he understood you so that you can adjust your message accordingly, although it is often up to the person sending the message to ask for this feedback.

  This process is depicted in Figure 1: a classic model of two-way communication. Although it shows a conversation between two people, you can extend it to any number of people and any form of communication.

  In this model, you are the *sender*, who wants to share information with your friend, the *receiver*. Your choice of medium—words, a picture, etc.—is called the *channel*. You convert the information in your head into a *message*—a process called *encoding*—that you communicate along the channel. Anything that interferes with the message is called *noise*. Your friend then *decodes* the message and forms his own understanding. He might then offer *feedback*, which is also subject to noise.

B.2 Figures and Tables

The following is an example figure with a caption. Note that no legend is used, but all data sets are described within the caption. This can be an appropriate technique, depending on the assignment or publication.

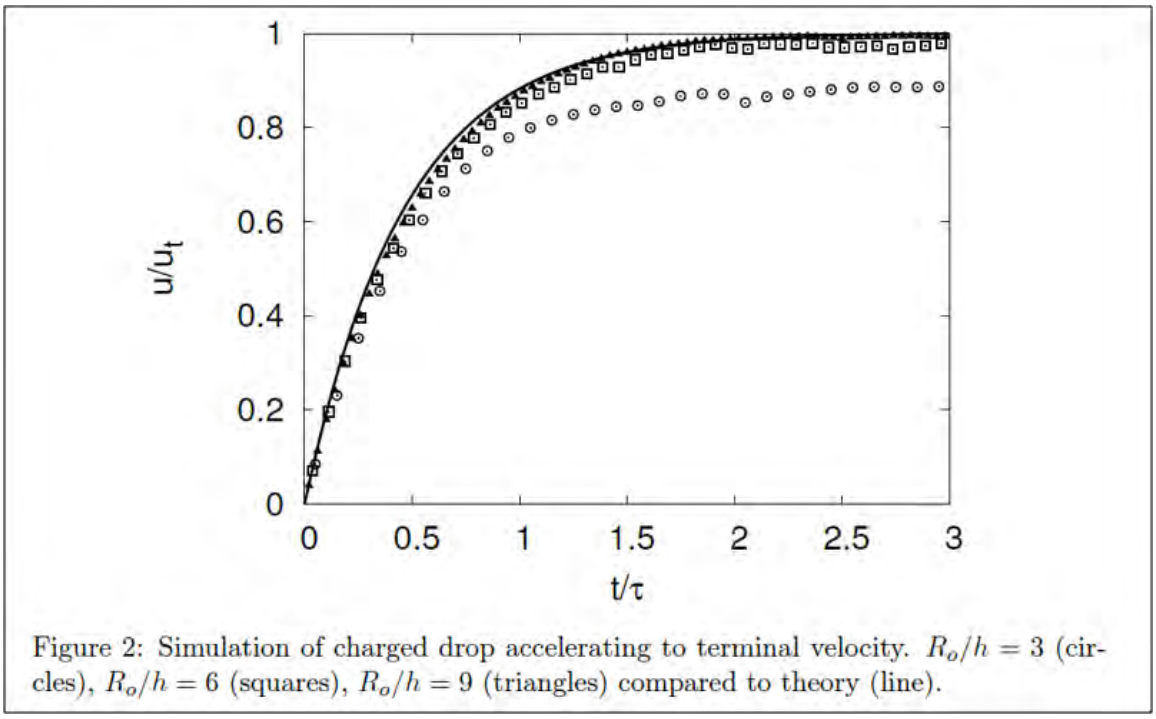


Figure 2: Simulation of charged drop accelerating to terminal velocity. $R_o/h = 3$ (circles), $R_o/h = 6$ (squares), $R_o/h = 9$ (triangles) compared to theory (line).

Figure 7: Example figure with caption.

Here is a more detailed example, illustrating good use of figures and tables integrated within a section of a technical report. In this example, a stakeholder has asked for help choosing which house to buy from among six options. The analysts used value modeling to arrive at a recommendation. Note the figures and tables, the occasional use of first person, and the description of an equation.

At the stakeholder's request, we assessed the value of six candidate houses using six metrics: number of bedrooms, number of bathrooms, lot size, area (square footage) of house, quality of neighborhood, and whether or not the house had attic storage. The goal of the work was to recommend to the stakeholder the best house to buy based on the metrics. The six houses are briefly described below using their nicknames, provided by the stakeholder:

- **Commonwealth:** A modified 1950's era ranch house.
- **Boo Radley House:** A low house in need of a paint job and lawn care.
- **Funky Town:** A first floor condo in a multi-family home.
- **Fixer Downer:** An unmodified 1920's era multi-family home.
- **The Burrow:** A tall, multi-family home occupied for many years by a single large and reclusive family.
- **Lawyer Foyer:** A cookie-cutter, newly constructed home, part of a development.

A picture of each house is provided in the appendix.

Table 3 contains the metrics for each house alongside their asking prices. The metric "Neighborhood" collapses several variables of neighborhood quality into an integer ranging between 1 and 5, with 5 being best. Variables of neighborhood quality included walkability, crime rate, school ratings, and proximity to outdoor leisure activity.

Table 3: Metrics and price of each house.

House	Bedrooms	Bathrooms	Lot Size (Acres)	Area (ft^2)	Neighborhood	Attic	Price ($)
Commonwealth	3	2	0.45	1,400	5	No	565,000
Boo Radley	4	2.5	0.75	1,650	3	Yes	515,000
Funky Town	2	1	0.30	850	5	No	550,000
Fixer Downer	3	1.5	0.65	1,200	2	No	375,000
The Burrow	7	3	2.00	2,750	4	Yes	825,000
Lawyer Foyer	5	4	1.75	3,250	3	Yes	850,000

Each house's metrics were converted to scores ranging between 0 and 100 (with 100 being best) using the value functions in Figure 8, which reflect the stakeholder's priorities. Table 4 contains the resulting scores.

These metric scores were combined into a single overall value for each house using the weighted average in Equation 2. In this equation, the subscript h corresponds to an individual house and the subscript m corresponds to an individual metric. Each subscript ranges between 1 and 6—there are six houses and six metrics. Additionally, v_m corresponds to the value function for metric m, $x_{h,m}$ corresponds to the raw metric score m for house h, w_m corresponds to the global weight of metric m, and V_h corresponds to the total value of house h. The six global weights and their corresponding swing weights were determined based on stakeholder preferences and are summarized in Table 5. Note that neighborhood quality has the highest weight, reflecting the importance of neighborhood quality to the stakeholder.

$$V_h = \sum_{m=1}^{6} w_m \cdot v_m(x_{h,m}) \text{ for } h = 1, ..., 6 \tag{2}$$

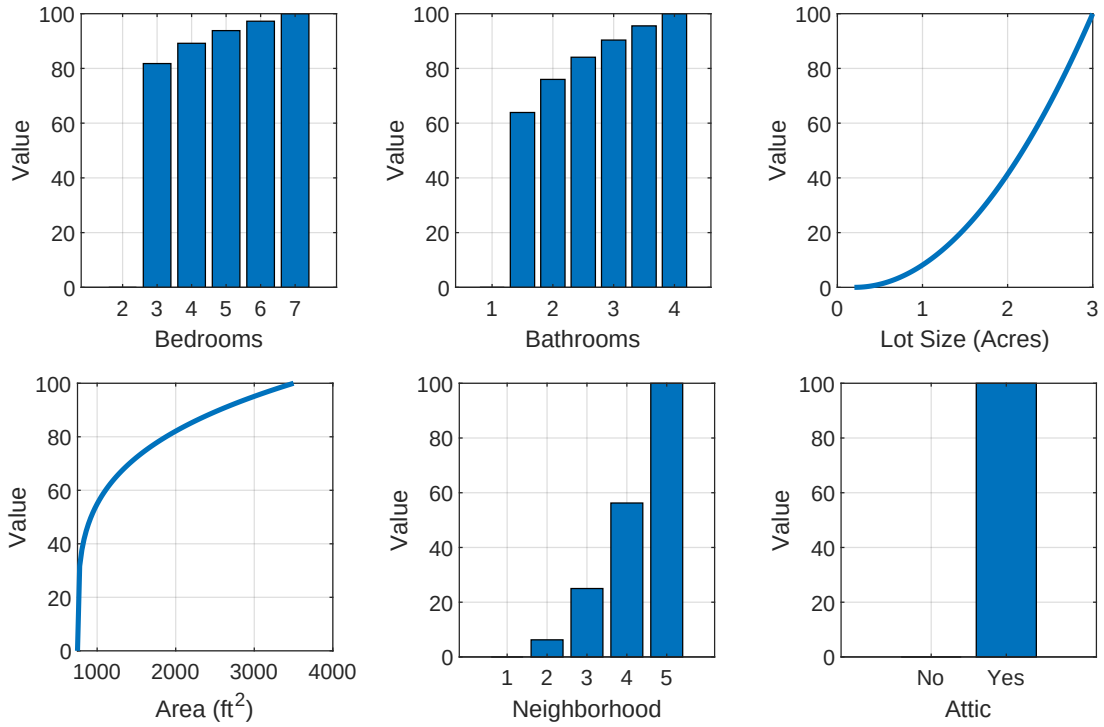


Figure 8: Value functions for the six metrics. Discrete variables are depicted as bars and continuous variables are depicted as curves.

Table 4: Value scores for each house, corresponding to $v_m(x_{h,m})$ in Equation 2.

House	Bedrooms	Bathrooms	Lot Size	Area	Neighborhood	Attic
Commonwealth	81.8	83.1	0.8	70.0	100.0	0.0
Boo Radley House	89.2	89.1	4.0	75.8	25.0	100.0
Funky Town	0.0	0.0	0.2	44.7	100.0	0.0
Fixer Downer	81.8	74.4	2.6	63.2	6.3	0.0
The Burrow	100.0	93.5	41.0	92.4	56.3	100.0
Lawyer Foyer	93.8	100.0	30.3	97.7	25.0	100.0

Figure 9 shows the resulting total values (V_h) for each house and the contributions of each metric to total value. The figure also contains a “Maximum” case that represents an ideal house where each metric is at its greatest magnitude.

As shown, *Funky Town* has the lowest value (31.0) and *The Burrow* has the highest (76.5). Also note that while it has the third-highest value (64.9), *Commonwealth* is in a neighborhood with the highest rating, unlike the higher-valued *The Burrow* and *Lawyer Foyer*.

Figure 10 compares the value of each house to its cost. Notice that *Lawyer Foyer* and *Funky Town* are each dominated, as they cost more yet have less value than other houses (*The Burrow* and *Fixer Downer*, respectively). Also notice the gap in price of more than $250,000 between *The Burrow* and *Lawyer Foyer* and the other four houses.

Based on these results, we plan to recommend *The Burrow* and *Commonwealth* to the stakeholders for further discussion. *The Burrow* was selected because it has the highest value, and *Commonwealth* was selected for its relatively high value, low price compared to *The Burrow*, and its high-quality neighborhood.

Table 5: Metric weights.

Metric	Swing Weight	Global Weight
Bedrooms	175	0.212
Bathrooms	125	0.152
Lot Size	150	0.182
Area	125	0.152
Neighborhood	200	0.242
Attic	50	0.061
Sum	825	1.000

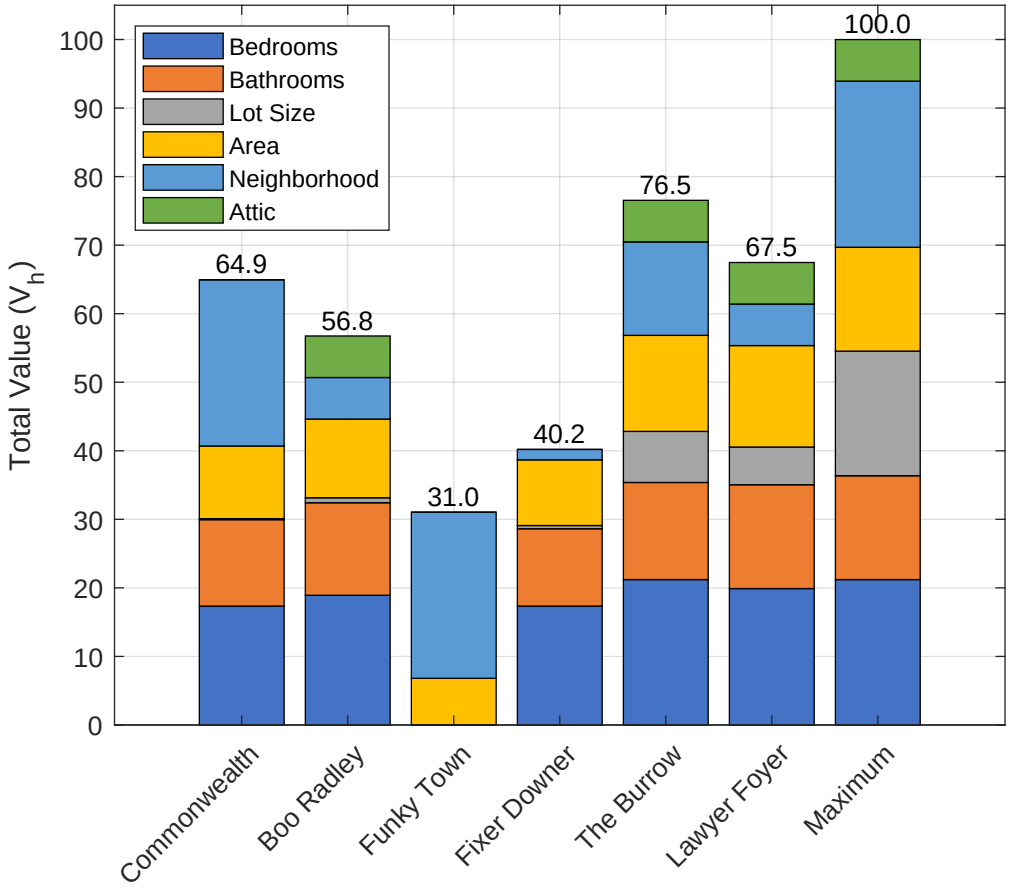


Figure 9: Stacked total values of each house.

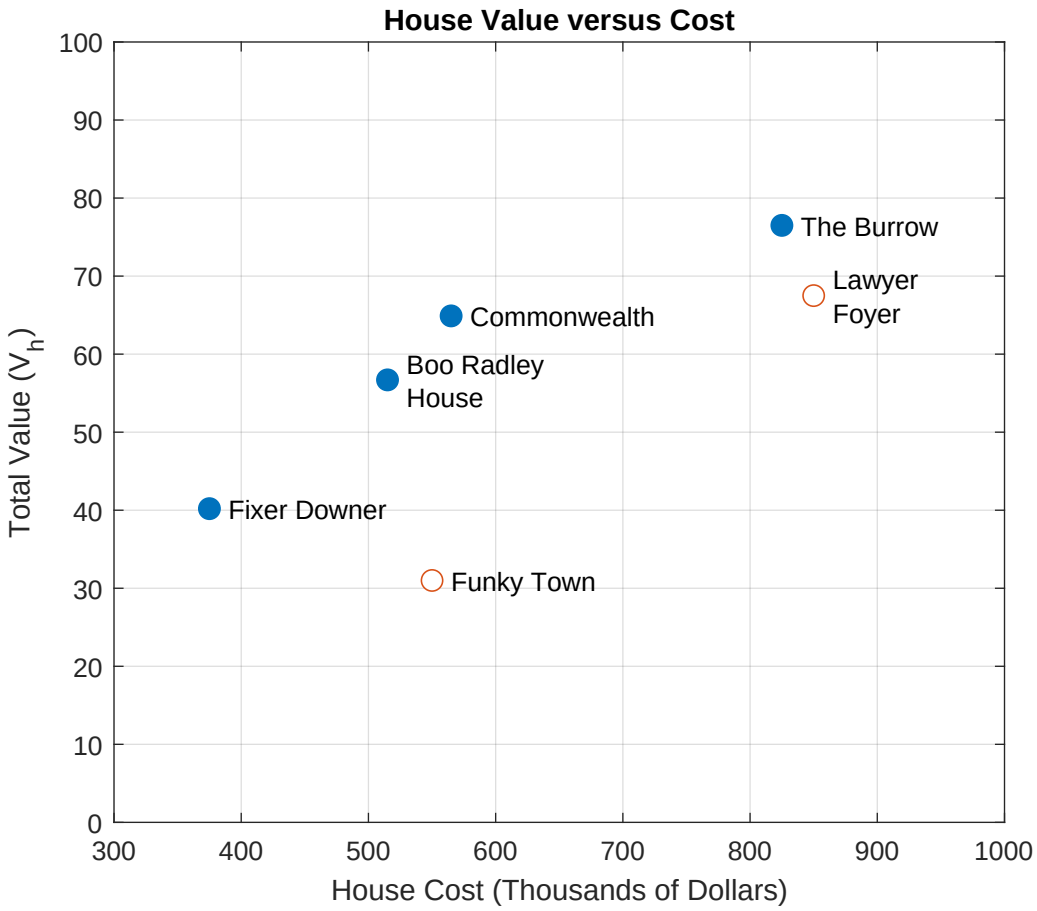


Figure 10: House values versus cost. Open circles represent dominated houses.

B.3 Equations

This example shows how to develop a series of equations in a paper. The premise is that the analysts have been asked to estimate the flight time of a fired projectile. They use a simple model to calculate the projectile's trajectory and arrive at an estimated time. Note how each variable is introduced and defined and how the equations are read and punctuated as part of the text.

To estimate the flight time of the projectile, we modeled it without air resistance and assuming flat terrain. Its vertical position as a function of time is represented by Equation 3,

$$p(t) = p_0 + v_0 t + \frac{1}{2} g t^2, \tag{3}$$

where t represents time, $p(t)$ represents the vertical position of the projectile at time t, p_0 represents its initial vertical position, v_0 its initial vertical velocity, and g the local gravitational acceleration constant, approximated as 32.2 ft/s^2.

The flight time can be estimated by solving for t when $p(t)$ is equal to 0:

$$0 = p_0 + v_0 t + \frac{1}{2} g t^2. \tag{4}$$

Because the projectile starts on the ground and we are modeling flat terrain, its initial position p_0 is also 0, yielding

$$0 = v_0 t + \frac{1}{2} g t^2, \tag{5}$$

which simplifies to

$$0 = t(v_0 + \frac{1}{2} g t). \tag{6}$$

Equation 6 has two solutions for t: t = 0, which is the start of the projectile's flight; and

$$t = \frac{-2v_0}{g}. \tag{7}$$

For a projectile launched with a vertical velocity at 150 ft/s (approximately 102 mph), the flight time in seconds would be calculated as

$$t = \frac{-300}{-32.2} \approx 9.3. \tag{8}$$

Notice that the answer is shown to only one significant digit. This is appropriate for the assumptions of the problem. The calculator answer of 9.31677019 is far too precise and would make no sense to report. Refer to the SLAM for a refresher on numerical precision and measurement reporting (a link is in Appendix C).

B.4 Example Theory or Methods Section

This example extends the previous example and illustrates a full section of a report that could be titled Methods, Mathematical Modeling, or Theory. Note the multi-line equation, which is not numbered because it is used primarily for clarification. Also note the placement of references for some equations.

For internal flow through a tube of circular cross section, the Reynolds number can used to classify the flow regime as *laminar*, *turbulent*, or within the *transition* region, as [Bergman, Ch. 8]

$$\mathrm{Re}_D = \frac{\rho u_m D}{\mu} = \frac{4\dot{m}}{\pi D \mu} \tag{9}$$

with the following ranges for flow regime

$$\begin{cases} 2,300 & \leq \mathrm{Re}_D \quad \text{Laminar} \\ 2,300 & < \mathrm{Re}_D < 10,000 \quad \text{Transition} \\ 10,000 & \geq \mathrm{Re}_D \quad \text{Turbulent}, \end{cases}$$

where u_m is the mean flow velocity, formally defined in the Bergman text as

$$u_m = \frac{2}{r_o^2} \int_0^{r_o} u(r,x) r dr \tag{10}$$

with r_o the inner radius of the tube. Common assumptions—incompressible flow, constant fluid properties, and laminar fully developed flow—further simplify the mathematical model to Poiseuille flow, with a mean flow velocity expressed as [Bergman, Ch 8]

$$u_m = -\frac{r_o^2}{8\mu} \frac{dp}{dx}, \tag{11}$$

with $\frac{dp}{dx}$ the axial pressure gradient. The experimental apparatus is capable of generating flows with Reynolds numbers near 5,000, short of the fully-turbulent regime. For this reason, observations remain within the laminar flow regime for the laboratory.

As expected, thermal considerations of the internal convection problem begin with a first-law energy balance for a control volume, expressed as

$$q = \dot{m} c_p (T_{m,o} - T_{m,i}), \tag{12}$$

where $T_{m,i}$ and $T_{m,o}$ represent the mean temperatures at the tube inlet and outlet, respectively, and c_p the specific heat. The mean temperature is defined in Bergman and other texts as

$$T_m = \frac{2}{u_m r_o^2} \int_0^{r_o} u T r dr. \tag{13}$$

Most convection heat transfer problems require computation of the Nusselt number,

$$\mathrm{Nu}_D = f(\mathrm{Re}_D, \mathrm{Pr}) = \frac{hD}{k_f}, \tag{14}$$

where k_f represents the thermal conductivity of the fluid and h the convection coefficient. For correct computation of both relevant non-dimensional parameters, Re_D and Nu_D, the most appropriate thermo-physical properties must be retrieved from appropriate table references. Bergman derives an expression for the axial variation of the mean temperature, T_m using a control volume approach, as

$$\frac{dT_m}{dx} = \frac{q_s'' P}{\dot{m} c_p} = \frac{P}{\dot{m} c_p} h (T_s - T_m), \tag{15}$$

where q_s'' represents the surface heat flux, $\dot{m}$ the mass flow rate, P the perimeter (equal to πD for tubes of circular cross section), and T_s the surface temperature. The constant surface temperature case is approximated with the ice bath, so the analytic solution of Equation 15 becomes [Bergman, Ch 8]

$$\frac{\Delta T_o}{\Delta T_i} = \frac{T_s - T_{m,o}}{T_s - T_{m,i}} = \exp\left(- \frac{PL}{\dot{m} c_p} \bar{h} \right), \tag{16}$$

with $\bar{h}$ the average convection coefficient over the full tube length.

An alternative form of the Equation 16 employs the overall heat transfer coefficient, $\bar{U}$, in place of $\bar{h}$ to account for the conduction through tube,

$$\frac{\Delta T_o}{\Delta T_i} = \frac{T_\infty - T_{m,o}}{T_\infty - T_{m,i}} = \exp\left(- \frac{\bar{U} A_s}{\dot{m} c_p} \right), \tag{17}$$

where T_∞ replaces T_s and represents the ice bath temperature, and A_s is the tube's surface area. Equation 17 can be used to express the rate of heat transfer, and taking the form of resistance in a thermal circuit (electricity analog) with R as the thermal resistance yields

$$\frac{1}{\overline{U} A_s} = R_{tot} = R_{convection} + R_{conduction} = \frac{1}{\overline{h}_i A_{s,i}} + \frac{\ln(D_o/D_i)}{2\pi k L}, \tag{18}$$

where D_o and D_i represent the outer and inner diameters, respectively, and L the tube length.

For laminar, fully developed flow and constant surface temperature conditions, the Nusselt number for a tube of circular cross section can be approximated as

$$\mathrm{Nu}_D = 3.66. \tag{19}$$

Combining Equations 14 and 16, measured data is used to solve for the modeled tube length, L, which is then compared to the actual tube length. The analysis can be repeated using Equation 17 in lieu of Equation 16 to reveal the effects of conduction through the tube wall, as shown by Equation 18.

B.5 Department of Defense Distribution Statements

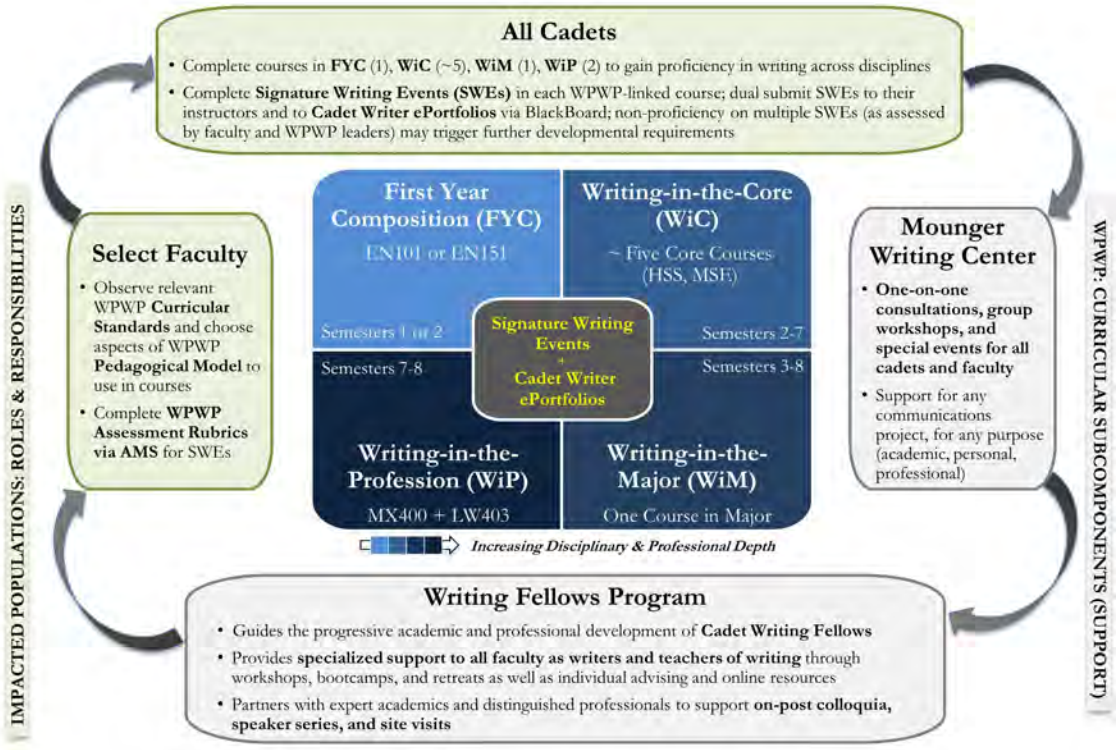
Distribution statements provide guidance for UNCLASSIFIED documents beyond the provisions of security classification. Many technical projects require distribution statements on some or all documents, and all posters and presentations must be marked with the appropriate distribution statements for final presentation at Projects Day.

The following distribution statements and notices are authorized for use on DoD technical documents. Additional information for each distribution statement can be found at the Defense Technical Information Center (DTIC, www.dtic.mil).

- DISTRIBUTION A. Approved for public release: distribution unlimited.
- DISTRIBUTION B. Distribution authorized to U.S. Government Agencies (reason) (date of determination). Other requests for this document shall be referred to (controlling DoD office).
- DISTRIBUTION C. Distribution authorized to U.S. Government Agencies and their contractors (reason) (date of determination). Other requests for this document shall be referred to (controlling DoD office).
- DISTRIBUTION D. Distribution authorized to Department of Defense and U.S. DoD contractors only (reason) (date of determination). Other requests for this document shall be referred to (controlling DoD office).
- DISTRIBUTION E. Distribution authorized to DoD components only (reason) (date of determination). Other requests for this document shall be referred to (controlling DoD office).
- DISTRIBUTION F. Further dissemination only as directed by (controlling office) (date of determination) or higher DoD authority.

C RESOURCES

- **LaTeX:** Learning LaTeX takes time and assistance from experienced users. A great place to start is Overleaf.com, which offers an introduction to LaTeX and a collaborative space to create LaTeX documents. See https://www.overleaf.com/.
- **R Markdown:** An introduction to R Markdown is available at https://rmarkdown.rstudio.com/.
- **U.S. Army Regulations:** U.S. Army Regulation 25-50, *Preparing and Managing Correspondence*, is available at https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/r25_50.pdf.
- **Science Laboratory Analysis Manual (SLAM):** A link to the full SLAM is available here: https://usarmywestpoint.sharepoint.com/sites/setcfeedback.
- **West Point Writing Program:** Figure 11 shows the high-level components of the WPWP (Figure 11a) and the strategies it uses to help cadets improve their writing (Figure 11b). You can find more information about the WPWP here: https://westpoint.edu/academics/curriculum/west-point-writing-program.



(a) Major components.

PEDAGOGICAL MODEL PROCESS WRITING PEDAGOGY (PWP) & WRITING-TO-LEARN (WTL) APPROACHES
1. Cadets utilize low or no stakes writing to engage with primary material in the course. (E.g. reading responses, quick summaries or reflections, problem statements, discussion questions, journal entries, notebooks, learning logs, case briefs, rhetorical or stylistic exercises, etc.)
2. Faculty explain a major writing assignment in part by distributing and discussing in class guidelines and multiple examples for the products Cadets must author. (Examples may be good or bad, drawn from scholarly or professional writing in the field or from student or faculty writing at USMA or elsewhere.)
3. Cadets complete planning or prewriting activities inside or outside of class in relation to a major writing assignment. (E.g. annotating, brainstorming, freewriting, journaling, blogging, clustering, dramatizing, concept-mapping, outlining, etc.)
4. Cadets are required to iteratively draft one or more key components of a major writing assignment inside or outside of class. (E.g. theses, hypotheses, introductions, methods or results sections, literature reviews, conclusions, abstracts, charts, tables, graphs, figures, or other discrete elements.)
5. Faculty provide Cadets with feedback on ungraded drafts or pieces of drafts that Cadets may use in revision before submitting a major writing assignment. (Feedback may be oral or written; it should be tailored to the Cadet and delivered in a timely fashion.)
6. Cadets conduct collaborative, team-based conferences or workshops with each other inside or outside of class that centrally involve writing. (Cadets could be organized in small groups of any number; they should work with each other toward outcomes clearly specified in guidance from instructors.)
7. Cadets reflect on the strengths and weaknesses of their writing process and products in organized, formal ways. (Such reflexive self-examination helps Cadets grow more self-aware as writers; faculty can construct opportunities for formal reflection in many kinds of activities. *Note: because almost all Signature Writing Events include a reflective component—the "brief reflective cover letter" (p.14), almost all WPWP courses include this approach.*)

(b) Pedagogical model.

Figure 11: Components and pedagogical model of the WPWP.

D CHECKLIST

For All Assignments

- ☐ Correct format used, including:
  - ☐ Page/slide numbers
  - ☐ Document/slide template
  - ☐ Margins
  - ☐ Headers and footers
  - ☐ Font face and size
  - ☐ Citations
  - ☐ Cover sheet
  - ☐ Brown bomber, including name plates
  - ☐ Specific requirements of assignment
- ☐ Assignment:
  - ☐ Tailored to audience
  - ☐ Purpose driven
  - ☐ Peer reviewed
- ☐ Assignment proofed for:
  - ☐ Spelling
  - ☐ Punctuation, syntax, capitalization
  - ☐ Consistency in style
  - ☐ Brevity and clarity
  - ☐ Use of numbers instead of words
  - ☐ Appropriate significant digits
  - ☐ Appropriate math symbols (e.g., $\geq$, not $>=$)
- ☐ Introduction covers:
  - ☐ Background
  - ☐ Motivation
  - ☐ Purpose
  - ☐ Scope
  - ☐ Literature Review (if appropriate)
- ☐ Conclusion:
  - ☐ Reintroduces key points
  - ☐ Does not introduce new technical information
- ☐ Figures and tables aesthetically pleasing, easy to read

For Papers

- ☐ Figures and tables referenced, labeled, captioned
- ☐ Equations labeled (where appropriate)
- ☐ Use of first person, passive voice, and nominalization appropriate
- ☐ One font used (exceptions: code, math, some quotes)

For Presentations

- ☐ Main text font size between 14 and 20
- ☐ White background used
- ☐ Colors easy to distinguish on projector
- ☐ Title slide includes:
  - ☐ Name(s) of presenter(s)
  - ☐ Date
  - ☐ Venue (if appropriate)
  - ☐ Title addressing purpose of presentation, not name of assignment
  - ☐ Graphic (if appropriate)
- ☐ Critical slides included:
  - ☐ Summary
  - ☐ Agenda/Outline
  - ☐ “Thank you! Any questions?”
- ☐ Audience regularly reminded of agenda
- ☐ Contact information present
- ☐ Backup slides are high quality
- ☐ Relevant graphics included
- ☐ Image sources written on respective slides
- ☐ Figures and tables annotated appropriately
- ☐ Rehearsals conducted
- ☐ Slides printed
- ☐ Slides emailed (for teleconferences)
- ☐ Slides contain bumpers, where appropriate
- ☐ For group presentations, all group members:
  - ☐ Aware of their slides to present
  - ☐ Prepared to present
- ☐ Backup plan established for technological or personnel problems

E CITATIONS

1. Society for Technical Communication, n.d.
2. Parnell, Driscoll, & Henderson, 2011, p. 3
3. Strunk & White, 2000, p. 23
4. Omega Alpha Association, n.d.
5. Pinker, 2014, p. 59
6. R Markdown, n.d.
7. Paraphrased from Weissberg & Baker, 1990, p. 41
8. Paraphrased and simplified slightly from Alred, Bruslaw, & Oliu, 2012, pp. 521–523
9. Inspired by a similar example in Pinker, 2014, p. 55
10. Memmott, 2013
11. Sword, 2012
12. This discussion is modified slightly from Alfred, Brusaw, & Oliu, 2012, p. 364
13. Alred, Brusaw, & Oliu, 2012, p. 395
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16. Modified slightly from Pinker, 2014, p. 45
17. Adapted from Alred, Brusaw, & Oliu, 2012, p. 576
18. Figure 2a from Bridgham, Henderson, & Li, 2019
19. National Eye Institute, n.d.
20. This suggestion is based on presentations given by CDTs J.M. Borrego Acosta, A. Henderson, and S. Rosdahl in AY19-2 of SE302.
21. Figure 4 modified from Carroll, Cromer, & Franco, 2019
22. Inspired by presentations given by CDT J. Tweedy during AY19-2 of SE302
23. Some of the guidance in this section was based on Alred, Bruslaw, & Oliu, 2012, pp. 164–169
24. Sehgal, 2016

25. Alred, Brusaw, & Oliu, 2012, p. 184

26. Guidance based on Finkelstein, 2005, pp. 215–216

27. U.S. Army, 2013

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