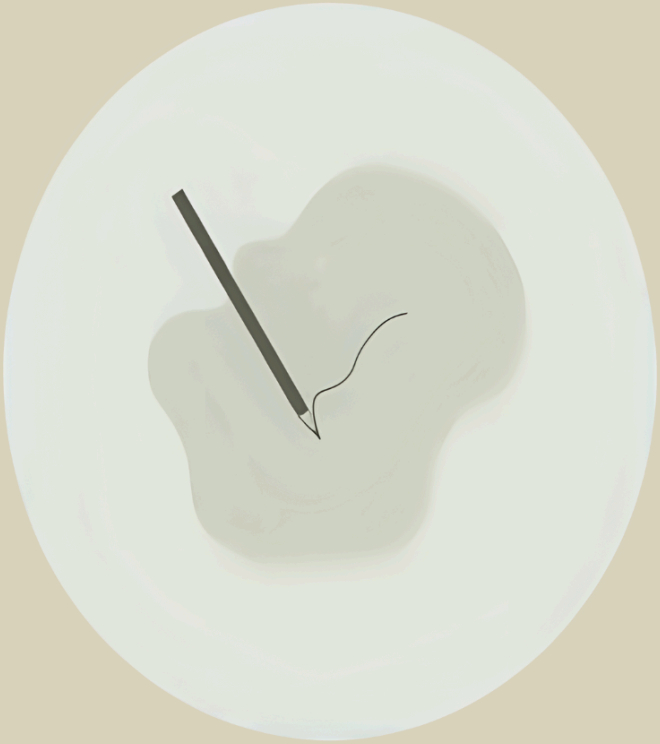
The Practical Guide to Technical Writing for Engineers and Computer Scientists



STUART JAMES MACMILLAN
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The Practical Guide to Technical Writing for Engineers and Computer Scientists

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Preface



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In an increasingly interconnected world, the ability to communicate technical information effectively has never been more important. As industries expand beyond national borders, engineering, science, and technology professionals must collaborate across diverse cultures, languages, and time zones. The rapid globalization of technical work — whether in software development, aerospace engineering, or medical technology — means that professionals often find themselves working in international teams, where clear, precise, and accessible communication is essential for success.

Demographic shifts are also transforming the landscape of technical work. In the 2020s, we live in a world of over 8 billion people. In developed countries, we see aging populations, with many people living well beyond the traditional retirement age; in developing countries, we see more youthful populations, where, in some cases, more than 50% of people are less than 18 years of age. Although birth rates are now steadily falling across the globe, for the next decades at least, this is the demographic reality in which technical fields will operate. Much of the work involved in engineering and computer science gets outsourced to countries with younger populations that are increasingly educated and that can do work at a lower cost. At the same time, much of the essential design work continues in developed countries such as Canada or the USA. Accordingly, the engineer or computer scientist of the future is much more likely to be working in international teams and communicating across borders. We see tasks like electronics design, applied research, accounting, aerospace design, technical consulting, and medical imaging assessment being done more economically outside of the developed countries. However, we're still seeing the results of this outsourced international work transmitted back to developed countries in a globalized technology ecosystem.

What new challenges does this present for aspiring engineers or computer scientists who need to communicate technical knowledge? What new skills are required in this global context? For one, this means that communication must always be achieved in the clearest and most direct way possible. To do this, future engineers must communicate in a style that is direct, clean, and dynamic — an approach that will be developed in many activities in this book. It also means that future communicators of technical information need to develop greater sensitivity to intercultural differences. That way, there is less chance of misunderstandings or of people being offended by cultural missteps in communication.

Another challenge relates to the complexities of modern technologies. New technologies draw on know-how from different fields. Accordingly, we see the emergence of new microdisciplines within engineering, such as microelectronics, photonics, and biomechanics. In biomechanics, for instance, biology and medicine merge with mechanical engineering. To communicate ideas in these blended domains, we need people who can integrate various fields of knowledge through effective communication.

In conclusion, the ability to clearly communicate technical information is no longer just a supplementary skill for engineers and computer scientists; it is a fundamental necessity. As international collaboration becomes the norm and interdisciplinary fields continue to emerge, professionals must be equipped with the ability to convey complex ideas clearly, concisely, and with cultural sensitivity. Whether working across borders, adapting to new

technologies, or bridging knowledge gaps between disciplines, effective communication will be the key to innovation and success.

Accessibility Statement

This book is designed to be accessible to as many readers as possible. The following accessibility practices are applied throughout the book and guide its ongoing development:

- **Clear structure and navigation:** Content is organized using consistent heading levels to support screen readers and improve navigation.
- **Readable text and layout:** The book uses clear language, short paragraphs, and a logical flow of information to support readers with diverse cognitive and linguistic needs.
- **Accessible images and visuals:** Informative images include alternative text that conveys essential meaning. Decorative images are used sparingly and do not contain critical information.
- **Tables designed for accessibility:** Tables use proper headers and simple structures to ensure they can be interpreted correctly by screen readers.
- **Accessible links:** Links use descriptive text that clearly indicates their destination or purpose, rather than generic phrases such as “click here.”
- **Consistent terminology and formatting:** Technical terms, labels, and formatting are used consistently to reduce cognitive load and improve comprehension.
- **Downloadable and printable content:** Downloadable materials are provided in PDF format, with attention to readability and basic accessibility features.
- **Ongoing improvement:** Accessibility is treated as an ongoing process. Feedback from readers is welcomed and used to improve the accessibility of future editions.

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Chapter 1: Introduction to Technical Communication

Chapter Contents**The Role of Technical Communication in Engineering**
Identifying Purpose, Audience, and Genre
Key Takeaways
Practice Task
Case Study

The Role of Technical Communication in Engineering

Technical communication for engineers refers to the process of conveying complex technical information in a clear, precise, and accessible manner to a variety of audiences. Engineers must communicate effectively to ensure that their designs, analyses, and solutions are understood by their colleagues, clients, regulatory bodies, and the public. In the end, it ensures safety, compliance, and efficiency in engineering projects.



Photo by Headway on Unsplash

Identifying Purpose, Audience, and Genre

Understanding purpose, audience, and genre is essential for effective technical writing. Your **purpose** defines why you are writing. For example, are you explaining a design, persuading stakeholders of the value of project, or documenting a process? Your **audience** determines the level of technical detail and the style of language you use. Are you addressing fellow engineers, clients, or the public? The **genre** — or type of document or communication used (e.g., technical report, proposal, or email) — also determines the format, tone, and structure of your message.

By considering these elements before you write, you will make your communication clearer and more rele-

vant for others. This upfront analysis saves time and ensures your writing fits the situation. Let's take a closer look at each of these three dimensions: purpose, audience, and genre.

Purpose

All communication serves specific purposes. In the technical fields, your writing might aim to persuade, request, instruct, inform, or evaluate. For example, proposals attempt to persuade clients to accept a solution to a defined problem; technical manuals instruct users how to perform tasks; and reports may evaluate different technical solutions to engineering challenges. Of course, most technical documents serve more than one purpose — they may have two or more dominant objectives. The key takeaway, however, is that you must clarify your purposes before you begin to write.

Audience

Who are you writing for? The answer to this question has important effects on the content and style of your writing. For readers who are not specialists in your field, you may have to use less technical vocabulary, or if you use technical terms, you will need to clearly define what they mean. You may also need to provide longer explanations and concrete examples to help your readers understand. On the other hand, if your readers are also specialists in the field, you can assume a great deal more shared knowledge. The reality, though, is that technical professionals, more often than not, present ideas to people who have less technical knowledge. Business managers or clients, for example, might read technical reports. Therefore, it's essential that you take their interests and needs into account. After all, if you lose the support of key stakeholders in a project simply because your ideas were not presented in audience-friendly terms, everyone loses out.

Genre

You may have heard the word genre used in relation to literature or film — the "horror film" genre, for example. However, the same term can be applied to different conventional forms of technical or professional communication. Think of genre as a conceptual "container" whose form has been collectively agreed upon over years of use. You might say that genres of engineering writing exist because they efficiently respond to reader needs in situations that arise repeatedly. By adhering to genre conventions, you ensure that your ideas are presented in a form that is recognizable and familiar to your audience. What's more, readers will likely expect information to be conveyed in a conventional form.

To clarify this concept, take the example of a lab report. The lab report is a genre that many students encounter during their university studies. Lab reports are recognizable as such because they share features of content and form. Think for a moment about the "introduction," where the author sets the scene. Important background information and context are provided, as are the goals of the experiment. Perhaps a hypothesis is put forward — an idea that will be tested empirically. In the "methods," the author lays out what was done in the experiment, including the materials used and the procedures followed. In the "results," observable or measurable findings are presented. Finally, in the "discussion," those results are interpreted. Writers who ignore genre conventions do so at their own risk. For example, a research writer who interprets results before clearly laying out the procedures will confuse or frustrate readers. Table 1.1 lists some common genres of engineering communication, along with their purposes.

Table 1.1 Common Genres in Engineering Communication and their Purposes.

Genre	Purpose
Business proposals	To outline a business plan to seek investment or partnerships
Feasibility studies	To assess the practicality and viability of a proposed project or solution
Grant proposals	To seek funding for research or development projects
Instructional manuals	To provide instructions and guidance on the use and operation of tools or equipment
Progress reports	To track the progress of a project, highlighting achievements, and identifying challenges
Research reports	To document original research findings, methodologies, and conclusions
Specifications	To provide detailed descriptions of the requirements and characteristics of a product or system
Technical presentations	To communicate technical information to audiences through oral presentations

Perhaps you can think of other genres from your own subfield of engineering or computer science. Regardless, a challenge you should embrace is to search out models of these different types of writing and become a "researcher" of writing in your own field. By looking at numerous examples with an analytical eye, you will greatly improve your ability to craft writing in a recognized form and style.

Key Takeaways

In the end, it's your job to make yourself understood. Your writing process should always begin with upfront analysis:



1. Identify your purposes in writing.
2. Plan for your audience's needs.
3. Establish the best genre through which to convey your ideas.

Keep these points in mind all the way from the conception and planning of the document to the final revisions and editing.

Practice Task



Become a researcher of writing in your own field. Search the Web for a well-crafted technical report. Which reader needs are addressed in each section of the report?

Case Study



When Words Kill: The Boeing 737 Max Tragedy

Imagine waking up, heading to the airport, and boarding a plane — a routine experience for many of us. Now, imagine that the pilot flying your plane is unaware of a critical control system on board, a system that can suddenly take control and force the aircraft toward the ground. Imagine further that when this system activates, there is nothing in the manual to explain what's happening or how to stop it.

This is not a hypothetical scenario. It's exactly what happened on October 29, 2018, when Lion Air Flight 610 (JT 610) plunged into the Java Sea just 13 minutes after takeoff, killing all 189 people on board.

This isn't just a story about aircraft design or aerodynamics. It's about something far more fundamental — something that cuts across every industry, every project, and every team: technical communication, and how its failure can have deadly consequences.

The Silent Killer

The Boeing 737 MAX featured a new system called the Maneuvering Characteristics Augmentation System (MCAS). It was designed to automatically push the nose down if it detected the plane might stall. However, the pilots didn't know that it existed.

In the entire 1,600-page flight manual, MCAS was mentioned only in the glossary. No explanation of what it did. No instructions on how to disable it. Nothing.

Why would Boeing omit such critical information? The answer reveals something troubling about how we communicate in high-stakes industries. Boeing wanted to market the 737 MAX as requiring minimal additional training for pilots who had flown previous 737 models. More documentation meant more training. More training meant higher costs. Higher costs meant fewer sales.

Critics and congressional investigators later concluded that, in effect, lives were traded for market share.

Links in a Fatal Chain

The Indonesian investigation identified five critical factors that led to this disaster, and nearly every single one involved a failure of technical communication.

One: A critical sensor, which miscalibrated during earlier repair, was installed without proper testing or documentation.

Two: 31 pages were missing from the maintenance log—information that should have grounded the plane before its fatal flight.

Three: The checklist included a long-standing 'runaway stabilizer' procedure that could have

addressed the malfunction, but pilots were unaware that the new MCAS system was responsible for causing it.

Four: The cockpit warning systems provided conflicting information that the pilots couldn't reconcile.

Five: The previous day's crew experienced the exact same issue but didn't effectively communicate the severity to the maintenance crew.

The day before the crash, a pilot travelling as a passenger in the jump seat of the same aircraft recognized the issue and explained to the flight crew how to disable the system.

Those pilots landed safely. However, that knowledge — that critical, life-saving information — wasn't documented. It wasn't passed on. It wasn't communicated to the next crew.

A total of 189 people died because of it.

A Second Chance Missed

After the Lion Air crash, Boeing finally issued a bulletin explaining the MCAS and how to disable it. However, they insisted the 737 MAX was still safe to fly without further changes.

Five months later, on March 10, 2019, Ethiopian Airlines Flight 302 crashed under nearly identical circumstances. 157 more lives were lost.

They were the result of a choice — a choice to prioritize simplicity over safety, profits over people, and, most critically, a choice to withhold information rather than communicate.

The Communication Gap

A dangerous myth exists in engineering and the technical fields: that good technical work speaks for itself. That the data tells its own story. That if something is important, people will figure it out.

This is dangerously wrong.

The hard truth is this: Your brilliant design, your revolutionary code, your groundbreaking research is worthless if you can't communicate it effectively. Technical communication isn't just about transferring information. It's about transferring understanding.

And understanding can save lives.

The Responsibility We All Share

So, what do we do about this? How do we prevent the next Lion Air disaster in our own fields?

First, we need to recognize that technical communication is not an afterthought. It's not something to be delegated to technical writers after the real work is done. It is the real work.

Second, we need to document for crisis, not for convenience. The true test of technical documentation isn't whether it works when everything goes right. It's whether it works when everything goes wrong.

Third, we must understand our audiences very well. The Boeing case shows the fatal consequences of one-size-fits-all documentation practices. The process failed to account for how a pilot would react under extreme stress. Knowing your audience, their knowledge level, and their needs isn't optional. It's essential. Different audiences require different approaches, and assuming that one type of writing works for everyone is a dangerous mistake.

Fourth, we need to create cultures where communication is valued as highly as innovation — where an engineer who writes clear documentation is celebrated as much as one who writes clever code.

History is filled with communication failures as dramatic and as preventable as Boeing's. In the 2003 Columbia Space Shuttle disaster, poorly designed PowerPoint slides obscured critical safety information that might have saved the lives of seven astronauts **[1]**. Similarly, the 1981 Hyatt Regency walkway collapse in Kansas City, which killed 114 people, was partly the result of unclear communication between engineers and fabricators about a seemingly minor design change **[2]**. These are just two additional examples, but there are countless other tragedies where poor communication played a decisive role.

Your Turn

As an engineer, you must continually ask yourself: What critical information am I holding right now? What knowledge seems obvious to me but might be invisible to someone else? What am I assuming "they'll figure out" when the stakes are high?

Most importantly: What am I not communicating that could cost someone everything?

The 346 people who died in the two 737 MAX crashes can't speak to us. But their story can. It tells us that in a world of increasingly complex systems, our greatest vulnerability isn't technical failure. It's a communication breakdown.

The pilots of those Boeing planes were fighting not just a malfunctioning system, but a vacuum of information. They were trying to solve a problem they didn't know existed, with tools they didn't know they had.

Don't let that happen on your watch.

Because the most dangerous words in any industry aren't "I don't know." They're "I didn't tell you."

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Chapter 2: Technical Writing Style

Chapter ContentsPrinciples of Technical Writing StyleWriting Coherently and CohesivelyChoosing Appropriate WordsImproving ReadabilityEditing with Writing Style ToolsKey TakeawaysPractice Task

Principles of Technical Writing Style

Technical writing style requires you to communicate complex information clearly and concisely, whether your audience is technical or nontechnical. The goal is to use direct and unambiguous language so readers can quickly grasp your message. As an engineer, mastering this style allows you to produce documentation that is complete, accurate, usable, and clear. In so doing, you not only present technical information effectively but also respect your reader's time.

Read the paragraph on the issue of orbital debris. Consider whether the explanation is clear and accessible for the intended audience.

Audience: Members of an environmental advocacy group interested in space sustainability issues

Original Paragraph

Orbital debris proliferation stems from multiple anthropogenic activities in space, beginning with the earliest satellite launches and continuing with contemporary space operations. Defunct satellites that remain in orbit following their operational lifespan, expended rocket stages abandoned after payload delivery, and mission-related debris, including items such as payload fairings, adapter rings, and lens covers are among the primary contributors. Through collision events, both accidental and deliberate, thousands of fragments are generated. Noteworthy incidents include China's 2007 anti-satellite missile test and the 2009 collision between the Iridium 33 and Cosmos 2251 satellites. Spacecraft deterioration through material degradation, such as micrometeoroid impacts, extreme temperature fluctuations, and radiation exposure, causes paint flaking, insulation detachment, and component fragmentation. Whereas aluminum oxide particles are released with solid rocket motor firings, coolant leakage from nuclear-powered satellites has also introduced sodium-potassium (NaK) droplets into orbit. This accumulation of debris creates a cascade effect known as the *Kessler Syndrome*, wherein collisions between objects generate additional fragments, potentially rendering certain orbital regions unusable for satellite operations and threatening future space exploration.

This paragraph about orbital debris is not reader-friendly for the target audience because it lacks coherence and clarity. Therefore, let's revise it step by step in the following sections to improve readability and make it easier for environmental advocates to understand.

Writing Coherently and Cohesively

Coherence refers to the logical and meaningful organization of ideas within a text. In technical communication,

coherence is vital for helping readers easily follow procedures, instructions, or explanations of complex concepts. For example, a troubleshooting guide for a software application might start with an overview of common issues, move to a step-by-step diagnostic process, and end with solutions ranked by effectiveness. This logical flow allows users to identify and resolve problems efficiently, without confusion or wasted time. Coherence can be improved by using clear section headings, presenting information from general to specific, and organising ideas in a way that makes intuitive sense.

Cohesion, on the other hand, refers to the use of words and phrases to create smooth and logical connections between sentences and paragraphs. So, while coherence is about the logical and predictable flow of ideas, cohesion focuses more specifically on the surface-level connectors.

Cohesive writing makes good use of transition words such as "therefore," "however," and "consequently" to establish relationships within and across sentences. It also uses consistent terminology to bind the text as a meaningful thematic whole, as well as backward-glancing pronouns and synonyms to maintain connections to previously mentioned ideas. In this way, sentence grammar and words work together to ensure a tight "mesh" of links within the text. Good cohesion reduces the burden on readers. Without it, even well-detailed documents can feel fragmented, forcing users to piece together information by themselves. This can lead to frustration and misunderstandings.

Editing for Coherence and Cohesion

In the original paragraph on orbital debris, the ideas and the sentences that express them do not interconnect effectively, which makes the passage difficult to follow. The following revisions demonstrate strategies for improving coherence and cohesion. Text highlighted in green illustrates transitions that establish order and logic between the main points. Underlined text shows words — either repeated words, pronouns, or synonyms — that link back to earlier ideas, creating a chain of back-glancing reference. This strategic use of back referencing ensures that readers are not confronted with entirely new and potentially confusing information at the beginning of new sentences — a strategy known as the "known-to-new contract" in the presentation of information.

Space junk is a growing problem in Earth's orbit for several key reasons. First, when satellites stop working, they usually remain in orbit rather than returning to Earth. These inactive satellites, along with leftover rocket parts from launches, form the initial layer of debris. Second, collisions in space create even more fragments — when satellites or other objects crash into each other, they break apart into thousands of smaller pieces. Notable examples of such incidents include China's 2007 anti-satellite weapon test and the 2009 collision between two satellites, both of which significantly contributed to the amount of debris. Third, the harsh environment of space causes spacecraft materials to deteriorate; temperature fluctuations, radiation, and micrometeoroid impacts cause paint to flake and insulation to detach. Additionally, certain space activities worsen the problem, such as solid rocket motors releasing aluminum oxide particles and some satellites leaking coolant. Together, these debris sources drive a dangerous cycle known as the *Kessler Syndrome*: as debris accumulates, more collisions occur, creating even more fragments. If this cycle continues, some orbital regions could eventually become too hazardous for satellites or future space missions.

Choosing Appropriate Words

Well-designed technical documents present information in language that readers can understand immediately. Therefore, choosing audience-appropriate wordings is essential for helping users correctly interpret instructions, procedures, and technical concepts without confusion. Choose words that are only as precise or technical as necessary for your purposes. If you must use technical terms with a less technical audience, define those terms clearly the first time they appear. Selecting the right level of technicality and precision reduces the risk of misinterpretation and prevents readers from having to reread passages to grasp your meaning.

Editing for Word Choice

In the original paragraph on orbital debris, the language is overly technical and too jargon-heavy for an environmental advocacy audience. Terms such as "anthropogenic activities," "payload fairings," "adapter rings" are used without explanation, assuming a level of specialized knowledge the target audience may not have. Consider the following revisions which remove unnecessarily precise details and jargon. By replacing these with more general, everyday terms, we make the text more user-friendly for this less technical group of readers.

> Space debris orbiting Earth comes from four main sources. First, old satellites and discarded rocket parts remain in orbit after they stop working. Second, collisions in space—such as China's anti-satellite weapon test in 2007 or the crash between two satellites in 2009—break objects into thousands of smaller pieces. Third, spacecraft materials gradually break down in the harsh environment of space. Extreme temperatures, radiation, and tiny meteoroid impacts cause paint to chip and insulation to detach. Fourth, certain activities add even more debris. For example, solid rocket motors release aluminum oxide particles, and some satellites leak coolant into space. This growing collection of debris leads to what scientists call the *Kessler Syndrome*—a dangerous cycle where more debris leads to more collisions, creating even more fragments. If this continues, some regions of space could eventually become too hazardous for satellites or future space exploration.

Improving Readability

Readability refers to how easily readers can process and understand written text. Good readability is crucial for making complex content accessible to your audience, regardless of their level of expertise. For example, in a technical report on space debris mitigation, the sentence "Satellites must deploy deorbiting mechanisms before reaching end-of-life" is more readable than "The implementation of descent-facilitating apparatuses is obligatory for orbital vehicles prior to the termination of their operational functionality period."

The following features of writing can decrease its readability:

- Longer, more complex sentence patterns;
- Dense text, especially with larger numbers of technical words grouped into a small area;
- Longer word length, including the number of syllables in words; and
- Lower frequency or specialized vocabulary.

Readable technical writing helps prevent misunderstandings that can lead to errors, inefficiencies, or safety risks. To enhance readability, use shorter sentences, simpler words, active voice, and manageable paragraph lengths. By focusing on readability, you increase the likelihood that your readers will understand and apply the information correctly.

Editing for Readability

The original paragraph on orbital debris uses complex sentence structures, passive voice, and dense technical vocabulary that slow down comprehension. In addition, the lengthy paragraph format may overwhelm readers with too much information at once. Consider the following revisions for improved readability in the text below. Long sentences have been broken into shorter sentences. Underlining shows consistent use of concrete and active verbs. Overly technical terms have been removed.

Orbital debris, commonly known as space junk, is a growing form of pollution caused by human activity in outer space. This problem began with the launch of the first satellites and has continued through today's expanding space missions. There are four main sources of this debris. First, non-functioning satellites and discarded rocket parts often remain in orbit long after their missions end. Second, collisions between objects in space — both accidental and deliberate — create thousands of smaller fragments. Notably, in 2007, China destroyed one of its own satellites with a missile, and in 2009, two satellites, Iridium 33 and Cosmos 225, collided. Both events added significantly to the debris cloud surrounding Earth. Third, operational spacecraft shed materials over time. Exposure to tiny meteoroids, extreme temperature changes, and radiation can cause paint to flake off and insulation or hardware to break apart. Fourth, certain rocket engines release aluminum oxide particles into space, while some older, nuclear-powered satellites have leaked coolant droplets into orbit. As the amount of debris increases, the risk of further collisions also increases. This creates a chain reaction known as *the Kessler Syndrome.* It is a dangerous cycle in which each collision generates more fragments, which in turn increases the chance of more collisions. If this pattern continues without intervention, this could threaten future satellite operations and long-term space exploration.

Editing with Writing Style Tools

Writing style tools check the clarity of your text. They can help match your writing style to your audience by identifying issues such as overly complex sentence structures, unnecessary use of passive voice, and jargon. These tools often provide real-time feedback on tone, readability, and sentence flow. Examples, such as the *Hemingway Editor,* highlight areas for improvement and suggest revisions that enhance the clarity of writing.

While writing style tools, such as *Grammarly,* already incorporate AI, general-purpose AI writing tools such as *ChatGPT*, *Claude*, and *Paperpal* can assist with more advanced writing tasks. These tools go beyond grammar and clarity by offering paragraph-level rewrites, simplifying complex explanations, and adapting the tone for specific audiences.

If you use writing style tools to edit your work, always include a disclosure statement. Your disclosure should

specify which tool(s) you used, for what purposes, and on what date. It might also include a link to the conversation, if applicable. You can use the following sample disclosure statement to guide the wording.

Suggested Disclosure Statement

This document was reviewed and revised for clarity and cohesion using ChatGPT on July 10, 2026. The AI tool helped me [insert how it helped]. The conversation can be accessed at [insert link].

For example, if you use *ChatGPT* to improve the clarity and cohesion of a paragraph about Kessler Syndrome, you might choose to add a brief disclosure such as follows:

Orbital debris, commonly known as space junk, is a growing form of pollution caused by human activity in outer space. This problem began with the launch of the first satellites and has continued through today's expanding space missions. There are four main sources of this debris. First, non-functioning satellites and discarded rocket parts often remain in orbit long after their missions end. Second, collisions between objects in space—both accidental and deliberate—create thousands of smaller fragments. Notably, in 2007, China destroyed one of its own satellites with a missile, and in 2009, two satellites—Iridium 33 and Cosmos 225—collided. Both events added significantly to the debris cloud surrounding Earth. Third, operational spacecraft shed materials over time. Exposure to tiny meteoroids, extreme temperature changes, and radiation can cause paint to flake off and insulation or hardware to break apart. Fourth, certain rocket engines release aluminum oxide particles into space, while some older, nuclear-powered satellites have leaked coolant droplets into orbit. As the amount of debris increases, the risk of further collisions also increases. This creates a chain reaction known as *the Kessler Syndrome*. It is a dangerous cycle in which each collision generates more fragments, which in turn increases the chance of more collisions. If this pattern continues without intervention, this could threaten future satellite operations and long-term space exploration.

This paragraph was reviewed and revised for clarity and cohesion using ChatGPT on July 10, 2026. The AI tool helped us refine sentence flow and simplify technical language.

To conclude, as you develop your technical writing skills, aim to use only as many words as necessary to convey your message clearly and efficiently. Also, always remember that you are ultimately responsible for the content you create and for any revisions and edits to your documents.

Key Takeaways

In the end, it's your responsibility to communicate technical information effectively. The editing strategies discussed in this chapter aren't optional. They're essential to ensuring that your message is effective and impactful.



- Ensure coherence by organizing ideas logically for your readers;
- Build cohesion through transitional phrases and consistent terminology;
- Maintain clarity with language that is well adapted to your audience's needs and understanding; and
- Enhance readability to ensure content connects effortlessly with your readers.

Keep these principles in mind from your first draft through final editing to create technical documents that your audience can understand, trust, and use correctly the first time.

Practice Task



Revise the following paragraph to make it clearer for an educated, non-technical audience. As you work, focus on these four areas:

- **Coherence**: Does the paragraph flow logically from one idea to the next?
- **Cohesion**: Do the sentences link smoothly to one another?
- **Word Choice**: Are the words clear and appropriate for the intended audience?
- **Readability**: Can the audience easily understand the information?

After analyzing the paragraph, provide a revised version that addresses the weaknesses you identified. If you use a writing style tool during editing, add a short disclosure statement at the end.

Autonomous vehicles integrate sophisticated sensor arrays with artificial intelligence algorithms to navigate roadways independently of human intervention. LiDAR technology generates three-dimensional environmental mapping, whereas radar systems penetrate adverse weather conditions that optical sensors cannot reliably interpret. Convolutional neural networks process these multisensory inputs to identify objects, predict movement trajectories, and execute decision pathways with low-latency processing to provide real-time decision making. The implementation challenges encompass both technical obstacles, such as edge case identification and hardware redundancy requirements, and ethical dilemmas regarding unavoidable collision scenarios. Regulatory frameworks remain fragmented across jurisdictions, impeding standardized deployment despite potential benefits, including accident reduction, enhanced mobility access, and traffic congestion mitigation through vehicle-to-vehicle communication protocols.

Chapter 3: Document Design

Chapter ContentsDesigning Technical Documents for Accessibility and Usability Controlling Paragraph Length Writing Clear and Structured Headings Using Bulleted or Numbered Lists Controlling White Space Following Style Guides Key TakeawaysPractice Task

Designing Technical Documents for Accessibility and Usability

Information in technical documents must be readily accessible and easy to use. In many ways, a well-designed technical document is like a well-designed website. In both, readers should be able to scan the content quickly and locate what they need with minimal effort. Achieving this level of accessibility requires deliberate design choices.

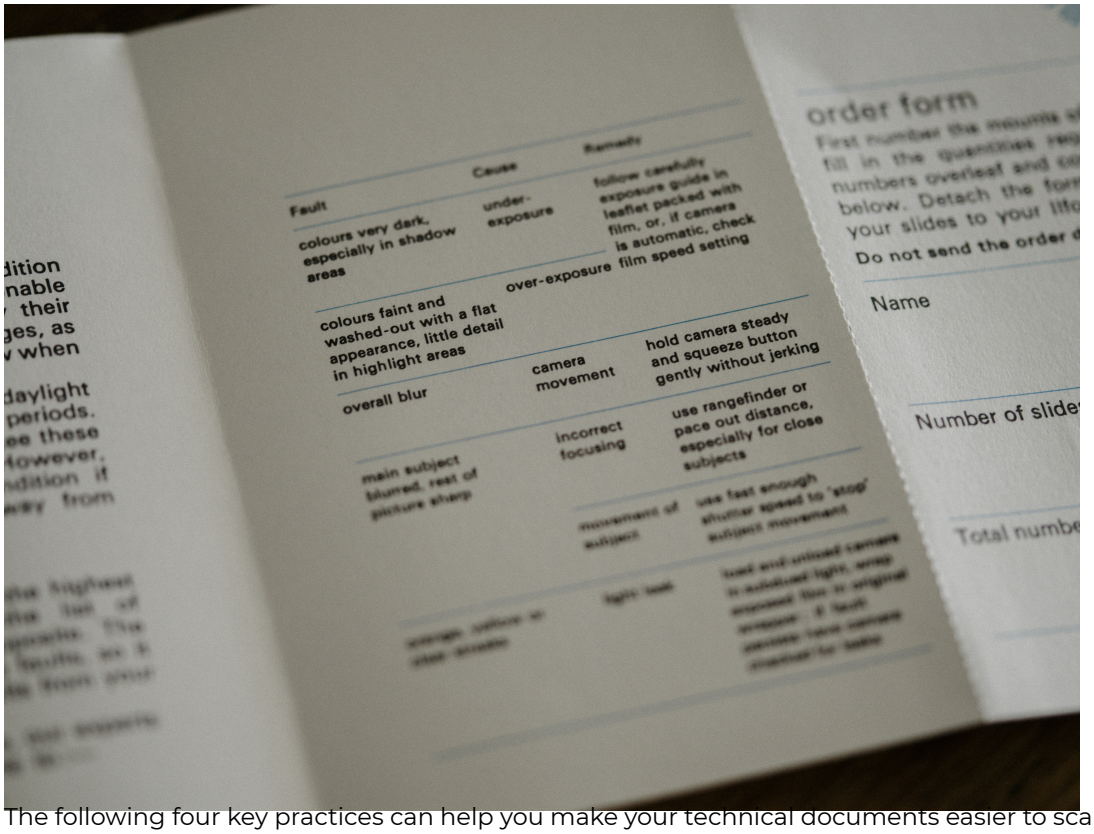


Photo by Annie Spratt on Unsplash

The following four key practices can help you make your technical documents easier to scan and use:

- Control paragraph length to keep information digestible.
- Write clear, well-structured headings to guide readers through the content.
- Use bulleted or numbered lists to present information in concise and scannable form.
- Manage white space to make the page visually clear and inviting.

Let's look at each of these accessibility features in more detail.

Controlling Paragraph Length

In engineering communication, controlling paragraph length is essential for effective document design and readability. Unnecessarily long paragraphs can create dense blocks of text that are difficult to scan, making it harder for readers to quickly identify key ideas. Conversely, very short paragraphs may disrupt flow or provide insufficient context. There is no universal guideline for limits on the number of words or sentences, as paragraph length will vary depending on the type of technical document. However, regardless of format, every paragraph should convey one clear concept — a single main idea, with supporting details — to keep the writing precise, professional, and user-friendly.

Writing Clear and Structured Headings

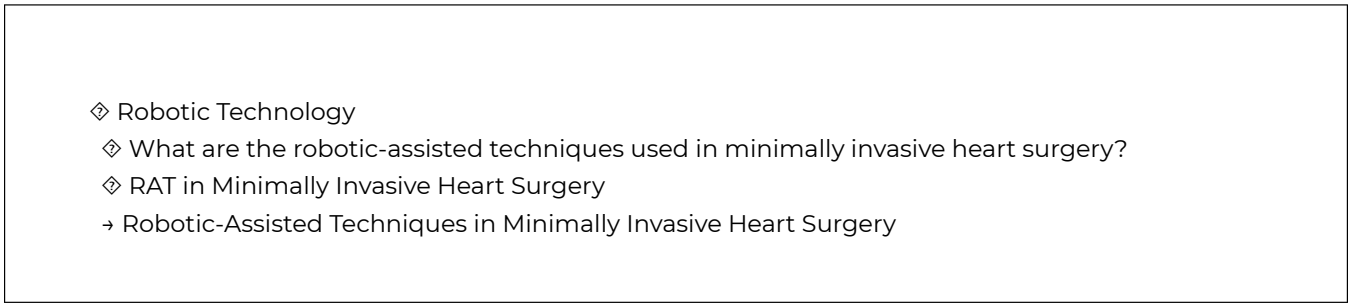
Headings are one of the most important tools for organizing technical documents. They help readers quickly understand the flow and hierarchy of information in a document. To be effective, they must be descriptive, concise, and structurally parallel.

Writing Descriptive Headings

Each heading should convey the smallest meaningful unit of your message and include keywords that signal the section's content. Descriptive headings help readers anticipate what they will learn, so it's best to avoid

- vague or overly general headings;
- questions, which may confuse readers before they see the main message; or
- abbreviations that readers may not immediately recognize.

Let's look at the following examples of headings and compare their effectiveness.



As you review these examples, note how small changes greatly improve clarity. The first heading is too vague, the second is phrased as a question, and the third contains an unclear abbreviation. In contrast, the last heading clearly and directly tells the reader what the section covers.

Note: When it comes to abbreviations in headings, use them only if the shortened form is more familiar to readers than the full name or phrase (e.g., NASA instead of National Aeronautics and Space Administration). Otherwise, write out the full term, followed by the abbreviation in parentheses, as shown in the following example:

Robotic-Assisted Techniques (RAT) in Minimally Invasive Heart Surgery

Keeping Headings Concise

Headings should be descriptive, but they shouldn't be too lengthy. In most cases, the clearest and most effective headings convey the message in as few words as possible without losing meaning. Let's examine the following examples and compare their effectiveness.

✗ A Comprehensive Overview of the Use of Robotic Technology in Various Types of Surgical Procedures on the Heart
→ An Overview of Robotic-Assisted Techniques in Minimally Invasive Heart Surgery

The first heading is wordy and includes unnecessary detail. The improved version is more effective because it conveys the main idea in fewer words.

Using Parallel Grammar in Headings

Once you create a descriptive and concise heading, it should also set the grammatical pattern for the other headings in that section — and ideally for the entire document. Choose a grammatical structure for your first heading and apply it consistently to the rest. The following are examples of headings with consistent grammatical structure:

An Increase in Sea Levels in Coastal Regions
A Decline in Ice Coverage in the Arctic
A Rise in Ocean Temperatures between 2015 and 2025

In this case, each heading is a grammatically parallel noun phrase. This structure makes it easier for readers to scan the document and compare the content of subsections.

Formatting Headings for Visual Hierarchy

Headings should reflect the logical structure of your content. Using levels such as Heading 1, Heading 2, and Heading 3 helps readers see the relationships between main topics and subtopics.

The approach you choose will also depend on the type of document. Shorter reports often use unnumbered headings, while longer reports with multiple sections typically use numbered headings.

Unnumbered Headings — For reports without numbered subsections, you can manipulate the size and weight of the fonts to indicate where specific information fits within the broader hierarchy of the document.

> FIRST-LEVEL HEADINGS
>
> These label the main sections of a report. To make them stand out, use a larger font size and consider capitalizing all letters. Leave at least one empty line of white space above and below the heading to separate it clearly from the surrounding text.
>
> Second-Level Headings
>
> These are slightly smaller than first-level headings. Capitalize only the first letter of each word.
>
> **Third-level headings.** To differentiate these, capitalize only the first letter of the first word. Third-level headings can also be placed on the same line as the text they introduce, separated by a period or a colon.

Additionally, consider using a sans-serif typeface, such as Arial or Calibri, for headings and a serif typeface, such as Times New Roman or Georgia, for body text to further distinguish them visually.

Numbered Headings — For numbered headings, each heading receives a number corresponding to its position in the hierarchy, with indentation levels to reflect their order of importance.

> **1. FIRST-LEVEL HEADINGS**
>
> Label these with whole numbers (e.g., 1.) and use bold, capital letters.
>
> **1.1 Second-Level Headings**
>
> Indent these slightly and capitalize only the first letter of each word.
>
> **1.1.1 Third-level headings:** Indent further and capitalize only the first letter of the first word.

You can use as many levels as necessary, but be mindful of page aesthetics. Excessive heading levels can reduce the space for body text and make the document appear cluttered.

Using Bulleted or Numbered Lists

Lists are an effective way to organize information so that readers can quickly scan content. Bulleted lists are best for items without a fixed order, while numbered lists work well for steps in a sequence or points ranked by priority. Properly formatted lists improve readability and make complex information easier to process. To maximize clarity, list items should follow parallel grammatical structure. In other words, each item should begin with the same part of speech and follow a similar grammatical pattern. This consistency helps readers compare points more easily and understand relationships between them. The following example shows how a bulleted list can be used effectively:

When installing a solar panel system, follow these safety precautions:

- **Turn off all power sources** before beginning any work.
- **Wear appropriate protective gear**, including insulated gloves and safety glasses.
- **Use a stable ladder or scaffolding** when working at heights.
- **Check weather conditions** and avoid installation during rain or high winds.
- **Follow manufacturer guidelines** for wiring and component connections.

This format helps readers quickly scan and act on each safety point, reducing cognitive load and minimizing the chance of overlooking important steps.

Now, compare with the following example of a numbered list:

The following steps are typical of the engineering design process:

1. **Identify the Problem** — Define the issue or need that requires a solution.
2. **Research and Gather Information** — Study existing solutions, requirements, and constraints.
3. **Develop Possible Solutions** — Brainstorm and generate multiple design concepts.
4. **Select the Best Solution** — Evaluate alternatives and choose the most effective option.
5. **Build a Prototype** — Create a working model to test the proposed design.
6. **Test and Evaluate** — Assess performance, gather feedback, and identify necessary improvements.
7. **Refine and Implement** — Optimize the design and prepare for final production.

Controlling White Space

White space in a document refers to the areas between lines and around blocks of text, images, and headings. Controlling white space is essential for enhancing readability and improving the overall user experience. In engineering documentation, where complex data, formulas, and diagrams are common, well-managed white space

can be used to group related content and emphasize key concepts. Conversely, dense, information-heavy pages can overwhelm readers, make scanning difficult, and bury critical information. Excessive white space can make documents look sparse or disorganized. Striking the right balance ensures that documents are visually appealing and optimized for quick reference.

Two main strategies can help you control white space effectively: consistent spacing and consistent alignment.

Consistent spacing refers to line spacing, which includes line height and spacing before and after paragraphs. In technical writing, using *single* spacing or *1.5* spacing makes your documents easier to read by preventing excessive gaps between the lines in paragraphs. Therefore, it is recommended to set the line spacing value to either *single* or *1.5*. Additionally, pay attention to the *before* and *after* paragraph spacing. Keep these values consistent throughout the document.

Consistent alignment is also key to managing white space effectively. Centering content is generally not reader-friendly in technical documents because it disrupts the flow and control of the white space. For example, if you center an image, its caption, and the following heading, you lose control over spacing and alignment. Therefore, it is best to left-align all content, including lists, headings, titles, images, and other components. These strategies reduce potential reader distraction.

Following Style Guides

Style guides are documents that explain how to write and format content in a clear, consistent, and professional way. Common examples include the *IEEE Editorial Style Manual* or the *Chicago Manual of Style (CMOS)*. They provide clear rules for formatting, terminology, units of measure, and citation practices. Their use is critical in engineering writing, where mistakes stemming from inconsistencies in notation, abbreviations, or formatting can lead to costly errors or safety risks.

Using a style guide also makes it easier to work with others because everyone follows the same formatting and structure. This consistency helps your reports, manuals, or project documents look organized and professional. In the end, a standardized approach makes your writing easier to read, easier to trust, and easier to work with — for both you and your readers.

Note: Style guides may vary depending on the context, but becoming comfortable with using one is an essential skill in both academic and professional writing. In the workplace, you are typically expected to follow the style guide your company adopts. If you are submitting a research article to a journal, you must adhere to the formatting rules specified by that journal. In academic settings, you may follow the style guide provided by your instructor or institution. If you are reading this book as part of the ENCS 282 Technical Writing and Communication course, you can consult the ENCS 282 Technical Writing Style Guide in Appendix A.

Key Takeaways



You will often need to communicate complex information clearly and efficiently. By paying attention to features of document design, you help readers understand and use content more effectively. The following four key strategies can help you make your technical documents easier to scan and use:

- Control paragraph length by ensuring each paragraph communicates one clear idea.
- Write clear, structured headings that are descriptive, concise, and parallel in form.
- Use bulleted or numbered lists appropriately — bullets for unordered items and numbers for sequences or priorities — to organize information and improve scannability.
- Manage white space by keeping spacing and alignment consistent, reducing visual clutter, and enhancing readability.

Applying these principles from your first draft through final editing will help you create technical documents your audience can read, understand, and use with confidence.

Practice Task



Find a technical document (such as an online user guide or a product manual). First, identify the strengths in the document design. Then, identify areas where the documentation could be improved in terms of the following:

- **Paragraph Length** — Are paragraphs appropriately structured to support readability and scanning?
- **Headings** — Do the headings clearly indicate the structure and content of each section? Are they consistent in format and hierarchy?
- **Lists** — Are bulleted or numbered lists used effectively to organize the information? Could any long paragraphs be broken into lists?
- **White Space** — Does the layout use spacing effectively to reduce visual clutter and support user navigation?

After completing your analysis, share your thoughts on the strengths and weaknesses of the documentation with a classmate.

Chapter 4: Visuals

Chapter ContentsUsing Visuals Effectively in Technical CommunicationChoosing VisualsMaking Visuals AccessibleKey TakeawaysPractice Task

Using Visuals Effectively in Technical Communication

Visuals are essential in technical communication because they clarify complex ideas and make information easier to understand and remember. Diagrams, charts, and tables allow readers to grasp relationships and patterns quickly, improving efficiency by presenting large amounts of data at a glance. Well-designed visuals not only engage readers and break up dense text but also reduce the risk of misinterpretation, ensuring clearer and more accurate communication — especially in fields where precision and safety are critical.

Visuals can take many forms, depending on subject matter and audience needs. Table 4.1 shows some common types.

Table 4.1 Common Types of Visuals in Technical Documentation

Type of Visual	Description and Common Uses
Illustrations and diagrams	Schematics, exploded views, cutaway drawings, and conceptual diagrams that explain how a mechanism or process works
Photographs	Real-world images of equipment, parts, or processes, often used for identification or showing real operating conditions
Charts and graphs	Bar charts, line graphs, scatter plots, and pie charts for showing trends, comparisons, and data relationships
Tables	For organizing numerical data or specifications in a concise, easy-to-scan format
Flowcharts and process maps	For visualizing sequences, decision points, and workflows
Maps	For spatial or geographic information
Icons and symbols	For safety warnings, user interface elements, or quick-reference markers
Screenshots	In software documentation, for showing menus, interfaces, or settings

Visuals are powerful tools for the following reasons:

- **Visuals summarize and organize information.** For example, a table could effectively consolidate key points at the beginning or end of a report.
- **Visuals enable comparisons.** For instance, a bar chart is effective for comparing the incidence of heart disease across different demographic groups.
- **Visuals illustrate relationships.** For example, a graph could effectively display the correlation between smoking and the development of lung cancer.

- **Visuals emphasize key points.** For example, a flowchart might highlight the essential steps in an engineering process.
- **Visuals transcend cultural and language barriers.** A well-designed graph is interpretable in multiple languages, making it accessible to a global audience.

Choosing Visuals

You'll likely use various types of visuals in your assignments and reports. The following subsections outline best practices for specific types of visuals.

Tables

Tables are a valuable tool in technical communication because they allow you to present complex or detailed information in a clear, organized, and easily scannable format. Unlike prose, which requires the reader to extract and mentally organize information, tables arrange data into rows and columns so that patterns, relationships, and exact values can be seen at a glance. They are especially useful for presenting numerical data, specifications, or comparisons where precision is essential. In engineering, for example, a table of material properties enables readers to quickly compare density, tensile strength, and thermal conductivity to select the most appropriate material for a specific application.

Table 4.2 is a good example because it uses concise headings with units and consistent numerical formatting.

Table 4.2 Material Properties of Common Structural Metals

Material	Density (g/cm³)	Tensile Strength (MPa)	Thermal Conductivity (W/m·K)
Carbon Steel	7.85	400	54.0
Stainless Steel	8.00	520	16.0
Aluminum Alloy 6061	2.70	310	170.0
Titanium Alloy	4.50	900	21.9
Copper	8.96	210	385.0

Bar Graphs

Bar graphs are excellent for showing differences across categories or within series. Use them for general comparisons when precise measures aren't critical. If specific values matter, label each bar with its value. Fig. 4.1 shows an example of a clustered column chart comparing tensile strength of five alloys at two different temperatures with bars labelled with the measures. Categories are displayed along the horizontal axis and values on the vertical axis. This makes it easier to compare multiple data series side by side.

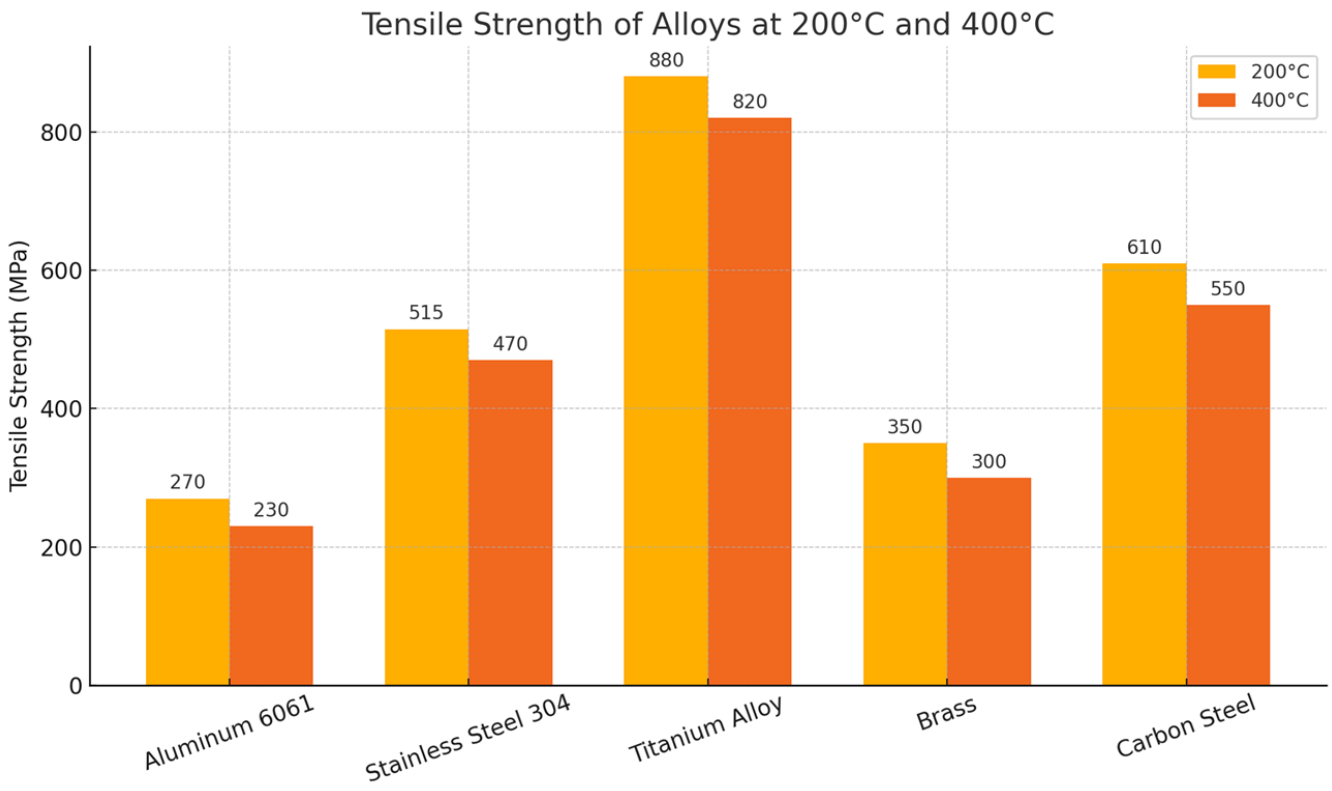


Fig. 4.1 Tensile strength decreases at higher temperatures for all alloys, with titanium alloy maintaining the highest strength retention compared to the others.

Note that the category labels in this case have been written on the diagonal because of space constraints. If category labels are long phrases, putting them on the vertical axis with measures along the horizontal axis could avoid cramping.

Stacked bar charts are useful for showing proportions within categories. Consider Fig. 4.2, showing the material composition of different battery types.

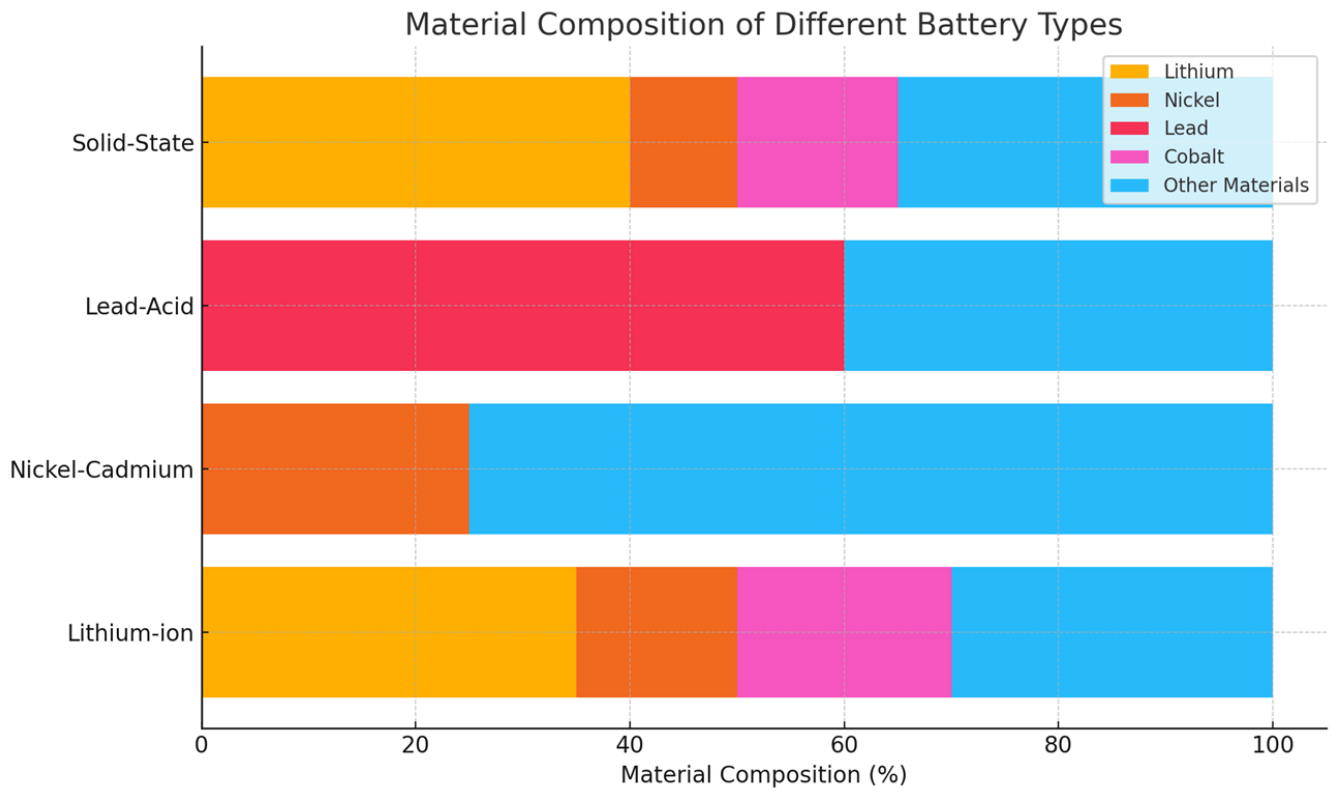


Fig. 4.2 This chart shows the percentage composition of key materials in various battery types. Lithium-ion and solid-state batteries have the highest lithium content, nickel–cadmium batteries are dominated by nickel, and lead-acid batteries contain a majority of lead, highlighting distinct material priorities for each technology.

The material composition of battery types is best shown as a stacked bar graph because it shows the whole–part relationship clearly. Each battery type is represented as a single bar that adds up to 100%, so it's immediately clear how much each material contributes to the whole battery. It also allows direct comparison of total composition patterns. Note that the battery type labels run horizontally so that they fit comfortably on the graph.

Line Graphs

Line graphs are especially useful in engineering and technical communication when you need to show how something changes continuously or over an ordered sequence. They're one of the most powerful tools for revealing trends, patterns, and relationships in data. For example, Fig. 4.3 could help stakeholders choose the better-performing turbine based on efficiency loss trends over time.

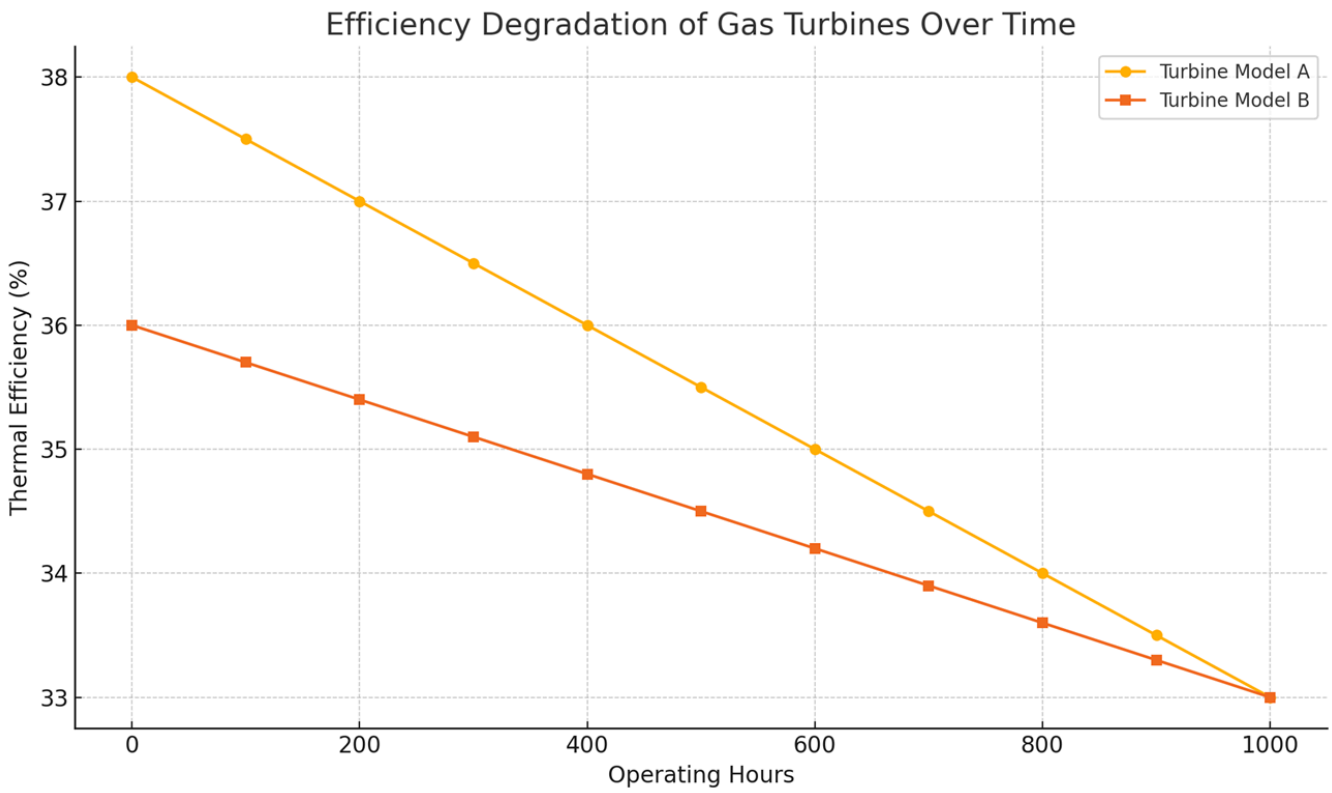


Fig. 4.3 Both turbine models lose efficiency with increasing operating hours, but Model B maintains a slower rate of degradation, suggesting better long-term performance.

Note that lines in the graph only approximate the values between data points. To ensure line graphs are used ethically, clearly state if any smoothing or transformations have been applied. Choose axis scales and intervals that accurately reflect the magnitude and pattern of change.

Area Graphs

An area graph is a variation of a line graph where the space under the line is filled with color or shading to emphasize the magnitude of the variable. In engineering contexts, area graphs are often used to

- show how a quantity changes over time while also highlighting the cumulative size or proportion of the values; or
- compare multiple related datasets by stacking them, which reveals both their individual contributions and their combined total.

For example, in renewable energy engineering, an area graph might display the daily power output of solar, wind, and hydro sources stacked together, making it easy to see not only how each source fluctuates but also the total available power at any point. This function is illustrated in Fig. 4.4.

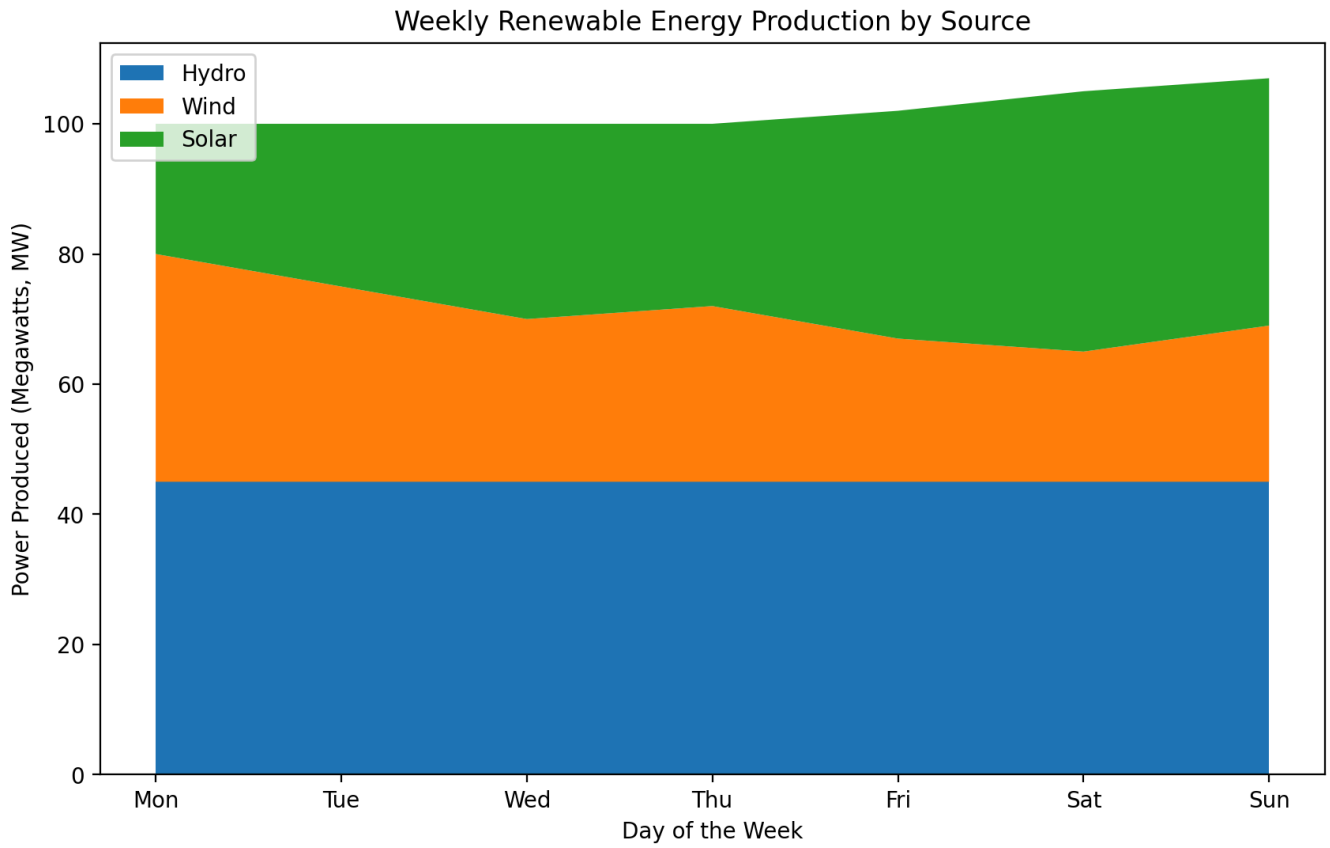


Fig. 4.4 The graph highlights both individual fluctuations in each energy source and the total combined output, showing how renewable sources complement each other across the week.

Area graphs, similar to line graphs, can show trends and totals across categories. They are effective for showing cumulative data but less so for displaying specific series values within totals.

Pie Charts

A pie chart is a circular chart divided into slices, where each slice represents a proportion or percentage of a whole. The size of each slice corresponds to its share of the total, making pie charts an intuitive way to visualize parts-to-whole relationships. In engineering, pie charts are especially effective for illustrating proportional data such as material composition (e.g., the percentage of steel, aluminum, and composites in a vehicle's body), energy source mix (e.g., the proportion of electricity generated from renewable versus non-renewable sources), maintenance cost distribution (e.g., labor, parts, downtime, and overhead), and project budget allocation (e.g., design, testing, manufacturing, and quality control). They provide a clear visual impression of how parts contribute to a whole, making them useful for highlighting dominant categories or overall balance. However, pie charts are less effective when precise value comparisons are needed, especially if the differences between categories are small. In such cases, a bar chart or stacked bar chart offers greater clarity. They can also become difficult to interpret if there are too many small slices or if category percentages are similar, which can visually blur distinctions between them.

Fig. 4.5 is a good use of a pie chart because the data represents a composition that adds up to 100%, with a small number of clearly distinct categories. Each slice visually conveys the proportion of a specific material in the battery, making it easy to see which materials dominate (e.g., nickel) and which play smaller roles (e.g., manganese).

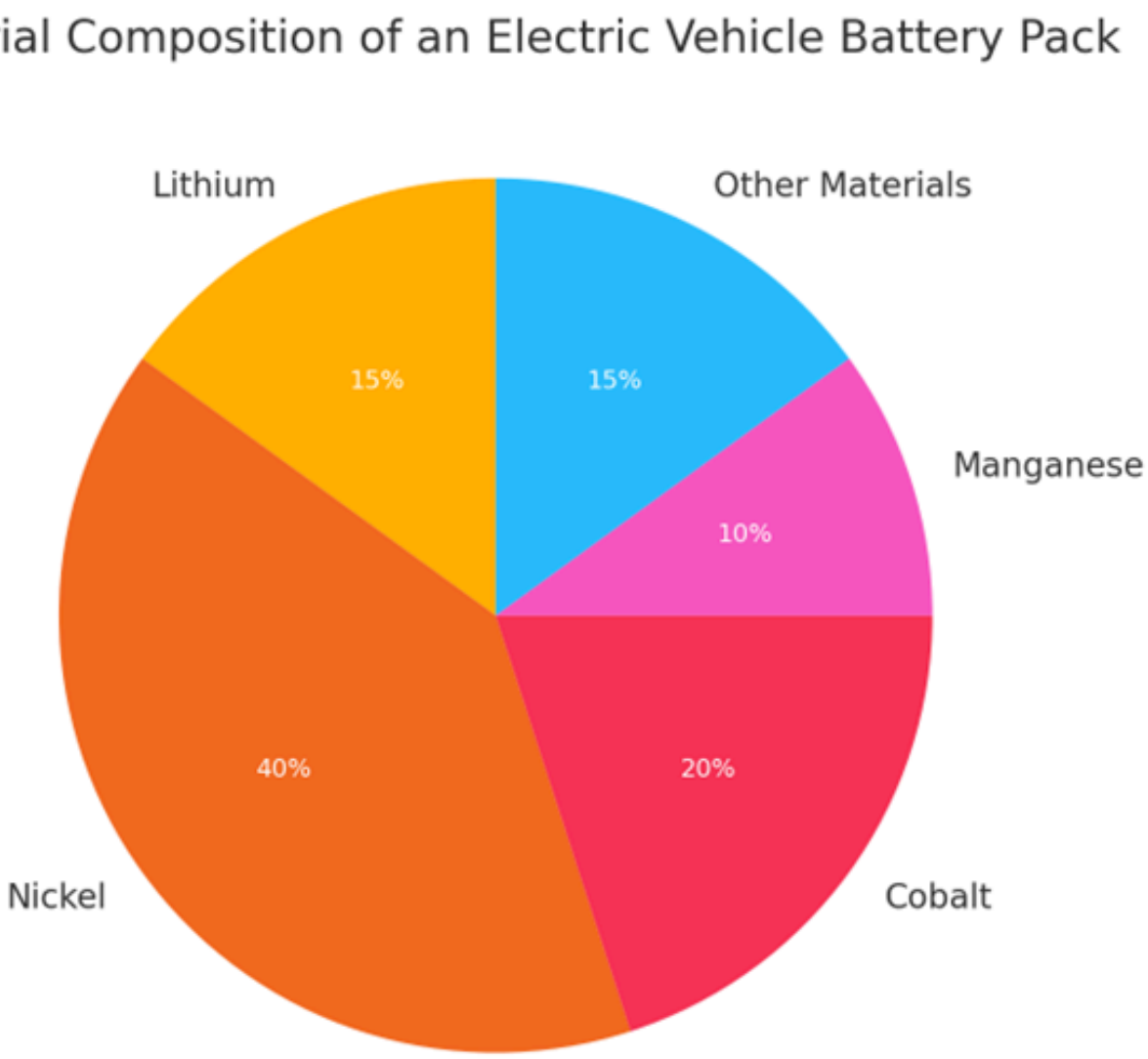


Fig. 4.5 Nickel makes up the largest portion of the battery composition, followed by cobalt and lithium, highlighting the importance of sourcing and managing these critical materials in electric vehicle manufacturing.

Pie charts are most effective for providing a quick, big-picture view of proportions rather than fine-grained comparisons, as the human eye is not good at judging small differences in angles. To maximize clarity, slices can be ordered from largest to smallest, with distinct, meaningful colors used to reinforce the message. Labels can be placed on or beside the slices as long as this doesn't clutter the graph.

Diagrams and Photographic Images

Diagrams are invaluable in technical reports, especially for explaining complex mechanisms. For example, a diagram of a vehicle's safety belt locking mechanism can convey information about form and functionality far more effectively than a written text. A well-designed diagram with clear labelling or a legend can simplify complex designs because it strips away unnecessary detail so the reader can focus on the most relevant features. Remem-

ber, however, to tailor diagrams to your audience's expertise. Technical readers, such as engineers, can interpret detailed diagrams (e.g., complex circuitry), whereas non-technical readers may require simplified visuals.

Photographic images are the better choice when realism, authenticity, and an accurate depiction of an actual object or condition are essential (i.e., when readers need to recognize something exactly as it appears in the real world). They convey far more visual detail than diagrams, which can be either an advantage or a drawback depending on the context. For example, in a bicycle repair manual, a photograph of the gear assembly would reveal metal textures, grease, reflections, and parts of the surrounding bike frame — details that might distract from the form and arrangement of the components. In such a case, a simpler black-and-white diagram could focus attention more effectively on the parts themselves.

When integrating images, remember the following points:

- Simulate the typical angle of vision.
- Crop unnecessary details to focus on relevant elements.
- Label specific features.
- Include a size reference, such as a coin or a pencil, to provide context (if appropriate).
- Refer to images by figure number in your text.
- Obtain permission for images owned by others.

By using diagrams and photographic images judiciously and adhering to these best practices, you can make your technical documentation clear, precise, and engaging for your audience.

Making Visuals Accessible

Accessible technical documents present visual information in a way that is clear, consistent, and easy to understand. For example, in a manual for a complex machine, high-contrast diagrams, simple and legible labels, and concise captions can significantly improve comprehension. These elements work together to help readers quickly understand how the machine operates.

Clean, well-organized visuals enhance usability, allowing readers to find and interpret information with ease. To achieve this, prioritize clarity and consistency in your visuals, use the same terms and labels throughout the document, place visuals next to relevant text where possible, and avoid unnecessary clutter. In the following section, we'll explore how to combine visuals and text effectively, with a focus on accessibility.

Integrating Visuals and Text

In technical communication, combining visuals with text is essential for conveying complex information more clearly than text alone. When used well, visuals can clarify concepts and improve understanding. When used poorly, they can cause confusion. The following guidelines will help you integrate visuals effectively:

- **Place visuals next to the related text so that readers can easily connect what they see with what they read.** When a figure, diagram, or table appears far from the section that explains it, readers must flip pages or scroll back and forth, which disrupts their focus and increases cognitive load.
- **Avoid placing figures immediately after headings. Instead, introduce each figure with at least one sentence that explains its purpose.** Dropping a visual directly under a heading without any lead-in text can leave readers uncertain about why it is there or how to interpret it. A brief introductory sentence sets the stage, clarifying the figure's relevance before the reader examines it.

- **Follow visuals with explanatory text that expands on what the reader sees.** Use visuals to show structure or relationships and use text to explain the underlying details or implications.

Visuals provide readers with the “big picture” at a glance, while text fills in the essential details. Consider the following example in which a visual supports the explanation of a mechanical system, making its operation easier to understand.

The VertexSphere window washing system is an automated solution designed to clean exterior glass on commercial and residential buildings. It employs a dual-axis mechanism for efficient glass maintenance. Its motorized central unit travels along horizontal guide rails while deploying four microfiber cleaning pads on adjustable arms. Fig. 4.6 shows the mechanical components of the system and their arrangement on a standard window frame.

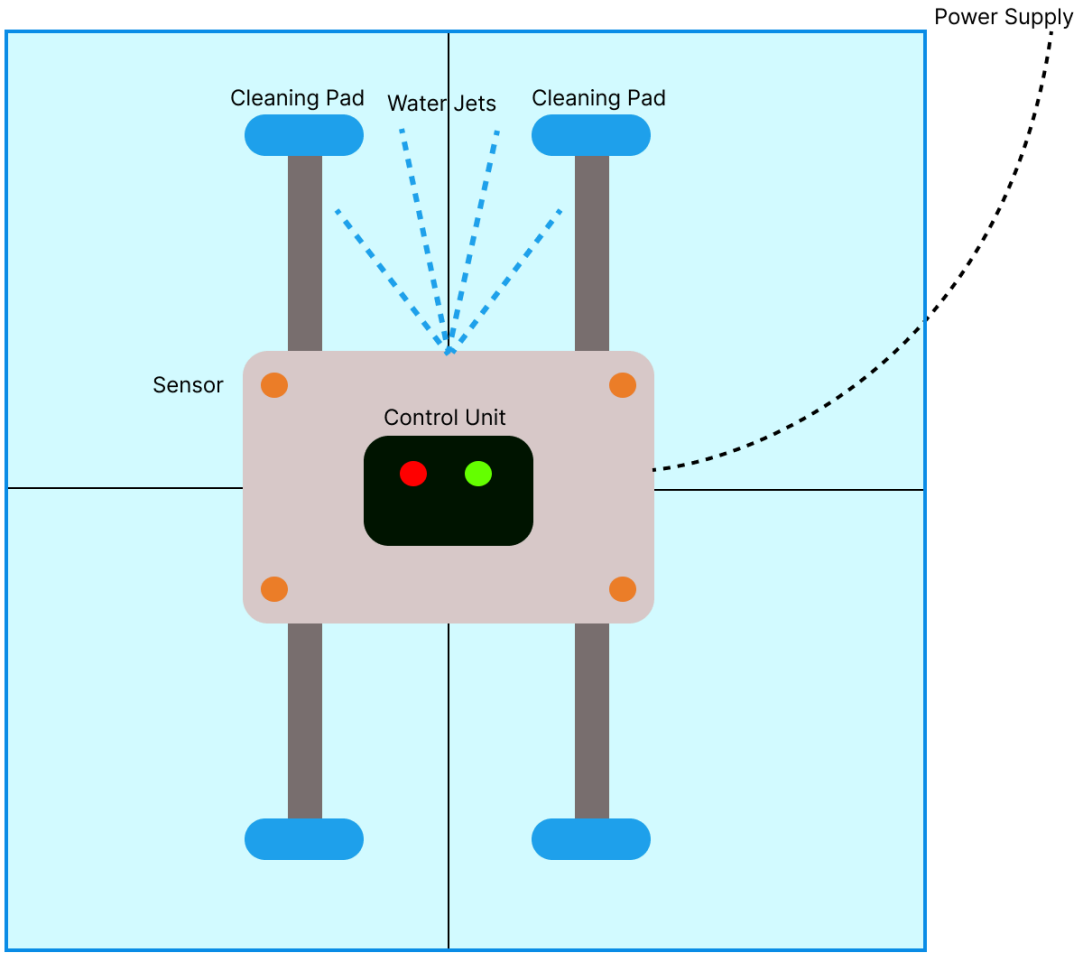


Fig. 4.6 Mechanical components of the VertexSphere window washing system, including sensors, cleaning pads, water jets, and power supply.

The system's integrated sensors constantly monitor surface contact pressure, ensuring thorough cleaning without damage. Four precision water jets spray biodegradable solution ahead of the cleaning pads, dissolving stubborn residue. The microprocessor control unit adjusts cleaning parameters based on environmental conditions and glass type. This synchronized mechanical-electronic approach allows the VertexSphere window washing system to achieve streak-free results on buildings of varying heights.

In the example, the first paragraph introduces the system's dual-axis mechanism and basic functionality before presenting the figure. It also mentions key components, such as microfiber cleaning pads and guide rails, to prepare readers for what they will see in the diagram. The figure, then, displays the spatial arrangement of the components, while the subsequent paragraph explains the operational details, such as how the sensors monitor the contact pressure and how the microprocessor adjusts the cleaning parameters based on the environmental conditions. This integration allows readers to easily understand the system's physical structure from the visual while gaining a deeper understanding of its functionality through the accompanying text.

Labelling and Captions

Labelling visuals means clearly naming important parts, features, or data right on a diagram or illustration. Good labels help readers understand complex visuals by pointing out key elements and showing how they connect. When you create labels,

- use consistent formatting;
- keep text concise;
- position labels close to their referenced elements; and
- maintain a clear visual hierarchy that distinguishes labels from other text elements.

Captions work alongside labels to provide context and highlight what is most important. A caption typically includes a figure number and a brief description. Use a consistent numbering system — such as Fig. 1, Fig. 2 — in the order visuals appear in your document. Keep captions short but informative, focusing on the visual's main point without adding unnecessary detail.

For example, the VertexSphere window washing system diagram uses clear labels to identify its key components — power supply, cleaning pad, water jets, sensor, and control unit — placed next to their corresponding parts. The caption, *Fig. 4.6 Mechanical components of the VertexSphere window washing system, including cleaning pads, sensors, water jets, and power supply,* provides both a sequential figure number and a concise description of the content of the figure.

Ensuring Clarity in Figures and Labels

Visual clarity is essential for effective technical communication because poorly designed visuals can confuse readers and obscure key information. To support visual clarity, use high-resolution images (at least 300 dpi for print) so details remain sharp when viewed closely. When resizing, maintain the original proportions to avoid distortion, which can misrepresent measurements or spatial relationships. This is especially critical in engineering,

where accuracy is key to correct interpretation. Consistent shapes, line weights, and styling across diagrams also make visuals more polished and easier to interpret.

Labels within figures are just as important as the graphics themselves. Choose fonts that are easy to read for labels and annotations, and use a consistent style throughout all visuals. Sans-serif fonts, such as Arial or Helvetica, work well for clean, professional-looking labels. A minimum of 10 pt is generally considered safe for accessibility, without overpowering the diagram. Ensure adequate white space around labels to maintain clarity and allow for easy tracing to their corresponding elements.

Clear visuals combined with consistent typography are not just matters of design. They directly affect how well your audience can interpret and apply complex information.

Key Takeaways



Visuals are essential in technical communication because they summarize information, enable comparisons, illustrate relationships, emphasize key points, and transcend language barriers. Creating effective visuals requires attention to the following six key practices:

- **Choose an appropriate visual format** for the information you need to present.
- **Integrate visuals and text effectively** by
    - placing visuals near the related text,
    - introducing each visual with a brief lead-in sentence or paragraph, and
    - following each visual with explanatory text.
- **Label visuals clearly** and use consistent terminology to prevent confusion.
- **Write informative captions** that include a figure number and a concise description so readers can understand the "story" of the visual.
- **Ensure visual clarity** through consistent formatting.
- **Maintain accessibility** by designing visuals that are easy for all readers to interpret.

By applying these principles, you can create visuals that are accessible, accurate, and effective in helping readers understand complex engineering information.

Practice Task



Find a technical document in your field that contains at least three different visuals, such as graphs, charts, diagrams, photographs, illustrations, or flowcharts.

1. Identify the types of visuals used and explain why each one is appropriate for its purpose.
2. Choose one visual to analyze in detail by answering the following questions:
    - How is it integrated into the text?
    - Do the labels use consistent technical terms?
    - Does the caption effectively explain the purpose?
    - How could visual clarity be improved?
3. Create an improved version of the visual that better applies the key elements discussed in this chapter.

Chapter 5: Writing Process

Chapter ContentsStages of the Technical Writing ProcessPlanning / PrewritingDraftingRevisingEditing and ProofreadingKey TakeawaysPractice TaskReferences

Stages of the Technical Writing Process

In technical writing, the writing process is a structured approach to planning, drafting, revising, and editing your work. This process ensures clear, accurate, and user-focused documentation. It typically involves the following stages:

Planning / Prewriting

Planning and prewriting are important in technical communication because they ensure content is tailored to the audience's needs and context of use. In this stage you do the following:

- Define the purpose and goals of the documentation
- Identify who will use the document
- Gather information
- Select an appropriate format

Remember: When planning writing, always consider the primary audience's needs first. Secondary audiences can be directed to supplementary information in appendices or through hypermedia links. To learn more about audience analysis, read *Audience Analysis* [1].

Drafting

Drafting is a crucial step in the engineering writing process. It involves writing a preliminary version of the text, which can then be revised and refined to produce the final version. During drafting, you may do the following:

- **Developing and clarifying ideas —** Drafting helps writers develop their ideas and arguments. Once externalized on the page, you can elaborate or expand upon blocks of text without overwhelming your memory. You can identify gaps in your arguments or areas where additional research is required.
- **Organizing ideas —** Drafting allows you to reorganize information in a logical manner, improving coherence and flow.
- **Collaborating —** Drafting facilitates collaboration. After producing a preliminary version of the text, you can share it with others to receive feedback for improvements.

Revising

Revising is a broader-level process that brings about changes to content, structure, and style. It refines the message to make it more coherent and engaging for the intended audience. During revising, you may do the following:

- Make changes to wording, sentence structure, or paragraph organization.
- Remove redundancies or unnecessary content.
- Check that figures and tables are well integrated within the text.

Editing and Proofreading

Editing and proofreading are granular-level processes that examine writing with a focus on grammar, punctuation, spelling, word choice, and formatting. In this stage, you may do the following:

- Polish the text to check for consistency in style — perhaps while referring to a style guide.
- Ensure that citations or references are accurate and properly formatted.

Key Takeaways

In technical communication, crafting a strong document is less about sudden inspiration and more about thoughtful steps taken with a purpose. Rather than beginning your document with the title or the first sentence right away, it may be more effective to follow a clear process. This typically involves a process of 1) planning/prewriting, 2) drafting, 3) revising, and 4) editing and proofreading. Following these steps can help you produce writing that is clear, accurate, and professional.



Practice Task



Write a short professional bio that could appear on a company website. Aim for around 100–150 words. This bio should introduce you, your background, and your professional interests in a clear and engaging way. As you complete this task, follow each stage of the writing process:

Planning — Define your purpose and consider your audience. Decide what key information you want to include.

Drafting — Organize your ideas and write a preliminary version of your bio. Once you've completed your draft, share it with a classmate and ask for feedback.

Revising — Based on the feedback you receive, revise your draft to improve its structure and flow. Make sure it accurately reflects your professional identity.

Editing and Proofreading — Make final adjustments to improve clarity, grammar, tone, and formatting. Check for typos and make sure your style is consistent throughout.

References

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Chapter 6: Argument in Engineering

Chapter ContentsArgument and Persuasion in Technical CommunicationUnderstanding Rhetorical SituationEthical and Professional Responsibilities in ArgumentationFormulating Effective ArgumentsKey TakeawaysPractice Task

Argument and Persuasion in Technical Communication

In engineering, making a strong argument is just as important as finding the right technical solution. In a proposal, for example, you must convince others — whether a client or another decision-maker — that your solution is worth pursuing. This involves earning trust, addressing different viewpoints, and demonstrating that your ideas can withstand scrutiny. When you argue effectively, good solutions are more likely to be understood, accepted, and implemented, even in complex situations.

Understanding Rhetorical Situation

Rhetoric is the art of effective or persuasive speaking and writing. When you use rhetoric, you aim to convince others to accept your interpretation of facts, help them understand those facts, or motivate them to act in response. The most persuasive messages are well adapted to the knowledge, values, and expectations of readers. Therefore, before you write or speak, ask yourself:

- Who is the audience?
- What is the main message you need to convey?
- How will you adapt to the audience's level of knowledge? (This doesn't mean "dumbing down" the message. Instead, it means choosing wordings and explanations that make the content clear and accessible.)
- How will you establish credibility and demonstrate your expertise through your communication?

Elements of the Rhetorical Situation

The rhetorical situation is the context in which communication takes place. Understanding this context means examining several key elements that shape how a message is created, delivered, and received. While different textbooks may categorize these elements in slightly different ways, the core components are generally the same: the writer (or speaker), the purpose, the audience, the message, and the broader context.

As part of context, it is also essential to consider constraints — the local factors that limit or direct the communication process. So, if "context" is the broader environment in which communication takes place, "constraints" are the walls, ceiling, and floor of that environment. These may include time limits, word counts, access to information, organizational policies, workplace-provided templates, as well as constraints relating to the medium of communication itself. Such constraints can significantly influence the way you structure and present your arguments.

Let's look at the elements of rhetorical situation in a bit more detail:

Writer

Writers inevitably bring their own experiences, perspectives, and identities to the act of communication. This includes prior knowledge and learning that shape their approach, as well as personal background factors such as culture, gender, values, and beliefs. These elements — a writer's "personal baggage" — influence decisions about what to include, how to frame ideas, and even which arguments feel most compelling. Far from being purely neutral, writing is always shaped by the writer's viewpoint. Recognizing these influences in yourself, along with potential biases they may create, is essential for crafting messages that are credible and trustworthy.

Purpose

Purpose is the reason for writing — the outcome you want to achieve through your message. Common purposes include the following:

- **Persuade —** Convince the audience to adopt a viewpoint or take a specific action.
- **Educate —** Help the audience deepen their understanding of a topic.
- **Call to action —** Motivate the audience to act, change behavior, or support a cause.
- **Inform —** Provide clear, accurate facts or explanations.
- **Entertain —** Engage and delight the audience through storytelling, humor, or other creative means.

In practice, many pieces of writing combine multiple purposes. For example, a proposal primarily aims to persuade but also informs and educates readers about the problem and possible solutions. Being clear about your primary and secondary purposes helps you focus your content, choose the right tone, and structure your message to achieve your writing goals.

Audience

An audience's ability to understand, connect with, and appreciate a message depends on a range of factors, including

- **Age —** which influences familiarity with certain topics, references, and communication styles.
- **Social class —** which shapes access to resources, life experiences, and perspectives.
- **Education and experience —** which affect background knowledge, vocabulary, and the ability to grasp technical details.
- **Culture —** which influences values, communication norms, and interpretations of meaning.
- **Expectations —** which shape what the audience anticipates in terms of content, tone, and structure.

By clearly identifying your audience — whether it's a single decision-maker, a broad public group, or a specialized professional community — you can adapt your content, tone, and level of detail to meet their needs and expectations. Effective communication begins with meeting the audience where they are, then guiding them toward where you want them to be.

Message

The message is the core content of your communication — the ideas, information, or arguments you want to convey. It includes not only the main points but also how those points are structured, emphasized, and supported. An effective message is tailored to the specific situation, aligning with the purpose, audience, and context.

Context

Context refers to the external circumstances that create the need for communication and that influence how the message is received. It shapes both the urgency of the message and the strategies used to convey it. Context can include

- **Timing —** The contextual moment, including crises, decision deadlines, or key project milestones, during which communication occurs.
- **Location —** The physical or virtual setting where communication takes place, which can affect tone, formality, and accessibility.
- **Events —** Current or recent developments that frame how the audience interprets the message.
- **Cultural expectations —** Shared norms, traditions, and values that shape what is considered appropriate or persuasive.

Recognizing context allows writers to adjust their message for maximum relevance and impact. Even a well-crafted argument may fail if it doesn't account for the situation in which it will be delivered.

Constraints

Constraints are the limitations or requirements that influence how you present your message. After identifying your influences as the writer, purposes, audience, message, and context, consider the possible constraints that relate to each of these.

- **Writer-related constraints —** your own expertise, position, or level of authority on the topic
- **Purpose-related constraints —** requirements to meet organizational objectives
- **Audience-related constraints —** technical background, time constraints for reading, or pre-existing biases
- **Message-related constraints —** availability and reliability of data, or the complexity of the subject matter
- **Context-related constraints —** deadlines, budget constraints, institutional policies, or prevailing cultural norms

Identifying constraints early can help you refine your approach to better fit the situation.

Once you have clearly defined the elements of the rhetorical situation — writer, purpose, audience, message, context, and constraints — you can plan, draft, and deliver your communication with greater confidence. Every communication task exists within a rhetorical situation. Whether you are writing a report, giving a presentation, or composing an email, success depends on your ability to assess the situation and adapt your approach. Effective communication is built on this awareness and the flexibility to tailor your message to fit the circumstances.

Ethical and Professional Responsibilities in Argumentation

Making complex ideas accessible is a core part of both effective persuasion and ethical engineering communication. An argument should not exclude, confuse, or mislead its audience. As well as being convincing, ethical arguments must be transparent, fair, and grounded in respect for the people who rely on them.

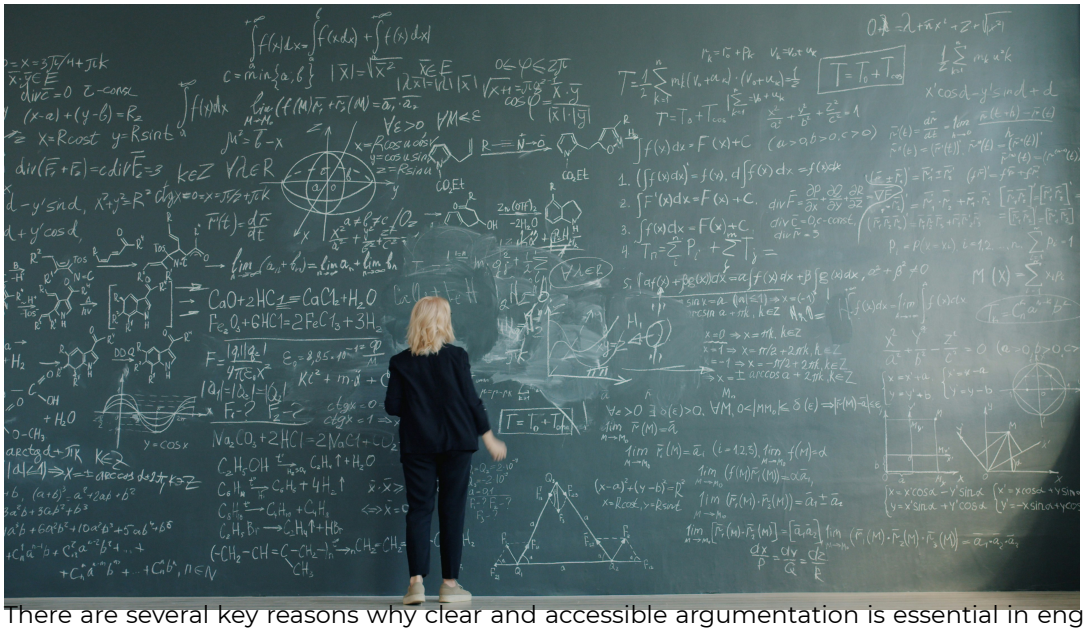


Photo by Vitaly Gariev on Unsplash

There are several key reasons why clear and accessible argumentation is essential in engineering communication:

- **Allowing readers to make informed decisions** — Engineers often write for a wide range of stakeholders, such as clients, policymakers, interdisciplinary teams, or members of the public, who may not have a technical background. If ideas are not communicated clearly, these audiences cannot make informed, ethical, or safe decisions based on the information provided.
- **Respect for the audience** — Clarity demonstrates respect for the audience's right to understand the implications of engineering work. Ethical persuasion involves transparency, not manipulation. Overwhelming the audience with jargon or unnecessary complexity can obscure risks or trade-offs and undermine informed consent.
- **Building trust and credibility** — Audiences are more likely to accept an argument when it is clear. Ambiguity or unnecessary complexity can create doubt, foster suspicion, or lead to misinterpretation
- **Fulfilling social responsibility** — Engineering decisions often affect public safety, the environment, and equity. Clear communication ensures that affected communities can understand what is at stake, participate in meaningful dialogue, and express concerns. This aligns with the engineer's responsibility to serve the public good.
- **Supporting accountability** — Clear communication creates a transparent record of reasoning and decision-making. If a decision leads to harm, the basis for that decision must be accessible and understandable — not buried in overly technical language.

In short, ethical communication in engineering demands that ideas be not only accurate but also understandable. This ensures that decisions are fair, inclusive, and based on a shared understanding — strengthening both the persuasiveness of your argument and your professional integrity.

Formulating Effective Arguments

Many documents in engineering or computer science are designed to present solutions to problems. One of the most important tasks, then, is to establish that the problem is serious enough to warrant attention. A common pitfall in effective argumentation is the tendency to either overstate or understate problems. For example, if a problem could lead to loss of human life, injury, or serious damage to equipment, you must communicate this idea clearly and forcefully. On the other hand, overemphasizing an issue the reader perceives as minor can weaken your argument and reduce your credibility.

One effective strategy for developing strong arguments is to appeal to the audience's rationality. In engineering and computer science, this means using measurements, data, and observable facts to support your claims. Emotional appeals may sometimes add context or human perspective, but they should not replace evidence-based reasoning.

The evidence you provide should meet four key criteria. It should be

- **Strong —** clearly and convincingly supports your claims
- **Specific —** directly relates to your argument and fits the given context
- **Credible —** comes from reliable sources that have been reviewed or tested
- **Reasonable —** persuades an informed audience through its fair interpretations

Another effective strategy for creating convincing arguments is to use familiar examples. Examples are especially valuable when addressing readers who may not be deeply familiar with a specific technology or its applications. By illustrating problems and solutions in clear, real-world contexts, you make your argument more accessible and persuasive. Providing examples in an argument is like adding illustrations to a textbook: while text alone can convey information, illustrations make the material more engaging and help clarify complex ideas. In the same way, examples allow your audience to visualize your argument in action.

For instance, suppose you need to persuade a group of decision-makers who are skeptical about electric vehicles (EVs) because of their higher upfront costs compared to gasoline-powered cars. To promote EV adoption within your company, you might verbally present your case to colleagues in a meeting as follows:

> While the initial purchase price of an electric vehicle (EV) may be higher than that of a comparable gasoline-powered car, the long-term financial and environmental benefits make EVs a more cost-effective choice over time. In Canada, federal and provincial rebate programs — such as Québec's *Roulez vert* incentives or British Columbia's *Go Electric* program — can significantly reduce the upfront cost. Once purchased, EV owners save on fuel, as electricity is generally cheaper than gasoline, and on maintenance, since EVs have fewer moving parts and require less servicing.
>
> Environmental benefits can also lead to economic advantages. Reduced greenhouse gas emissions and improved air quality can help lower healthcare costs associated with pollution-related illnesses, as seen in other countries. For example, Norway's widespread EV adoption, supported by strong incentives, has contributed to measurable reductions in air pollution and fuel dependence. This example suggests that higher initial costs are offset over time by savings on fuel, maintenance, and environmental impacts—making EVs both an economical and sustainable choice for the future.

Additionally, citing experts can strengthen your argument by lending authority and credibility to your claims. The opinions and findings of respected professionals in the field reassure your audience that your position is sup-

ported by established knowledge. For example, when persuading decision-makers about the cost-effectiveness and environmental benefits of EVs, you can reinforce your case by quoting recognized experts. When doing so, be sure to name the individuals and explain why they are credible sources — whether through their research, professional experience, or contributions to the field.

To promote EVs within your company, you can include the following paragraph in a report:

> The initial investment in electric vehicles (EVs) may seem higher than that of traditional gasoline-powered cars. However, both the financial and environmental long-term savings make EVs a more cost-effective choice over time. A study by the Natural Resources Defense Council, a leading environmental organization, shows that EV owners can save thousands of dollars over the vehicle's lifetime compared to gasoline vehicles. This includes savings on fuel, maintenance, and repairs **[1]**. Additionally, the International Council on Clean Transportation, a respected global authority on sustainable transportation, reports that battery electric vehicles (BEVs) in Europe produce 73% fewer life-cycle greenhouse gas emissions compared to gasoline-powered cars. This highlights the significant environmental benefits of widespread EV adoption **[2]**. These reports demonstrate that EVs not only offer significant financial savings over time but also have important environmental benefits.
>
> **References**
>
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>
> [2] International Council on Clean Transportation (ICCT), "Life-cycle greenhouse gas emissions from passenger cars in the European Union: A 2025 update and key factors to consider," Jul. 25, 2025. [Online]. Available: **https://theicct.org/publication/electric-cars-life-cycle-analysis-emissions-europe-jul25/**. [Accessed: July 15, 2025].

Another key strategy in building a convincing argument is to anticipate potential objections. Problems rarely exist in isolation, and solutions are often shaped — or limited — by factors beyond engineering design. These can include organizational priorities, technical feasibility, legal and ethical requirements, time constraints, and financial limitations. Readers will expect evidence that you have looked beyond the technical details to consider the broader social, environmental, legal, and ethical implications of your work. Addressing these concerns proactively strengthens your credibility and your argument.

To anticipate objections effectively, consider the kinds of questions your readers might ask:

- Do we really have a problem or a need?
- If so, is it important enough to justify action?
- Can the problem realistically be solved?
- What potential solutions exist?
- What benefits can we expect?
- What risks or liabilities should we be aware of?

Reflecting on these questions before framing your arguments strengthens your logic and shows that you understand your audience's concerns, which helps build trust with them.

Effective argumentation is never just about presenting the facts. It is also about showing why the problem matters to your audience. Therefore, think about their concerns, values, and priorities, and connect your ideas to what they care about.

Ask yourself:

- How is this problem personal to my audience?
- Do I have evidence demonstrating its importance to them?
- How can I connect my argument to what they need or care about?

Stepping outside of your own perspective to see issues from your audience's viewpoint is one of the most challenging aspects of writing. However, it is also one of the most essential strategies for crafting powerful and effective arguments.

Finally, always be honest in your arguments. Present your case with integrity. Never manipulate or deceive. If readers sense dishonesty, your argument will lose credibility and ultimately collapse.

Key Takeaways

In engineering, persuasive argument comes from careful analysis and planning. This process often involves



- **Understanding the situation —** Consider who you are, why you are communicating, who will read your work, what the content of the message is, and what constraints you may face.
- **Making complex ideas accessible —** Use straightforward language and clear explanations to help your audience follow your reasoning.
- **Supporting your claims with solid evidence —** Draw on data, expert opinions, and sound analysis, while also anticipating and addressing possible objections.

Focusing on these areas will help you create arguments that are technically sound, easy to follow, and persuasive to your audience.

Practice Task



Find a document in your field that includes an argument, such as a short report or an article.

Identify the rhetorical situation.

- Who wrote it?
- Who is the audience?
- What is the main purpose?
- What is the message?
- What constraints might have shaped it?

Analyze the argument.

- What types of evidence are used?
- Why is this evidence and structure suitable or not suitable for the situation?

Chapter 7: Professional Correspondence

Chapter ContentsProfessional Correspondence in Engineering and Computer ScienceUsing an Appropriate Tone and Level of FormalityWriting in a Professional Yet Natural ToneChoosing the Right FormatStructuring a Professional EmailKey TakeawaysPractice Task

Professional Correspondence in Engineering and Computer Science

Engineers and computer scientists, like professionals in many other fields, spend much of their day communicating with colleagues, clients, and supervisors. Professional correspondence — especially emails and memos — forms the nervous system of most workplaces. Whether teams are working in the same office or spread across time zones, clear, respectful, and well-structured communication keeps projects moving and teams connected.



Photo by Le Vu on Unsplash

You can adopt the following key practices to ensure that your readers understand your message quickly and easily, while also feeling respected:

- Use an appropriate level of formality.
- Write in a professional yet natural-sounding tone.
- Write with purpose and choose the right format.
- Structure your emails professionally.

Let's explore each of these strategies in more detail.

Using an Appropriate Tone and Level of Formality

The tone and formality of professional correspondence depend on the situation and audience. You can associate levels of formality with three correspondence styles:

Personal style — used between friends and acquaintances (casual, conversational language)

When writing in a personal style, the tone is more relaxed and conversational. You may find the following points helpful when writing in a personal style:

- Use casual language that reflects how you naturally speak.
- Feel free to use contractions or abbreviations.
- Openings and closings can be less formal, such as

Opening: "Hey," "Hi," or just the person's name.

Closing: "Take care," "Talk soon," or even just your name.

- Keep it short and friendly — there's no need for formal structure.

Memo style — used for internal communication within organisations (still professional but less formal)

To apply memo style effectively in internal communication, you may find the following guidelines helpful:

- Use block paragraphs (no indents) and present information in a structured format.
- Use headings, bold, and italics for emphasis.
- Openings and closings can be less formal, such as:

Opening: "Hello," "Good afternoon," or "Greetings"

Closing: "Regards," "Best," or even "Cheers"

- Ensure flawless spelling and grammar — use spell check.

Letter style — used for external communication with clients, customers, or suppliers (most formal)

When writing in letter style for external communication, it's important to follow a more formal structure. The following guidelines can help you write effectively:

- Use block paragraphs and present information in a structured format.
- Openings and closings should be formal:

Opening: "Dear Mr. Xu" (Use Ms. for all women unless otherwise specified)

Closing: "Best regards," "Sincerely," or "Yours truly" (avoid outdated phrases like "Warm regards" unless you have a personal relationship).

- Avoid informal abbreviations like "BTW" (by the way) or "FYI" (for your information).
- Use bullet points and numbered lists where appropriate to enhance readability.

Before you start writing emails or memos, it's important to think about tone and formality. Professional doesn't have to mean stiff or overly formal. In fact, the most effective workplace communication often sounds clear, respectful, and to the point. No matter what style you use, your tone should match the situation and audience while still sounding natural and approachable.

Writing in a Professional Yet Natural Tone

The best writing for professional correspondence is **clear**, **direct**, and **human**.

Clear writing means your message is easy to understand the first time someone reads it. Use simple sentence structures, familiar words, and avoid unnecessary jargon. Think of your reader, especially in the workplace, who may be skimming. If your meaning is buried in complex or vague language, your reader can easily miss it.

Direct writing gets to the point quickly. In professional settings, people often juggle multiple tasks and read messages on the go. That's why it's important to state your purpose early. To do this, avoid giving too much background before explaining why you're writing. Instead, present your reason as early as possible with a clear statement such as "I'm writing to follow up on..." or "I'm reaching out about...".

Human writing avoids robotic or overly formal language. You don't need to sound like a machine to be professional. In place of "robotic" or "stuffy" expressions, use plain English alternatives. Table 7.1 presents some common examples.

Table 7.1 Common Stuffy Phrases and Their Plain English Alternatives

Letterese	Plain English
As per your request	As you requested
Contingent upon receipt of	When we receive
I am desirous of	I want or I would like
Please be advised that	*(Just remove it!)*
At this point in time	Now
In accordance with your request	As you requested
Due to the fact that	Because
I wish to express my gratitude	Thank you

By writing clearly and getting to the point with a natural tone, you show respect for your reader's time. Finding the right balance between professionalism and plain language makes your correspondence more effective.

Choosing the Right Format

On a typical day, you might find yourself writing several messages to share updates, ask questions, send reminders, or follow up on tasks. Email is one of the most common ways to communicate at work. However, not every situation calls for written communication, and email isn't always the best or most effective option. Depending on your purpose and context, other formats might be better suited. Some examples are as follows:

Forms requiring completion — If recipients need to fill out pages, it's usually better to distribute these documents via a website or in print.

Confidential information — Email is not secure, so sensitive information is better conveyed through a phone call, an in-person meeting, or over a secure platform.

Printed materials — Messages intended for print are probably best distributed as print.

Complex information — If the content is complex or detailed, provide a summary in the email and attach a more detailed document.

Serious or important matters — These are best conveyed in a formal letter, phone call, or in-person meeting.

Back-and-forth discussions — If a topic requires multiple exchanges, a phone call, or a video meeting is more efficient.

Brainstorming or consensus-building — These are better achieved in meetings rather than in email threads.

Choosing the right type of communication helps your message come across clearly and smoothly. If the format doesn't fit the situation, it can lead to confusion or delays. Therefore, it's important to choose one that suits the context.

Structuring a Professional Email

A well-structured email helps your message get noticed, understood, and answered. Whether you're making a request, sharing information, or following up, organizing your email in a clear and structured way makes it easier for your reader to understand your message. A well-structured email consists of the following elements:

Subject Line — Clearly state the purpose of your email. For example, a vague subject like "Update" doesn't provide enough context. A more effective option would be "Project Review: Request for Updated Design Documents," which lets the reader immediately understand the purpose.

Opening Paragraph — Establish the context and purpose of your message at the outset. Use phrases such as "I am writing to..." to help clearly state the reason for your email.

Middle Paragraph(s) — Provide key details in a structured manner. Use one paragraph per topic for clarity.

Final Paragraph (Action Close) — Clearly state the action you need the recipient to take.

The following email from two students to a professor follows a professional structure and shows how to communicate your message with clarity:

From: jordanhash@mail.someuniversity.ca
To: lwong@someuniversity.ca
Cc: sandybell@mail.someuniversity.ca;
Subject: Request for feedback on potential innovation proposal topic

Dear Professor Wong,

We have begun work on our innovation proposal and would appreciate your feedback on one topic we are considering before proceeding further. Our goal is to confirm whether the topic offers sufficient scope and complexity and aligns well with the assignment objectives.

Proposed topic: A smart energy management system for multi-unit residential buildings in Quebec that uses AI to reduce electricity use during winter peak-demand periods, while maintaining tenant comfort and addressing data privacy and grid reliability constraints.

If possible, could you let us know by email whether this topic is appropriate for the assignment, or if you recommend narrowing or reframing it? We will adjust our direction based on your guidance.

Thank you very much for your time and support.

Best regards,

Jordan Hash and Sandy Bell

This email is clear, professional, and polite, making it effective for several reasons:

- The subject line immediately informs the recipient of the purpose of the email. This helps the reader understand the context before opening the message.
- The tone of the message is courteous and respectful. Phrases like "would appreciate your feedback..." and "could you let us know by email maintain a professional tone without sounding too formal.
- The message gets straight to the point by stating the purpose at the outset. This helps the recipient quickly grasp the required action.
- The email ends with a clear statement of what the sender requires ("could you let us know by email whether this topic is appropriate"), along with an appropriate closing, "Best regards."
- The email is brief and well-structured, making it easy to read and respond to. It avoids unnecessary details while still conveying essential points.

Together, these elements help create a message that's easy to respond to and encourages a prompt reply.

When emails aren't written well, they can cause confusion or even cost a company money. To illustrate, a cleaning company in Australia introduced an AI tool to help staff write emails faster. The idea was to speed up customer replies. However, emails ended up giving clients the wrong information, and this led to financial loss for the company **[1]**. This incident may show that what you write, how you write it, and how much care you put into your message make a big difference.

Now, let's examine an example of a poorly crafted email message, this time in a corporate context. Read through it and consider what went wrong.

From: **itdep@sdresidence.ca**
To: **lilycruz@sdresidence.ca**
Cc:
Bcc:
Subject:

Hi Lily,

WE RECENTLY HAD A DATA BREACH IN OUR SYSTEM AND IT'S POSSIBLE THAT YOUR INFORMATION WAS AFFECTED. IF YOU USED A WEAK PASSWORD, THAT MIGHT BE PART OF THE ISSUE. YOU'LL NEED TO CHECK WITH YOUR BANK TO MAKE SURE NOTHING HAS BEEN COMPROMISED. UPDATE YOUR INFORMATION IMMEDIATELY. WE'VE DONE WHAT WE CAN ON OUR END. LET US KNOW IF THERE'S ANYTHING ELSE.

Best,
IT Department
SD Residence Group

This email shows how ineffective communication can damage trust in a professional setting. The following issues make this email less effective in handling a sensitive topic in a company:

- The email lacks a subject line. Always include a clear and descriptive subject.

- The formatting of the email is inconsistent and difficult to read**.** The message is written in all caps, which feels aggressive.
- The tone of the message is accusatory. Phrases such as “if you used a weak password, that might be part of the issue” and “update your information immediately” create a hostile tone.
- The message lacks clarity. The email could be structured more effectively by first stating the problem in detail, then providing clear instructions for improvement.
- The wording in the message is harsh. Instead of issuing commands, the message should make polite requests.

To improve clarity and effectiveness, the email should

- Start with a subject line that reflects its purpose.
- Structure the body into clear sections: problem, necessary actions, and next steps.
- Use a professional and respectful tone.
- Format the message in a clean and readable way.
- Avoid vague language or assumptions that could confuse the reader.
- Include a polite and clear call to action at the end.
- Keep the message concise and focused on key points.

The following revised version shows how these changes can make the message clearer and more professional:

From: **itdep@sdresidence.ca**
To: **lilycruz@sdresidence.ca**
Cc:
Bcc:
Subject: Notice of Data Breach and Recommended Actions

Hello Lily,

We are reaching out to let you know about a recent data breach in our system. While the investigation is still ongoing, there is a chance that your personal information may have been affected.

As a precaution, we recommend checking your financial accounts for any unusual activity. You may also want to update your passwords, especially if you have used the same one across different platforms.

We understand that this news can be concerning, and we are here to help. If you have any questions or need further support, please do not hesitate to contact us.

Best regards,
IT Department
SD Residence Group

This email is much more effective than the previous version. It’s clear, respectful, and well-structured. This makes it easier for the recipient to understand and respond. Considering how much workplace communication occurs through email, adopting a clear, concise, and respectful style can positively impact your professional reputation.

Key Takeaways



In professional communication, effectiveness isn't just about what you say. It's also about how you present it. Careful attention to tone, structure, and purpose makes your emails more impactful. This means

- using an appropriate level of formality for your audience;
- writing in a tone that is both professional and easy to read;
- choosing the right format for the situation;
- structuring your content clearly so readers can find key information quickly; and
- recording decisions, responsibilities, and next steps accurately when documenting meetings.

Applying these practices may help your readers understand your message quickly, keep projects on track, and maintain positive professional relationships.

Practice Task



As an engineer, you'll often need to communicate clearly and professionally with teammates, supervisors, and clients. The following email from a student intern to their engineering supervisor lacks clarity, structure, and professionalism. Please revise the email using the key practices from this chapter.

From: smiller@gmail.com
To: pmartinez@gmail.com
Cc:
Bcc:
Subject: Question
Hey,
I don't get the last part of the instructions. Can you explain? Also, when is it due again?
Thanks,
Alex

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Chapter 8: Effective Teamwork and Meetings

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Effective Teamwork and Meetings

Teamwork is at the heart of engineering. No one designs, builds, or solves problems completely on their own. Engineers rely on their colleagues' strengths and ideas to make projects successful. And how does this usually happen? Through teamwork and meetings. Effective teamwork and productive meetings go hand in hand. While teamwork brings ideas together, meetings provide the structure to organize those ideas, make decisions, and keep everyone aligned. This chapter will teach you how to work effectively in teams and conduct meetings that are productive.

Effective Teamwork

We've all been part of a group during our student life, working on a project or assignment. And we've probably experienced a group where a few teammates do most of the work while others barely contribute. It can be exhausting and frustrating — and worst of all, it drags down the quality of the entire project. How well you collaborate with your teammates as an engineer and how much you contribute don't just affect the project's outcome. It also shapes everyone's experience and builds (or harms) your reputation as a reliable team member. Isn't it the same in sports? Just as a winning team relies on every player giving their best, successful engineering projects depend on effective teamwork.

In your own teamwork — whether it's a lab assignment or a large engineering design project — your contribution matters. Always be the teammate who helps keep the project moving forward, supports others, and ensures the team reaches its goal together. The following strategies will make your teamwork more effective:



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- **Select a team leader (project manager) —** Assign someone to coordinate tasks and keep the team on track.
- **Clarify roles and responsibilities —** Make sure everyone knows what they are responsible for.
- **Choose a communication method —** Decide how your team will stay in touch (e.g., email or chat).
- **Choose a platform to stay organized —** Use tools like Google Docs/Drive or Microsoft Teams to keep files, notes, and updates in one place.
- **Set team rules —** Establish clear expectations for everyone from the start.
- **Set deadlines —** Agree on deadlines for each task or milestone.
- **Follow deadlines —** Make sure to complete your work on time.
- **Share your work early —** Submit your work to the team leader before the deadline for feedback.
- **Give constructive feedback —** Encourage teammates by providing helpful, positive feedback.
- **Review progress regularly —** Have short check-ins or mini-meetings to track progress and address issues early.
- **Support each other —** Help teammates when needed and ensure everyone contributes fairly.

Remember, effective teamwork isn't just about completing a project. It's about how you collaborate, communicate, and support each other along the way. Every contribution matters, and the effort you put in helps the entire team succeed. By following these strategies, you can make your team stronger and achieve better results. With everyone doing their part, "teamwork truly makes the dream work."

Effective Meetings

Like most professionals, engineers spend a lot of time in meetings to share updates, solve problems, and keep

projects on track. In your future career, you'll find yourself meeting with many people: colleagues, clients, managers, and decision makers. For example, imagine a client coming to you with a problem. First, you'd meet with the client to understand what they need. Then, you'd sit down with your colleagues on the project team to discuss possible causes, maybe even set up another meeting with technical experts to explore solutions. Later, you might meet with managers to talk about costs and feasibility before finally returning to the client to present your proposal. Each step depends on strong teamwork and clear communication.



Photo by Mario Gogh on Unsplash

Meeting Agenda

To make meetings effective, it's important to have a clear agenda and to share this with the team ahead of time. This way, everyone knows what to expect and can come prepared.

More specifically, the agenda

- **Sets clear objectives.** It outlines the goals of the meeting, ensuring that the group knows what they need to accomplish (e.g., decide on a design, assign tasks, review a draft).
- **Organizes the discussion.** By listing topics in a logical order, an agenda helps keep the meeting focused and efficient. This prevents wasted time, side-tracking, or missing important items.
- **Assigns roles and responsibilities.** The agenda usually identifies who will lead discussions, present updates, or take notes, ensuring accountability and smoother teamwork.
- **Encourages preparation.** When shared ahead of time, the agenda tells participants what to prepare or bring (data, drafts, visuals, research) so everyone comes ready to contribute.
- **Serves as a framework for meeting minutes.** It helps the team track decisions, action items, and deadlines.

Meeting Minutes

Taking notes during a meeting is essential to avoid losing track of key points, decisions, and deadlines. Meeting minutes are the official written record of what was discussed and agreed upon. They highlight the main topics, outcomes, and action items, ensuring that all participants share the same understanding.

In both academic and professional contexts, minutes help track responsibilities and provide updates for those who could not attend. They also serve as a reliable reference for confirming past decisions and guiding future planning. The following example illustrates how meeting minutes are typically structured.

Meeting Minutes: Innovation Proposal – Identity Theft Solution for ABC Bank
Date: May 11, 2025
Time: 10:00 AM – 10:45 AM
Location: Online
Facilitator/Chair: Carlos Ramirez
Note-taker/Recorder: Alice Johnson
Attendees

- Alice Johnson
- Bob Lee
- Carlos Ramirez

Regrets

- Dana Smith

Discussion Items

- Carlos gave an overview of the current research on identity theft trends and statistics, emphasizing the rise in digital fraud.
- Dana summarized ABC Bank's report, highlighting vulnerabilities in their current security system.
- The team discussed consulting ABC Bank representatives to ensure the proposed solutions would be feasible within the bank's existing infrastructure.
- Alice proposed the integration of biometric authentication for secure logins.
- Bob suggested real-time fraud detection using machine learning.
- Carlos raised privacy concerns, and the team discussed the encrypted local storage of biometric data.

Decision Items

- The team decided to proceed with a combined solution of biometric authentication (fingerprint and facial recognition) for secure login and machine learning-based fraud detection to monitor transactions.
- The team agreed to implement encrypted local storage for biometric data to address privacy concerns and to comply with data protection regulations.
- The team agreed to schedule a follow-up meeting with the ABC Bank representative to ensure

the proposed solutions' feasibility.

- Alice will research the best biometric technologies available and provide a summary by May 18.
- Bob will begin drafting the machine learning model for fraud detection, focusing on transaction data patterns, to present it by May 20.
- Dana will contact ABC Bank's representative to discuss privacy concerns and the feasibility of integrating biometric authentication, aiming to get feedback by May 19.
- Carlos will review the regulatory guidelines for storing biometric data and provide a report by May 19.
- The team will meet again on May 22, 2025, to review progress and begin drafting a proposal for the ABC Bank.

Topics for Next Meeting Agenda

- Review updates on biometric and fraud-detection research.
- Discuss feedback from the ABC Bank.
- Evaluate privacy and compliance findings.
- Draft the proposal document.
- Plan the visual and technical elements of the final presentation.

As you can see from the sample above, meeting minutes usually include the date, time, and location of the meeting, the agenda items discussed, the decisions made, and who is responsible for each task. If you already know the date of the next meeting, include it in the minutes. If available, add any agenda items that are planned for the next meeting. When writing meeting minutes,

- be clear, concise, and objective;
- use bullet points or short paragraphs for clarity;
- write in the third person
- review and edit before sharing

The Language of Meeting Minutes

When meeting minutes are unclear, they can cause confusion and lead to misunderstandings about responsibilities or decisions. Therefore, when writing minutes, follow the prescriptions for clear writing in Table 8.1.

Table 8.1 Guidelines for Clear Writing in Meeting Minutes

Problem to avoid	Instead of	Write
Missing or vague agenda items	The team talked about various topics.	Agenda: Budget planning, timeline review, task delegation
Vague language	The team agreed on the deadline for the draft.	The team agreed to finalize the proposal draft by May 20.
Unclear decisions or statements of responsibility	Someone needs to follow up on the guidelines issue.	Carlos will review the regulatory guidelines for storing biometric data and provide a report by May 19.
Unnecessary details	There was a 10-minute debate about coffee preferences.	x
Personal opinions or observations	John seemed annoyed and didn't want to help	x

In the future, you'll be part of many meetings for different projects. Being able to write clear, accurate meeting minutes will make it easier to record decisions, keep track of responsibilities, and plan the next steps so your projects run smoothly.

Key Takeaways



Effective teamwork is central to engineering. In other words, the way you work with others and how much you contribute can make or break a project. It also shapes how people see you as a teammate. Good teams set clear rules, choose a leader, use shared platforms to stay organized, and commit to deadlines. Meetings are just as important. Sharing an agenda keeps everyone focused, and taking notes makes sure decisions and responsibilities don't get lost. In the end, good teamwork and well-run meetings help you work productively and build trust with colleagues, clients, and managers.

Practice Task

With your project group, talk about how you will organize your teamwork for your project. Take 10 minutes to go through each step and make sure everyone's ideas are heard. Use the following steps as a guide:



- **Select a team leader (project manager) —** Assign someone to coordinate tasks and keep the team on track.
- **Choose a communication method —** Decide how your team will stay in touch (email or chat).
- **Choose a platform to stay organized —** Use tools like Google Docs/Drive or Microsoft Teams to keep files, notes, and updates in one place.
- **Set team rules —** Establish clear expectations for everyone from the start.
- **Set deadlines —** Agree on deadlines for each task or milestone.

Chapter 9: Technical Descriptions

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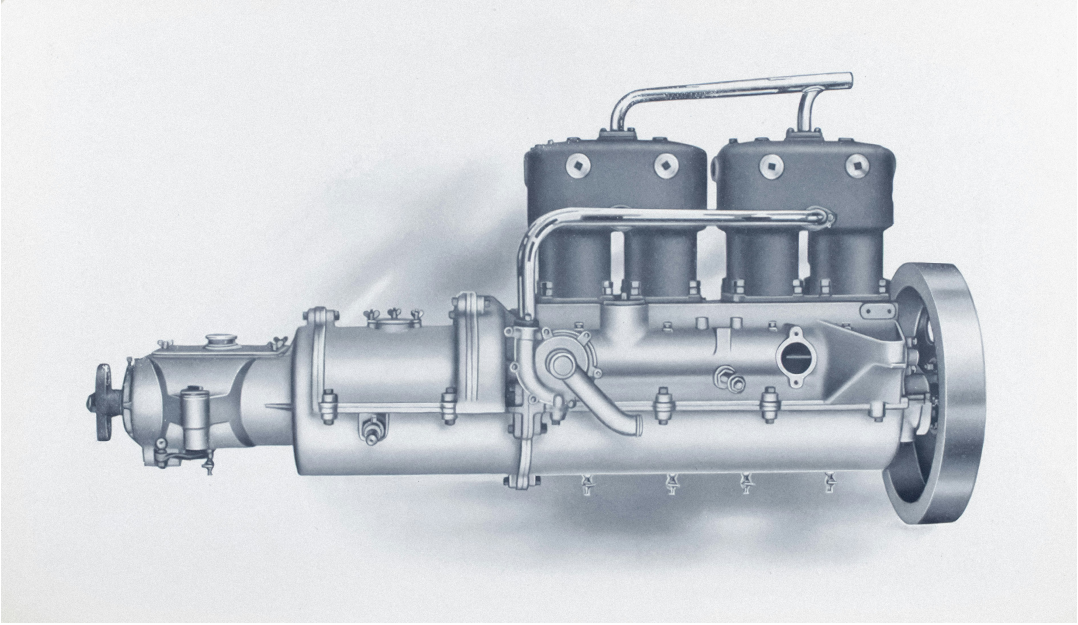


Photo by The New York Public Library on Unsplash

Writing Technical Descriptions

A technical description explains in clear, detailed terms what something is, what it looks like, or how it works. Its purpose is to give readers an accurate understanding of a product, mechanism, or process so that they can use it, build it, repair it, or simply understand it.

Writing mechanism and process descriptions is a critical skill for both engineers and computer scientists. Mechanism descriptions help clients determine whether a mechanism meets their needs, assist technicians in understanding how objects are assembled and function, and allow designers to document the development of new technologies. Process descriptions, on the other hand, explain how natural or technological processes work, such as how a quantum computer performs calculations.

Descriptions should be tailored to meet the specific needs of the audience. In other words, the focus and level of detail in a description should be adjusted based on what the reader will do with the information. A lay reader may need only a general understanding of how a particular device or system works, whereas a technician might require much greater detail.

Regardless of the level of detail required, when you describe an object, system, or process, aim to create a clear picture with words. As you do this, address key questions that help your reader understand what you're describing:

- What is it?
- What does it do?
- What does it look like, or what are its stages?
- What is it made of, or what elements or factors are involved?

- How does it work or function?
- How is it put together or organized?

Impartiality in Technical Descriptions

Technical descriptions should provide an impartial view, meaning that they focus on observable details and avoid personal impressions or subjective language. Consider the following two samples, one subjective and one objective:

> **Subjective —** This fantastic little motor is a masterpiece of engineering that fits nicely in your hand and feels surprisingly lightweight. The craftsmanship is outstanding, with a gorgeous copper winding that catches the light beautifully. The best part is how quietly it runs. You'll barely notice it's on, unlike those noisy competitors.
>
> **Objective —** The compact motor measures 7.6 cm in diameter and 12.3 cm in length, with a mass of 450 grams. The motor's copper windings are arranged in a standard 12-pole configuration around the stator core, with 0.25 mm diameter wire. During operation at the rated voltage of 24V, the motor produces 42 dB of sound measured at a distance of 1 m, which falls below the industry standard range of 48-55 dB for motors in this class. The aluminum housing features a textured surface with four mounting points for installation.

The subjective description uses adjectives like *fantastic* or *outstanding* that convey emotional responses rather than facts. In contrast, the objective description provides specific, observable details, such as *measures 7.6 cm in diameter* or *a mass of 450 grams*. When writing technical descriptions, avoid subjective or emotional language. Focus instead on precise, concrete details that allow readers to form their own conclusions.

Precision in Technical Descriptions

Precision refers to the use of specific terminology, exact measurements, and carefully defined parameters that eliminate ambiguity. Precision in technical descriptions helps ensure clarity, accuracy, and reliable decision-making. For instance, instead of saying *The motor is small and quiet* you may specify as *The motor measures 7.6 cm in diameter, weighs 450 grams, and produces 42 dB of sound when measured from a distance of 1 m.* Providing such precise details ensures clarity and helps your audience visualize the object or system more effectively. However, include only as much detail as your audience needs.

Organization of Mechanism and Process Descriptions

While impartiality and precision are essential in all technical descriptions, the way information is organized differs between mechanism and process descriptions. Whereas mechanism descriptions are typically spatial (focusing

on parts, materials, and shapes), process descriptions are typically chronological (focusing on action, duration, and sequence).

Writing Mechanism Descriptions

Think of a mechanism description as a precise visual portrayal. These descriptions typically focus on tools or systems composed of multiple parts that work together to perform a specific function. The text in the description focuses on physical characteristics. It may include details such as size, shape, color, finish, fit, and other attributes, both for the mechanism as a whole and for each of its parts.

Visual elements, including diagrams and images, should be closely integrated with the text. In other words, the text should directly draw attention to elements in the visuals, while the visuals should illustrate and reinforce the information provided in the text.

Structuring Mechanism Descriptions

When writing a mechanism description, it is essential to use a clear and logical structure. This typically begins with the overall purpose and structure of the mechanism, followed by a breakdown into its individual components. For instance, in describing an internal combustion engine, you would first present an overview of the purpose and structure of the engine before detailing its subcomponents, such as the engine block, cylinder heads, and pistons.

The Introduction

As with other forms of technical writing, you'll likely begin with an introduction. The introduction is essential for providing context and a broad overview, helping readers navigate the subsequent details. You can include the following elements to prepare the reader for what follows:

- A **technical definition** of the mechanism;
- An **extension of the definition**, incorporating key theory or principles as background (only if necessary for the reader);
- A **statement of overall function and purpose** of the mechanism;
- A **description of the mechanism's overall appearance**, including relevant attributes such as shape, color, material, finish, texture, mass, weight, or size; and
- A **list of components** in the order they will be described.

Writing Definitions

You may need to provide definitions whenever readers don't share the same level of expertise in the domain. Therefore, technical descriptions typically begin with a clear definition of the mechanism or system. Here, it's important to distinguish between two types of definitions: basic definitions and extended definitions.

Basic Definitions

A basic definition typically consists of the following elements:

- **The term being defined —** the word or concept to explain
- **The category or class —** the broader group to which the term belongs
- **Distinguishing details —** additional characteristics that distinguish the term from others in its category

For example, consider the term *thermal expansion valve*. A basic definition of the term could be as follows:

> A thermal expansion valve is a metering device that regulates the refrigerant flow in cooling systems based on temperature changes detected by a sensing bulb.

Tips for Basic Definitions

The following techniques may help you make definitions precise and reader-friendly:

Avoid circular definitions. In other words, do not use the word you are defining in its own definition.

> **Poor Example:** An *aileron* is an aircraft aileron that controls the rolling motion of an aircraft by creating a differential lift.

This definition is circular because it uses the term *aileron* to define itself, which gives no useful information about the category or class of mechanisms to which the aileron actually belongs.

> **Good Example:** An *aileron* is a control surface that helps control roll by changing the lift on each wing when it is deflected up or down.

This definition avoids using the term in its own explanation and clearly describes what an aileron is and how it functions.

Keep basic definitions concise.

> **Poor Example:** A turbofan engine is an advanced and historically important engine type that works in complex ways to make planes go faster and better than older engines.

This definition is vague, wordy, and filled with generalizations that fail to clearly explain what a turbofan engine is or how it works.

Good Example: A turbofan engine is a type of jet propulsion system that generates thrust with a central gas turbine core and a large fan that channels air around the core.

This definition is concise, clearly states which category the item belongs to, and provides just enough distinguishing detail to understand its basic function without overwhelming the reader.

Ensure precision. Definitions should be accurate and specific to avoid ambiguity.

Poor Example: Rebar is metal stuff that makes concrete stronger.

This definition lacks specificity about the type of metal, how it's shaped, and exactly how it reinforces concrete.

Good Example: Rebar is a reinforcement material embedded in concrete to increase tensile strength, prevent cracking, and enhance structural integrity under stress or load.

This definition clearly specifies the material, form, placement, and purpose.

Know your audience. For readers with technical expertise, include only essential definitions. For readers with less expertise, explain technical terms or highlight them in bold or italics and refer readers to a glossary.

Consider placement. Short definitions can be embedded directly within the text so that they don't disrupt the flow of ideas. Longer definitions could be placed in a glossary or appendix.

Extended Definitions

Extended definitions begin with a basic definition but provide additional details, such as

- History — the origin and development of the term;
- Etymology — the linguistic roots of the term;
- Applications — how a technology is used;
- Operation — how a process, technology, or system works; or
- Components — the parts that make up a technology.

An extended definition for a *thermal expansion valve,* focusing on the history of its development, could be as follows:

A thermostatic expansion valve (TXV) is a metering device that controls the amount of refrigerant entering the evaporator in a refrigeration or air-conditioning system. It senses the temperature at the evaporator outlet using a sensing bulb and adjusts refrigerant flow to maintain a stable level of super-

heat, which protects the compressor and improves system efficiency. Historical records show [1] that one of the first thermostatic expansion valves was developed in 1923 by E. Diffinger in Paris. A few years later, in 1927, H. Thompson patented a more advanced version of the thermostatic expansion valve. This design became the foundation for later TXVs and marked an important step in improving refrigerant control.

[1] M. Zogg, "History of Heat Pumps: Swiss Contributions and International Milestones", Zurich, May 2008, pp. 1–114. [Online]. Available: https://www.ehpa.org/wp-content/uploads/2023/07/History-of-Heat-Pumps-Swiss-Federation.pdf

Outlining Overall Function and Purpose

In the introduction, it's helpful to clearly state the overall function and purpose of the mechanism. This helps readers understand what the mechanism does before getting into the specific components and how they work. Consider the following example:

> The VertexSphere Window Washing System enhances safety and efficiency in high-rise maintenance by automating the cleaning of exterior windows, thereby reducing the need for manual intervention and improving overall performance.

This sentence explains what the system does and why it is useful, giving readers a clear sense of its overall purpose. With that framework in mind, they can more easily see how each component contributes to the whole.

Outlining Structural Breakdown

After establishing a mechanism's overall purpose and function, the next step is to provide a clear overview of its structural breakdown. This gives readers a mental image of the complete system and creates a framework for understanding how the individual components fit into the whole. When outlining the structural breakdown, carefully consider the sequence in which the parts are introduced.

Visual Sweep

A visual sweep emphasizes how components are arranged in space. It answers the question "What sits next to what?" For example, a visual sweep of a flashlight might follow the parts from left to right in an illustration: beginning with the front lens, moving to the bulb and reflector, and ending with the switch and cylindrical casing that holds the batteries — progressing from the front to the back of the device.

System Breakdown

A system breakdown emphasizes the functional or cause–effect relationships between components. This approach is most effective when the goal is to explain connections, interactions, or the flow of energy or information, rather than the physical arrangement of parts. It is best applied to mechanisms in action, such as the shutter system of a camera or the triggering sequence of a nuclear warhead. For example, when describing a flashlight from this perspective, the order of description would follow the operating principle: tracing the flow of electric current through the circuit to show how each part contributes to producing light.

Core-to-Periphery

Core-to-Periphery identifies the most critical elements before addressing supporting components. For example, a description of a coaxial cable (the type used for internet and cable TV) would likely start from the transmission cable. Layers surrounding the transmission cable all exist to protect and facilitate the transmission occurring at the center. In general, the approach is ideal to emphasize system hierarchy or levels of importance.

Part-By-Part Description

Following the introduction, the next step is to discuss the individual components. A precise description of each component is crucial for design, safety, verification, and standardization.

For each component, include the following:

- A definition of the component, with theory or operating principles as needed;
- A description of its function and purpose within the mechanism;
- A detailed description of properties (shape, color, material, finish, texture, size, etc.) that relate directly to its purpose and function;
- Figures, diagrams, or photographs, as necessary; and
- A transition to the next component in the description.

Repeat this pattern for each subsequent component.

In choosing which features to describe, the key is relevance — include only the features that help readers visualize the part and, more importantly, reinforce the broader claims about function and purpose established in the introduction. For example, if a key feature of a tool is its strength and durability, it would be important to discuss its materials and their ability to resist forces without cracking or deforming. On the other hand, if you are describing a system designed to transmit information efficiently across a network, you would focus on characteristics related to that function. In short, you must be selective in what you choose to describe and ensure that every detail serves a clear purpose.

The Conclusion

Your mechanism description should also have a brief conclusion. This should summarize key points and reiterate essential information from the introduction.

- Summarize the overall function of the mechanism.

- Provide a brief overview of one full operating cycle of the mechanism.

Visuals

Visual aids are almost always necessary in mechanism descriptions, and they should be tightly integrated with the text. In other words, your writing must refer directly to each visual, and the visuals should expand upon or support the information in the text. Only include visuals that enhance the description. Never add them purely for decoration. If you include multiple visuals, number them and refer to them in sequence.

Writing Process Descriptions

Writing a process description is similar to writing a mechanism description, but with a different focus. While mechanism descriptions explain how something is built or how its parts fit together, process descriptions focus on a sequence of actions that lead to a specific result. Take ChatGPT as an example. A mechanism description might explain its architecture, including neural network layers and attention mechanisms. A process description, on the other hand, would walk through the steps it takes to generate a response, from receiving the input to producing the output.

Structuring Process Descriptions

When writing a process description, use a clear structure that guides readers step by step. This typically involves following a chronological or cause-and-effect sequence. Begin with an overview of the entire process to give readers a framework for connecting the detailed stages that follow. Then move through each step in order, showing how one leads logically to the next. This creates a flow that mirrors how processes unfold in real-world applications, making transitions easy to follow.

Introduction

Similar to the mechanism description, a process description typically begins with an introduction. This gives readers the big picture before they get into the specific steps of the process. Start with a definition of the process, along with an overview of its core functions and purpose. Then, outline the main phases in the order in which they are described in the step-by-step description. The introduction includes the following:

- A technical definition of the process;
- An extension of the definition, incorporating key theory or principles as background (only if necessary for the reader);
- A statement of overall function and purpose of the process;
- A description of overall flow of the process; and
- A list of phases in the order they are described.

Step-By-Step Description

After the introduction, break the process down into steps or phases and describe them one at a time, in the order they occur. This section walks the reader through each step or phase, showing how the whole process proceeds from start to finish. Each phase description should be well-structured and organized. Start with a basic definition of the phase, then mention its function and purpose within the overall process. Next, provide details of the specific activities, transformations, or operations that occur during the phase. Focus on what is relevant and include only the details that help readers understand the phase's role in the overall process and support the broader claims made in the introduction. For instance, if a key feature of a phase is data transformation, emphasize how the input information is processed and changed during this stage. If you're describing a phase designed to analyze patterns, focus on the analytical methods and their significance to the overall process outcome. The final part of each phase description may include a transition to the next phase. Explain how the output of the current phase serves as the input for the next phase. This highlights the sequential nature of the process. Repeat this pattern for each phase until you have described the complete process from start to finish.

For each step/phase, include

- A technical description of the step/phase, explaining what it does, how it works, and why it is necessary;
- A description of its function and purpose within the overall process;
- A detailed explanation of what occurs during the step/phase and how it happens;
- A description of the step/phase‘s output or result;
- Figures, diagrams, or photographs, as necessary; and
- A transition to the next step/phase in the process sequence.

Repeat this pattern for each subsequent step/phase of the process.

Conclusion

Your process description should conclude with a concise summary. This section brings together the main ideas and emphasizes the most important details from previous sections.

- Summarize the overall function of the process.
- Re-list the steps/phases described.
- Provide a brief overview of one full cycle of the process.

Key Takeaways



Effective technical descriptions must be grounded in objectivity and logical structure. To ensure clarity for the end-user, follow these principles:

- Create a clear picture with words when describing objects or systems.
- Focus on observable details and avoid personal impressions or subjective language.
- Use consistent terminology, precise measurements, and clearly defined parameters to avoid ambiguity.
- Emphasize characteristics of components that allow them to work together to perform specific functions.
- Maintain a logical structure that helps readers follow through components or steps in order.

Following these principles — from early drafts to final revisions — helps ensure that readers can visualize, understand, and use technical information effectively.

Practice Task



You are working as a junior engineer when your project manager assigns you a task: The company needs to describe an engineering device or system to a client's technical team — engineers who are knowledgeable but unfamiliar with the specific technology. Whether it is a mechanical device, software system, or integrated solution, the challenge remains the same: to create a mechanism description that enables fellow engineers to understand exactly what they are evaluating. The manager explains that the engineers must fully visualize the mechanism to make an informed decision. Therefore, your technical description should be comprehensive enough for them to grasp both what it is and how it functions.

This scenario reflects a fundamental engineering reality: you will regularly need to communicate complex technical systems to other engineers who bring expertise but lack familiarity with your specific design. Your mechanism description must address the universal questions any engineer asks when encountering a new technology:

1. What is this system?
2. What does it accomplish?
3. How is it structured?
4. What are the key components and subsystems?

Choosing Your Documentation Strategy

Select from three organizing approaches based on the characteristics of the specific device or system:

The visual walkabout follows a spatially logical path through the system—top to bottom, left to right—without skipping in-between components. This approach works well when spatial relationships drive understanding.

The system breakdown emphasizes the functional relationships between components. This approach is ideal when understanding connections, interactions, or information flow is more important than physical arrangement. This method is suitable for both mechanical assemblies and software architectures.

The core-to-periphery approach identifies the most critical elements before addressing supporting components, making it ideal when system hierarchy or importance levels guide comprehension.

Essential Technical Details

Your engineering audience needs to understand the "why" behind every element. They also expect specific information: precise dimensions and measurements relevant to the system, descriptive details that enable component identification, exact positioning using clear technical language, and material or specification details that affect performance.

Professional Documentation Standards

Engineering communication always combines detailed written descriptions with appropriate technical visuals, such as diagrams, schematics, flowcharts, or photographs with clear labels. Reference these figures throughout your text to guide your readers between written explanations and visual representations.

Technical Writing Excellence

Structure your work using focused paragraphs that maintain precision while remaining accessible to your audience. Use direct and professional language that conveys complexity without unnecessary jargon. Aim for 600-750 words — comprehensive enough to understand the details while respecting professional time constraints.

Chapter 10: Instructions and Manuals

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The Importance of Clear Instructions

Imagine you're faced with a difficult new task and a strict time limit. You start by carefully reading the instructions, but soon get stuck and can't move forward. You try several times, guessing what might be missing or what a step really means. After repeated failed attempts, frustration sets in — and you abandon the task altogether.

Most of us have experienced this kind of situation at least once. In everyday life, the consequences are usually minor — perhaps a piece of furniture left half-assembled or a recipe that didn't turn out as expected. In engineering, however, unclear instructions can have far greater effects, compromising safety, functionality, user satisfaction, and even a company's reputation.

As an engineer, you'll design products, systems, and structures that shape the modern world. These may range from intricate devices to large-scale infrastructure projects — all intended to improve everyday life. However, your role doesn't end with creation. You must also communicate effectively with the people who will use what you build. Even the most innovative design can fail if users don't understand how to operate it correctly.

Considering the Audience for Technical Instructions

Before you begin writing your instructions, conduct an audience analysis. Understanding who will use a product or tool greatly influences how you communicate the steps. For example, if you were writing instructions on how to create a flowchart using new software called *LogicNest Pro*, would you begin by explaining how to download the software, or would you start directly with creating data flow diagrams? If your audience were first-year engineering students with no prior experience, you would likely start by downloading and installing *LogicNest Pro*. However, if your readers were experienced system designers transitioning to a new tool, you might begin by creating the data flow diagrams. This difference in audience knowledge and experience highlights the importance of providing audience-tailored instructions.

With the question of audience in mind, consider these poorly written first aid instructions for those outside the medical field who may be faced with a choking victim:

More difficult to understand: Perform Heimlich maneuver and prepare for possible tracheal intubation if airway obstruction persists.

This instruction is ineffective for readers outside the medical field because it uses technical terms such as *Heimlich maneuver* and *tracheal intubation* without explanation. It assumes prior medical knowledge and omits essential sub-steps. Instructions in this case should use plain language and include enough detail for the audience to understand and act confidently.

Easier to understand: To help someone who is choking, follow these steps:

1. Stand behind the person.
2. Wrap your arms around their waist.
3. Make a fist with one hand and place it just above their belly button.
4. Grasp your fist with your other hand.
5. Deliver quick, upward thrusts into the abdomen until the object is expelled or the person can breathe again.
6. If the person becomes unconscious or the blockage does not clear, call 911 immediately.

These instructions are easier to understand because they

- provide step-by-step guidance using clear and simple language;
- break down the actions into easy-to-follow steps without using medical jargon;
- explain medical terms, such as *Heimlich maneuver*, in plain language; and
- describe physical movements in detail, so the reader knows exactly what to do at each stage.

Writing Effective Lead-ins

A lead-in is an opening sentence or short paragraph that gives readers a clear idea of what to expect next. Before presenting step-by-step instructions, it's helpful to explain why the task matters and what it will accomplish. A strong lead-in prepares readers, provides essential context, and helps them understand the purpose and scope of the procedure before beginning the steps. Consider the following example:

> **Starting the Cleaning Cycle**
>
> In this step, you will start the automated cleaning process using the Vertex mobile app. The precision water jets will activate and begin spraying the cleaning solution ahead of the cleaning path. The microfiber pads will rotate and apply pressure based on sensor feedback. The system will move across the entire window, cleaning in a predefined pattern generated by the microprocessor control unit.
>
> **Note:** The cleaning path is optimized automatically based on window size and shape detected during calibration.

In the example above, the lead-in helps readers by

- explaining the purpose (starting the automated cleaning process);
- identifying the tool they'll use (Vertex mobile app); and
- setting expectations for what they're about to accomplish (to start the cleaning cycle).

Presenting Known Information Before New

A key feature of well-designed instructions is that they present known information before introducing new concepts. By connecting new information to the familiar, you create a logical progression that helps readers build their understanding step by step. You also reduce confusion that can arise when readers encounter unfamiliar procedures.

Consider the following two examples:

> **More difficult to understand:** Perform signal conditioning on the raw sensor data before you analyze bioelectrical measurements.
>
> **Easier to understand:** Before you can analyze the bioelectrical measurements, perform signal conditioning on the raw sensor data.

In this version, we start with familiar information (analyzing bioelectrical measurements) before introducing the new concept (signal conditioning). This approach helps the reader transition smoothly to new ideas from a familiar foundation.

Writing Instructions with Clarity and Precision

When presenting steps, use clear and direct language. Precise wording and simple sentence structures help readers follow procedures confidently, without hesitation. Clear language also eliminates ambiguity that could lead to errors. This is especially important when readers must perform tasks quickly or under pressure.

Consider the following two examples:

> **Indirect and confusing:** The technician should adjust his or her equipment settings according to the specifications.

This instruction is weak because it addresses the technician in third person (the technician), which creates distance between the instruction and the reader. It also uses gendered pronouns (his or her), which are unnecessary and can make instructions feel dated or exclusionary. Additionally, the phrase *should adjust* sounds less like a direct command than the imperative a*djust*, making it less clear whether the step is required. Finally, *according to the specifications* is vague. Which specifications? Where are they located? This may force readers to search for additional information before they act, leading to wasted time.

> **Direct and clear:** Adjust your equipment settings to 50 Hz frequency and 120V input.

This version is stronger because it uses an imperative verb (command) to provide clear direction, removes redundant or cluttered wordings, and includes the required values (50 Hz frequency and 120V input), eliminating confusion about which settings to use.

The following strategies can help you write clear instructions.

Use imperative verbs for actionable steps — Direct instructions make tasks clear and easy to follow, guiding readers toward the exact action they need to take.

Instead of

> The cable should be connected to port A.

write

> Connect the cable to port A.

Choose concrete words — Specific measurements and values eliminate guesswork. Replace vague terms with precise alternatives.

Instead of

> Adjust the settings appropriately.

write

> Set the frequency to 50 Hz.

Keep sentences short and simple — Short and simple sentences make instructions easier to process and reduce the chance of reader error.

Instead of

> It is important to connect the cable to port A.

write

> Connect the cable to port A.

Use consistent terminology — When you have a technical term in your instructions, use it consistently throughout the document. If you call something a *control panel* in step one, don't refer to it as a *dashboard* in the next step. Consistent terminology reduces misunderstandings.

Include only necessary details — By including only the essential information, you keep instructions focused and prevent readers from getting distracted by irrelevant details. Provide essential information, such as safety warnings and specific measurements, but avoid cluttering instructions with background theory that is "nice to know" but ultimately unnecessary.

Instead of

> Before connecting the power supply (which converts AC to DC using transformer technology), ensure the voltage is set to 12V.

write

> Before connecting the power supply, set the voltage to 12V.

Use affirmative phrasing — Affirmative (positive) phrases reduce cognitive load and improve comprehension. Negative phrasing makes instructions harder to process.

Instead of

> Do not leave any wires loose in the terminal block.

write

> Tighten all wires in the terminal block.

Use parallel language — Ensure that all steps in a sequence follow the same grammatical pattern. This consistency creates a predictable pattern that helps users process information more efficiently. Consider this non-parallel example:

> To set up your email account, follow these steps:
>
> 1. Open the email application.
> 2. Your account settings should be accessed.
> 3. Entering your email address is required.
> 4. Click the **Add Account** button. Your email account will now be added and ready to use.

Inconsistency in sentence structure makes these instructions harder to follow. A revision uses imperative verbs at the beginning of sentences, maintaining parallel grammar throughout the list of steps:

> To set up your email account, follow these steps:
>
> 1. Open the email application.

2. Access your account settings.
3. Enter your email address.
4. Click the **Add Account** button. Your email account will now be added and ready to use.

Make text and visuals interact — Instructions rely heavily on visuals, such as diagrams, flowcharts, or photographs. However, visuals should not simply accompany the text. They must "interact" with it. This is especially useful in instructions because it's often easier to show rather than tell, particularly for complex tasks.

The following instructions rely solely on text, which makes it harder for users to follow:

To access the Concordia University Library's online resources, follow these steps:

1. Go to the **Concordia University Library Discovery Tool**.
2. Click **Sign in** in the top-right corner. The *Sign in Selection* window opens.
3. Click **Login with your Concordia netname and password (for current students, faculty, and staff)**. A sign-in window will appear.
4. In the sign-in window, enter your Concordia Netname and password. Then, click **Sign in**.

Note: Your Netname is your Concordia email prefix. For example, if your email is *jsmith@concordia.ca*, your Netname is *jsmith*.

5. To verify your account, select one of the available verification options and complete the verification process. After you verify your account, you will have full access to Concordia Library's online resources.

Without visuals to guide them, readers must interpret all navigation steps and login details, which can be confusing and overwhelming for them. Now, consider the following version with visual support.

To access the Concordia University Library's online resources, follow these steps:

1. Go to the **Concordia University Library Discovery Tool** (see Fig.10.1).

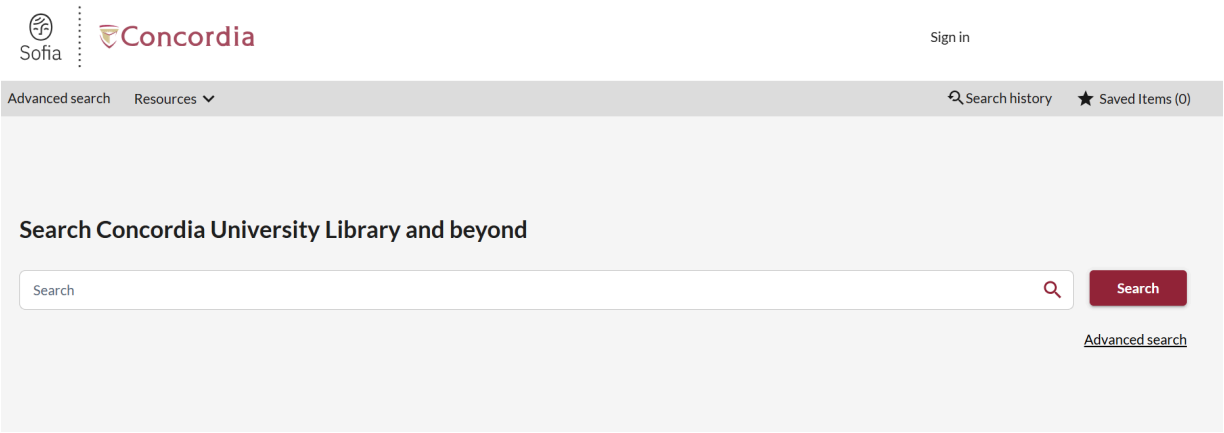


Fig. 10.1 Concordia University Library Discovery Tool.

2. Click **Sign in** in the top-right corner. The *Sign in Selection*window opens (see Fig. 10.2).

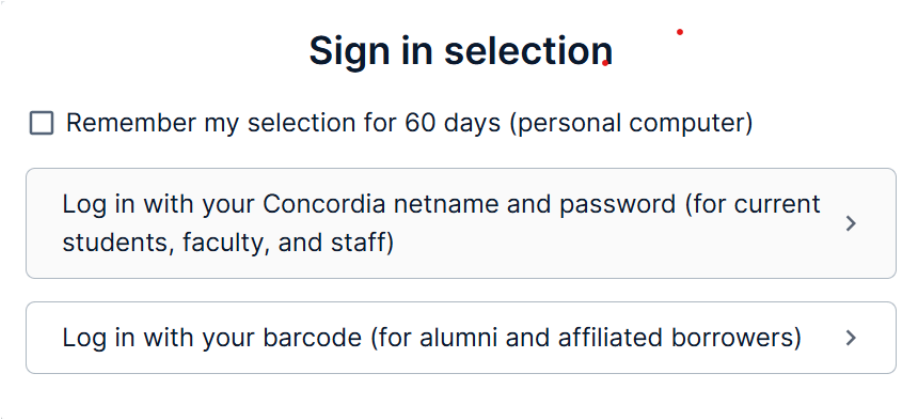


Fig. 10.2 The *Sign in Selection*window with Netname and password option for students, faculty, and staff.

3. Click **Login with your Concordia netname and password (for current students, faculty, and staff)**. A sign-in window will appear (see Fig. 10.3).

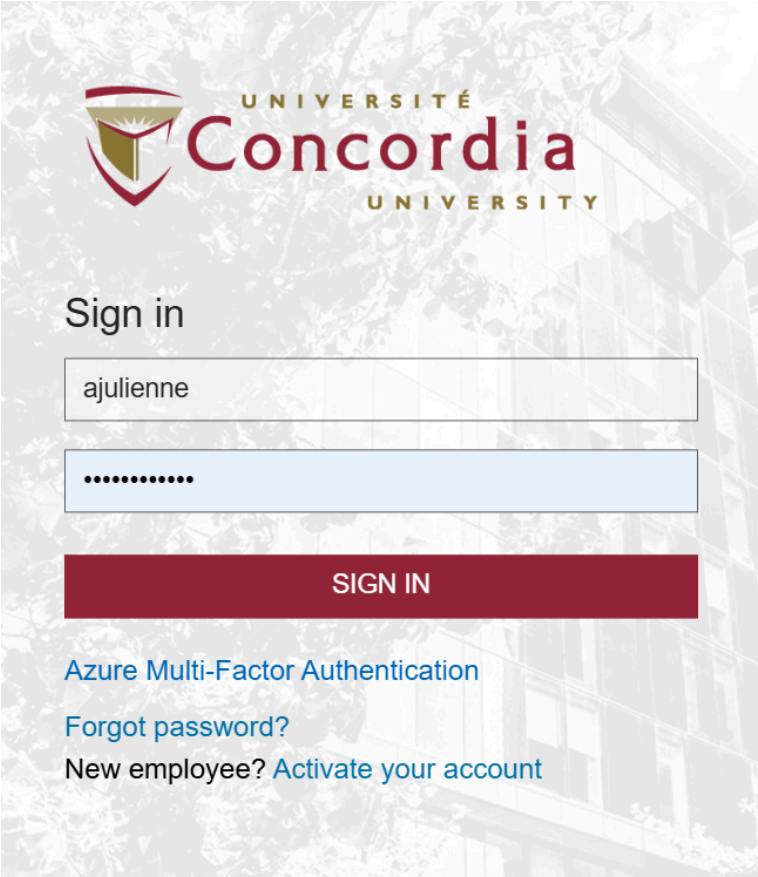


Fig. 10.3 Sign-in window for entering your Netname credentials

4. In the sign-in window, enter your Concordia Netname and password. Then, click **Sign in** (see Fig. 10.4).



Fig. 10.4 Account verification step with available authentication options.

Note: Your Netname is your Concordia email prefix. For example, if your email is *jsmith@concordia.ca*, your Netname is *jsmith*.

5. To verify your account, select one of the available verification options and complete the verification process. After you verify your account, you will have full access to Concordia Library's online resources.

This version uses clear instructions paired with visuals that illustrate each action. The images highlight menu options and fields, helping users quickly identify what to do at each step. To use visuals effectively, consider these strategies:

- Write clear figure captions.

Fig. 10.2 The *Sign in Selection* window with Netname and password option for students, faculty, and staff.

- Reference visuals within the text.

The flowchart in Fig. 1 illustrates...

- Place visuals near their textual references.

The reader's eyes should move directly from the text to the corresponding visual. If they must flip to another page in a manual or move to another screen on a website, their concentration is broken, increasing cognitive load (the mental effort required to understand the instructions). For more information on using visuals effectively, see *Chapter 4: Visuals*.

Emphasize safety in instructions — Safety is a critical component of effective instructions. Always inform users of potential hazards or conditions that could lead to failure. Use widely recognized safety icons to highlight potential hazards. Additionally, choose the appropriate level of warning based on the severity of the risk. The four commonly used levels of warnings are as follows:

Note: Used for non-hazard-related messages — often for equipment protection or general information. Let's look at the following example:

Note: Software update required before operation.

Caution: Indicates a potential hazard that may result in minor or moderate injury or equipment damage. Let's look at the following examples:

Caution: A brief power interruption may cause loss of unsaved data.
Caution: Wear gloves when handling sharp parts.

Warning: Indicates a potential hazard that could result in death or serious injury if not avoided. Let's look at the following examples:

Warning: Moving parts. Keep hands clear to avoid serious injury.
Warning: Rotating shaft. Do not operate with guard removed.

Danger: Indicates an immediate hazard that will result in death or serious injury if not avoided. Let's look at the following examples:

Danger: High voltage. Contact will cause severe electric shock or death.
Danger: Moving blades. Keep hands and clothing clear.

Provide expected results — To guide users effectively, instructions should conclude with the expected result or outcome. Ending abruptly can leave readers uncertain. For example, if your final step reads *Click **Finish** on the pop-up window*, users may wonder, "What happens next?" Instead, include the outcome: *Click **Finish** on the pop-up window. The process completes, and your changes are saved*. Clearly describing what users should see or expect at the end of a step helps them confirm whether they have completed it successfully.

Remember: Effective instructions should be

- **Clear —** Use direct language.
- **Concise —** Remove unnecessary words and redundant information.
- **Consistent —** Maintain a predictable structure and vocabulary. Use parallel grammar.
- **Audience-appropriate —** Adjust the level of technicality to match the reader's background.
- **Well-supported with visuals —** Use visuals to enhance understanding.

By following these principles, instructions are more likely to be clear, usable, and support safe task completion.

Writing Manuals for Usability

Manuals are essentially extended versions of instructions. They follow the same principles but tend to be more comprehensive. Common types of manuals include the following:

- assembly manuals (e.g., guides for furniture assembly)
- owner manuals (e.g., guides for cars or appliances)
- operator manuals (e.g., guides for industrial machinery)
- service manuals (e.g., guides for maintenance and repair)
- technical manuals (e.g., in-depth engineering documentation)

All principles recommended for writing instructions apply to manuals as well.

Structuring Instruction Guides and Manuals

Include the following components in your instructions:

A clear and specific title — Your title should accurately reflect the task covered in the instructions. Ensure that it clearly communicates the action involved.

Poor example: The Drive Head of a Laptop Computer

This title is vague and does not indicate an action or task.

Good example: How to Clean the Drive Head of a Laptop Computer

This title specifies the task and the action involved.

A Strong Introduction — Instructions, like other technical documents, begin by establishing a broader picture before moving to specific details. The introduction provides an overview of the task or procedure, giving the reader context and establishing its importance. It outlines the overall goals and any prerequisites to help readers understand what to expect and why they should follow the instructions.

At the very least, a good introduction should include

- A definition of the overall process described;
- A statement of purpose — what the process accomplishes;
- Any necessary background theory or principles (if relevant to the reader);
- Tools or resources required to complete the procedure; and
- A list of individual steps that will be detailed in the body of the instructions.

The introduction can also motivate the reader to complete the task. For example, if you are teaching readers how to back up important files, you could highlight the risks of not doing so.

Failure to back up your data may result in permanent data loss due to:

- Damage caused by extreme temperature or moisture.
- Data corruption from a power surge.
- Information scrambling due to magnetic interference.

Clearly state any assumptions about the reader's background knowledge. This helps them determine if the instructions are suitable for them. For example, in a guide for backing up data, you might include:

To follow these instructions, you should be familiar with the following components of a Macintosh system:

- Computer
- Monitor
- Keyboard
- Mouse
- Compact disk drive and recordable disk

Additionally, define any specialized terms that appear in the instructions. For instance, imagine that you are writing instructions on how to set up an external hard drive. You might use the term *initialize* when describing the steps required before the drive can be used. However, this term might be unfamiliar to some readers; therefore, it might be helpful to explain what *initialize* means in the introductory text

The final part of the introduction should list the steps that will be covered in the body of instructions.

A Discussion of the Steps — The discussion of the steps explains how to complete each step, while providing essential background on equipment, safety, and expected results.

When describing individual steps, follow a consistent and predictable pattern to enhance readability and usability. A well-structured approach makes instructions easier to follow, improving user experience and overall effectiveness. The process should follow this structure:

- **Define the step.** Start by describing what happens in this step.
- **Provide necessary information.** Note any dangers, cautions, or required tools and equipment.
- **Give specific directions.** Clearly explain how to execute the step.
- **Describe the expected result.** Let the user know what should happen when the step is completed correctly.
- **Transition to the next step.** Provide a logical connection if there is a following step.

Effective Conclusion — Like other types of documents, instruction guides and manuals should end with a conclusion. Effective conclusions may do the following:

- Indicate that the task has been successfully completed.
- Summarize key steps in a concise manner.
- Provide resources for additional information, if applicable.

Key Takeaways

Clear instructions are key to connecting complex engineering solutions with real-world use. Well-written instructions help people complete technical tasks safely and successfully—and getting them right starts with a few core principles. The six points below can help guide your writing process:



- **Know your audience**. Think about who will be using your instructions, and adjust language and content based on their background, knowledge, and experience.
- **Organize information logically.** Provide an overview that provides context and then present steps in a natural, logical order. Start with what the reader already knows before introducing new ideas.
- **Write clearly and directly.** Use imperative verbs for actionable steps. Use concrete, consistent wordings throughout. Remove unnecessary details that could cause confusion.
- **Use visuals intentionally.** Place diagrams or images next to text they relate to, and include helpful captions.
- **Handle safety warnings appropriately.** Use standard labels like n*otice*, *caution*, w*arning*, and d*anger* to match the level of risk. Avoid overloading the reader with too many alerts.
- **Wrap up with a quick summary of the key steps** (if needed) and direct the reader to any additional information or resources.

Whether you're writing simple instructions or full manuals, these strategies will make your work practical and user-friendly. Remember: unclear instructions don't just frustrate users. They can lead to equipment damage, safety risks, and even legal issues. That's why clear communication is more than a skill; it's a key responsibility of engineers.

Practice Task



As a junior engineer at Trevora Consulting, you've just received an assignment to create a user guide. Your company has partnered with the Regional Technical Training Institute to develop user manuals for their professional development program. The institute trains experienced technicians and engineers who need to expand their expertise into new technological areas as their industries evolve.

Your project manager explains the challenge: "These professionals are skilled in their own fields, but they struggle when they encounter unfamiliar equipment. A mechanical engineer might need to operate spectroscopy equipment, or an electrical technician might need to use advanced CAD software. We need user guides that help competent technical people quickly master equipment outside their specialization. Your job is to create documentation that transforms potentially intimidating technology into accessible tools."

She continues: "I'm giving you flexibility to select the equipment you'll document. These could be laboratory instruments, industrial software applications, specialized measurement devices, testing equipment, control systems, diagnostic tools, or any other technical equipment you are familiar with. The important thing is that it should be something a qualified professional could learn to operate correctly with proper documentation even if it's outside their primary field."

Your user manual must bridge the gap between general technical competence and specific equipment. As you approach this task, consider how the principles discussed in this chapter will guide your documentation strategy. Additionally, consider the following guidelines while creating your manual.

Selecting Your Technical Object, Equipment, or System

In this assignment, you will create instructional materials for completing a technical task. A key goal is to help the audience understand the procedure in its technical details. To do so, choose a piece of technical equipment or system that you can document effectively. Your choice of medium is open. You could, for example, create a written manual (min. 700 and max. 900 words), a series of linked webpages, or a short video (4-5 minutes). Context of use will dictate the choice of medium.

You can organize your user guide in the following structure:

Introduction

- Indicate the specific task presented as well as the scope. (What will and will not be covered?)
- Give a general idea of the procedure (the big picture) and what it accomplishes.
- Indicate conditions when these instructions should (or should not) be used, considering your target audience.

General Warnings, Cautions, Dangers, and Notices

- Alert your audience to the possibility of ruining their equipment, screwing up the procedure, or hurting themselves.
- Emphasize key points or exceptions using special notices—note, warning, caution, and danger.

Equipment and supplies

Include a list of equipment — the tools used in the procedure (such as mixing bowls, hammers, drills, or screwdrivers) and materials — the substances consumed in the procedure (such as wood, paint, oil, flour, and nails).

Discussion of the steps

- Provide step-by-step instructions in the required order. For example, if you are changing the oil in a car, draining the oil is a step that must come before putting in the new oil.
- Give additional explanatory information about
    - the expected result of each step;
    - why the user should care about doing the step; or
    - mechanical principles that allow the step to happen.
- Use graphics (pictures, illustrations, animations, etc.) to support the verbal information.

Style

- Use a direct, conversational tone.
- Imperative verbs best convey actions the user must take. Use parallel structure.

Chapter 11: Technical Reports

Chapter ContentsThe Role of Technical Reports in Engineering and Computer ScienceWriting Lab ReportsProgress Reports Feasibility ReportsKey TakeawaysPractice Task

The Role of Technical Reports in Engineering and Computer Science

In engineering and computer science, reports are one of the primary ways technical work becomes meaningful beyond the screen, lab, or whiteboard. A report turns experiments, code, designs, and decisions into a clear, permanent record that others can understand, evaluate, and build upon. Whether the goal is to document results, analyze a problem, justify a design choice, or recommend a solution, all technical reports share a common responsibility: to present complex information accurately, logically, and with the reader's needs in mind. Learning to write effective reports is therefore not just an academic exercise — it is a core professional skill that enables collaboration, accountability, and sound decision-making.

In engineering and computer science, technical reports take many forms — ranging from progress updates and test results to design analyses and postmortems — but they all serve the same core purpose: to communicate technical information clearly, accurately, and usefully to a specific audience. Regardless of type, effective reports document context, methods, data, and reasoning in a structured way that supports understanding, decision-making, and accountability. They prioritize clarity over style, evidence over opinion, and organization over narrative flair, allowing readers to quickly locate essential information and act on it with confidence.

This chapter focuses on three genres of report that you will likely come across during your engineering or computer science studies or in professional practice: the lab report, the progress report, and the feasibility report.

Writing Lab Reports

Lab reports are a foundational genre of technical writing in engineering and computer science, designed to document experimental work in a clear, systematic, and verifiable way. Their primary purpose is not simply to record what happened in a lab, but to demonstrate how results were obtained, how data were analyzed, and what conclusions can reasonably be drawn from the evidence. A well-written lab report allows readers — such as instructors, teammates, or future engineers — to understand the experimental method, assess the reliability of the results, and replicate the work if needed. By emphasizing precision, transparency, and logical organization, lab reports train students to think and communicate like professionals who must justify their findings with data rather than intuition.

Cover Page

If writing the lab report for a university course, refer to your instructor's guidelines or the lab report formatting requirements.

At a minimum, include

- Title of the report that clearly reflects the experiment's subject or purpose;
- Your full name;
- Instructor's name;
- Course name and number;
- Lab section or group number (if applicable); and
- Date of submission.

Abstract (if required)

The abstract briefly summarizes the purpose, method, key results, and main conclusion of the lab so readers can quickly understand what was done and why it matters without reading the whole report. In the abstract, include

- Main objective;
- Methods used;
- Results discussed in the report; and
- Conclusions of the experiments.

Introduction

The introduction provides essential background information and context for the experiment or research study. In the introduction, include

- Description of the experiments to be undertaken;
- Objective of the experiments; and
- Expected findings.

Methods (Procedures)

The methods (or procedures) section describes how the experiments were conducted. It allows others to reproduce what you have done and to evaluate your methods. In the methods section, include

- Preparations;
- Calibrations;
- Safety issues; or
- Description of statistics collected.

Results and Discussion

Results and Discussion is where data is presented and then analyzed, providing a comprehensive understanding of the experiment's outcomes, their significance, and their implications. It's a critical part of the lab report that showcases scientific reasoning and critical thinking. In this section, include

- Results of statistical analysis;

- A theoretical analysis of the outcome of the experiment;
- Tables or figures that demonstrate outcomes of the analysis;
- Comparisons between expectations based on models or theory and the results of the experiments; and
- Interpretations and judgments on findings.

Conclusion

The conclusion compares the stated objective in the introduction with the findings discussed in Results and Discussion.

References (if required)

Provide a list of references in the required format (e.g., IEEE referencing scheme)

Appendices

In this section, include large tables or supporting data that do not directly relate to the objectives of the experiment.

Points on Formatting

Proper formatting in a lab report is essential because it allows readers to navigate the document efficiently and focus on the technical content rather than its presentation. In particular, effective lab reports follow these formatting prescriptions:

- **Number sections and subsections,** making the structure of the report explicit and allowing readers to locate and reference information quickly.
- **Use fonts and font sizes consistently throughout the report**, ensuring readability and a professional appearance.

Together, these formatting choices support clarity, credibility, and ease of use — key expectations in engineering and computer science communication.

Progress Reports

Progress reports are used to keep stakeholders informed about how a project is advancing over time and to support timely, informed decision-making. Rather than presenting completed work, they focus on what has been accomplished so far, what challenges or risks have emerged, and what steps will follow next. In engineering and computer science contexts — where projects often involve tight timelines, interdependent tasks, and multiple contributors — progress reports play a critical role in coordination and accountability. An effective progress report

is concise, factual, and forward-looking, enabling readers to quickly assess project health and determine whether adjustments in scope, resources, or strategy are needed.

Introduction

The introduction helps the reader understand the context and purpose of the report. It should be concise and effectively convey essential information that prepares the reader for the subsequent report on project status. Include

- Purpose of the report (i.e., Why was the report written and what does it achieve?);
- Background of the project and proposed solutions; and
- Scope, including what the report covers and, potentially, what it does not cover.

Project Status

The status section provides a detailed snapshot of the project's current state, helping readers assess progress, make informed decisions, and take necessary actions to ensure the project stays on track and meets its objectives.

Tasks Completed

Include

- description of the task;
- statement of work accomplished;
- time taken to complete the task; and
- difficulties encountered.

Repeat pattern for tasks 1-n.

Tasks Remaining

Include

- description of the task;
- work that still needs to be accomplished;
- timetable and strategy for completing the task; and
- approach to completing the task, including risks.

Repeat pattern for tasks 1-n.

Conclusion

The conclusion ties together the information presented in the report, provides clarity on the status of the project, and offers guidance for future actions or decisions. Include

- summary appraisal of the current status;
- assessment of progress made so far; and
- forecast for completing the project.

Contact Information

Provide contact information.

Feasibility Reports

A feasibility report is a type of technical report that evaluates whether a proposed idea, project, or solution is practical and advisable. Common in engineering, business, and design contexts, feasibility reports help decision-makers assess the viability of a plan before committing significant time, money, or resources. These reports typically analyze multiple dimensions of feasibility — such as technical, economic, legal, operational, and scheduling factors — to provide a balanced and evidence-based recommendation. They aim to provide an objective assessment of the options, weighing the pros and cons based on clearly established criteria. Writing an effective feasibility report requires critical thinking, analytical reasoning, and a clear organizational structure to guide readers through complex evaluations.

Introduction

The introduction of a feasibility report sets the stage for the document by providing context, stating the problem or opportunity, and outlining the scope and objectives. It also establishes the report's relevance and significance. In general, it helps to orient readers, preparing them for the analysis in subsequent sections. Include

- the reason for writing the report (request or situation requiring the analysis);
- the problem that needs to be solved or opportunity to address;
- the proposed solution; and
- the criteria that will be considered, in the order they will be discussed.

Discussion (Analysis)

In essence, the discussion section of a feasibility report is where the critical thinking and analysis take place. It is a space for synthesizing information, making informed judgments, and guiding decision makers on whether to proceed with the proposed project and what adjustments or actions may be necessary. Include

Criterion one

- description of the criterion, why it was selected, and how it is used;
- findings or data used as evidence; and
- interpretation of data, including what it means for the feasibility of the solution.

Criterion two

Treat additional criteria in the same manner as criterion 1.

Conclusion

The conclusion of the report should leave the reader with a clear understanding of the study's findings, a sense of the project's feasibility or lack thereof, and a roadmap for what steps should be taken next. It is a critical section that helps decision-makers make informed choices based on the report's analysis and recommendations. Include

- a summary of results and interpretations, applying all criteria;
- bottom-line conclusions based on data and interpretations; and
- (if appropriate) a recommendation to move forward with or reject the proposed solution.

References (if required)

Provide a list of references in the required format (e.g., IEEE referencing scheme)

Contact Information

Provide contact information.

Appendix

Include materials that provide additional useful information but that are not required to understand the report.

Key Takeaways



Technical reports are a core part of professional communication in engineering and computer science. They turn technical work into information that others can understand, evaluate, and use. Whether the goal is to document results, analyze a problem, justify a design choice, or recommend a solution, reports must present complex information clearly and logically, with the reader in mind. The following points highlight the main purposes of common technical reports:

- **Write lab reports to explain results.** Lab reports are not just a record of what happened in the lab. They show how results were obtained, how data were analyzed, and what conclusions can reasonably be supported by the evidence.
- **Write progress reports to keep stakeholders informed.** Progress reports communicate how a project is advancing over time. They help stakeholders track progress, identify issues early, and make informed decisions about next steps.
- **Write feasibility reports to assess viability before moving forward.** Feasibility reports evaluate whether a proposed project or solution is practical. They typically examine technical, economic, legal, operational, and scheduling factors to support an evidence-based recommendation.

Clear, well-structured technical reports support better decisions and stronger outcomes. Writing them effectively is not just a course requirement—it is a key professional responsibility.

Practice Task



Imagine you are part of a team working on a technical writing group project (such as a proposal or design document) that is currently midway through the semester. Write a progress report addressed to your project supervisor.

Chapter 12: Technical Research

Chapter ContentsThe Role of Technical Research in EngineeringGathering Reliable InformationUnderstanding the Structure of AbstractsSummarizing and Paraphrasing SourcesSynthesizing SourcesCiting and Referencing SourcesWriting Annotated BibliographiesWriting a Review of Library SourcesKey TakeawaysPractice TaskReferences

The Role of Technical Research in Engineering



Photo by Jason Leung on Unsplash

As an engineer in training, developing strong research skills is one of the most important steps you can take toward becoming an effective problem-solver. Engineering isn't just about applying formulas. It's also about investigating real-world challenges, exploring possible solutions, and making well-informed decisions based on evidence. To do this, you need to know how to gather reliable information, analyze data, synthesize findings, and come up with convincing recommendations based on your work.

Gathering Reliable Information

Gathering reliable information ensures that your analysis is based on accurate, relevant, and up-to-date evidence—the foundation for decisions that withstand scrutiny. Consider the following tips as you prepare to gather sources:

Start with a clear research question. The first step is to clearly define the problem you're trying to solve, and then clearly articulate this in a research question. The wording is extremely important because you use these words—along with their synonyms—to limit your search to the most relevant and useful sources. A poorly articulated research question will almost certainly lead to time lost on unrelated information.

Identify precise search terms: Once you have a clear research question, the next step is to identify the keywords that will help you find relevant information. Start by highlighting the main concepts in your research question, then list synonyms, related terms, and variations in spelling or phrasing. These search terms will form the foundation of your online searches and database queries.

Imagine that your research question is the following:

> How does smartphone addiction impact the sleep quality and cognitive performance of university students?

This research question includes the following four key elements: (1) smartphone use, (2) sleep quality, (3) cognitive performance, and (4) engineering students.

Combine search terms: After selecting your keywords, you can refine your search by combining them with AND, OR, or NOT within the search field of the library catalogue or academic database.

- AND narrows your results by retrieving only sources that include all the specified terms (e.g., aerodynamics AND wind tunnels).
- OR broadens your results by including sources that contain any of the listed terms (e.g., unmanned aerial vehicles OR drones).
- NOT excludes certain terms from your search results. Applying these functions in field searches—such as titles, abstracts, authors, or subject headings—can make your searches faster and more relevant.

Table 12.1 Combining Search Terms and Their Synonyms

	keyword	keyword synonym	keyword synonym
Concept 1			
AND/OR/NOT			
Concept 2			
AND/OR/NOT			
Concept 3			

Focusing on sources at the intersection of key concepts narrows search results, while using different combinations of terms helps you gather information most relevant to the themes you want to develop in your arguments.

Examples

Theme 1: smartphone use AND sleep quality AND engineering students

Theme 2: smartphone use AND cognitive performance AND engineering students

Use reliable and credible sources. Prioritize peer-reviewed journal articles, academic books, government reports, technical standards, and publications from professional engineering organizations (like IEEE or ASME). These sources are typically reviewed for accuracy and quality.

Search in academic databases. Use databases like IEEE Xplore, ScienceDirect, or others that are accessible through the university's library portal. Sources from these platforms are more reliable than general web searches and give you access to high-quality technical and scientific work. Depending on your needs, you might also consider white papers, technical reports, or patents from engineering firms or government agencies. These can give insight into current technologies, gaps in the market, and practical applications. Case studies can be useful to explore how similar problems have been solved in real-world settings and to determine what has or hasn't worked in the past.

Read abstracts to evaluate sources. While gathering materials for your research, you do not need to read every research paper in full right away. Instead, focus on the abstracts—brief summaries of purposes, methods, and key findings—to determine whether the purpose and scope of a study align with your research focus. This

will save time and help you filter out less relevant works. For more information, refer to the section ***Understanding the Structure of Abstracts*** in this chapter.

Evaluate for bias and relevance. Ask yourself, "Who produced this source, and why? Is it objective? Is it directly related to the research problem?"

Stay current. Technology changes fast. As a general rule, try to use sources published within the last 5 years, especially if your research problem relates to emerging fields like AI, renewable energy, or aerospace.

Take organized notes and track your sources. Record citation details (e.g., in APA or IEEE format) as you go. This saves time later and reduces the risk of missing or incorrect citations in your final document. Record key points, technical data, and useful visuals. Keep track of where each piece of information came from—you'll need this for citations to back up your work with evidence.

By following these tips, you'll build a strong foundation of evidence that shows that you deeply understand the technical, practical, and social dimensions of the problem you're trying to solve.

Note: A spreadsheet can be an invaluable tool for organizing and managing information from sources during the search—especially when working on complex problems or group projects. Use the column headings in the spreadsheet to record title, author, publication date, type of source (e.g., journal article, report, website), and where you found it. This helps you keep everything in one place and easily compare sources. You can also use columns to note important points from each source—such as main findings, useful data, relevant quotes, or technical methods. Use a tagging system to identify how each source meets your specific needs. For example, you could tag them as supporting or advising against the application of a specific technology.

Understanding the Structure of Abstracts

Abstracts provide a condensed version of a longer piece of writing, so they are useful when searching for relevant source materials. They share some key characteristics:

- They are a concise summary of a specific type of work, often academic (a research paper or thesis).
- They are brief, usually a single paragraph.
- They focus on the purpose, method, findings, and conclusions of the work.
- They prioritize the research question, thesis, and major findings.
- They may include keywords to help with information retrieval.
- They are objective and factual, without personal opinions.

Two Types of Abstracts

There are two types of abstracts: descriptive and informative.

Descriptive abstracts: These summarize a report's structure but not its substance, including specific findings or recommendations. They resemble a paragraph-form table of contents, often mentioning the title, author, purpose, problem, and scope. They describe major topics but omit specific details. These abstracts are typically short, around 50 words. For example, the following abstract from the article "Affect and Cognition" **[1]** illustrates a descriptive abstract, as it outlines the topic, purpose, and scope without presenting specific findings.

ABSTRACT—One of the greatest puzzles of human nature concerns the poorly understood interplay between affect and cognition—the rational and emotional ways of dealing with the social world around us. Affect is a ubiquitous and powerful phenomenon in our lives, yet research on human affectivity has been neglected until quite recently. This article reviews traditional and contemporary approaches to this issue, and recent theoretical and empirical work exploring the links between affect and cognition is considered. The major achievements and shortcomings of this now-thriving research area are discussed, and the future prospectsof psychological research on human affectivity are considered.

Informative abstracts: They summarize the report's substance, not just its structure. They condense key points, while removing extra details, examples, and numbers. They typically don't include the title or author in the opening lines, as this information is already available in the document being summarized.

Most abstracts for research papers are informative, providing readers with a clear overview of the study's purpose, methodology, and findings. Some abstracts also include a brief background before stating the purpose, as shown in the following example from **[2]**.

Background: Existing research has demonstrated that depression is positively related to smartphone addiction, but the role of sleep has not been discussed thoroughly, especially among engineering undergraduates affected by the coronavirus disease 2019 pandemic.

Aim: To evaluate sleep as a mediator of the association between smartphone addiction and depression among engineering undergraduates.

Methods: Using a multistage stratified random sampling method, a cross-sectional survey was conducted among 692 engineering undergraduates from a top engineering university in China, and data were collected by self-reported electronic questionnaires. The data included demographic characteristics, such as age, gender, the Smartphone Addiction Scale-Short Version (SAS-SV), the 9-item Patient Health Questionnaire, and the Pittsburgh Sleep Quality Index. Pearson correlation and multiple linear regression analyses were used to examine the association between smartphone addiction and depression, while structural equation models were established to evaluate the possible mediating role of sleep.

Results: Based on the cutoffs of the SAS-SV, the rate of smartphone addiction was 63.58 percent, with 56.21 percent for women and 65.68 percent for men, among 692 engineering students. The prevalence of depression among students was 14.16 percent, with 17.65 percent for women, and 13.18 percent for men. Smartphone addiction was positively correlated with depression, and sleep played a significant mediating effect between the two, accounting for 42.22 percent of the total effect. In addition, sleep latency, sleep disturbances, and daytime dysfunction significantly mediated the relationship between depression and smartphone addiction. The mediating effect of sleep latency was 0.014 [P < 0.01; 95% confidence interval (CI): 0.006–0.027], the mediating effect of sleep disturbances was 0.022 (P < 0.01; 95%CI: 0.011–0.040), and the mediating effect of daytime dysfunction was 0.040 (P < 0.01; 95%CI: 0.024–0.059). The influence of sleep latency, sleep disturbances, and daytime dysfunction accounted for 18.42%, 28.95%, and 52.63% of the total mediating effect, respectively.

Conclusion: The results of the study suggest that reducing excessive smartphone use and improving sleep quality can help alleviate depression.

Keywords: Smartphone addiction, Depression, Pittsburgh Sleep Quality Index, Engineering students, COVID-19, Mediating effect

This is a well-written abstract because it enables readers to quickly and easily locate the information they need. While most abstracts do not use headings for each section, they should still include the essential elements: purpose, methods, results, and conclusion. A brief background may also be added if required by the journal format.

Summarizing and Paraphrasing Sources

When you read an abstract and find it relevant to your research focus, make sure to record it. Once all your sources are recorded and organized, the next step is to summarize and paraphrase them. Summarizing involves identifying the main ideas from your sources and presenting them in your own words. Don't attempt to summarize all information in the sources. Abstracts can again be very useful because they already provide a condensed overview of an entire study, pointing to the most important points.

Generally, when reading an abstract, you might look for these three key elements:

- The purpose of the study
- The method used
- The key findings

When summarizing a research article, paying particular attention to these three components may save you time. The purpose tells you why the study was conducted and whether it directly connects to your research question. The method helps you evaluate the quality and reliability of the research. The findings present results and conclusions that may support or challenge your argument.

Let's apply this to an example. The following summary is based on information extracted from the abstract of [1]. Because the abstract is well-structured, it's easy to find information you need for a summary. An initial attempt at summarizing might be as follows:

> The aim of the study was to evaluate sleep as a mediator of the association between smartphone addiction and depression among engineering undergraduates. A cross-sectional survey was conducted among 692 engineering undergraduates from a top engineering university in China using self-reported electronic questionnaires. Smartphone addiction was positively correlated with depression, and sleep played a significant mediating effect between the two, accounting for 42.22 percent of the total effect. In addition, sleep latency, sleep disturbances, and daytime dysfunction significantly mediated the relationship between depression and smartphone addiction. The results suggest that reducing excessive smartphone use and improving sleep quality can help alleviate depression.

However, if you copy exact words from the source or its abstract without rephrasing them and providing proper

credit, it is considered plagiarism. To avoid this, it is best to paraphrase. Paraphrasing goes beyond summarizing by restating specific information or ideas from a source in your own words while preserving the original meaning. This is especially valuable when incorporating technical details or specific data points into your research. The passage below provides a paraphrased version of the key ideas from the abstract.

> **[1]** examined the mediating role of sleep in the relationship between smartphone addiction and depression among engineering undergraduates. Based on data collected through a cross-sectional survey of 692 students at a leading engineering university in China, the study identified a significant positive correlation between smartphone addiction and depressive symptoms. Notably, sleep was found to be a substantial mediating factor, accounting for 42.22% of the total effect. Key sleep-related components, including increased sleep latency, frequent disturbances, and daytime dysfunction, were reported to significantly mediate this relationship. These findings underscore the importance of improving sleep quality and reducing excessive smartphone use as potential strategies for mitigating depression in engineering student populations.

As you can see from this paragraph, good paraphrasing shows that you understand the source and allows you to integrate the information more smoothly into your writing.

Synthesizing Sources

Synthesizing sources involves combining information from multiple texts to develop new insights and strengthen your arguments. It is different from simply summarizing each source individually. The goal is to weave ideas together, showing how sources support your points and where they align or disagree. To make these relationships clear, use connectors such as “whereas,” “similarly,” “in contrast,” “however,” and “on the other hand.” The following example illustrates this process.

> Research demonstrates that smartphone addiction significantly impacts sleep quality among university students, although the studies reveal different prevalence rates and focus on distinct health outcomes. **[1]** found smartphone addiction prevalence of 31.1% among health sciences students, whereas **[2]** reported substantially higher rates of 63.58% among engineering undergraduates. Similarly, both studies employed validated instruments lending credibility to their comparative findings. However, whereas **[1]** established a direct correlation between smartphone addiction and sleep quality (47.8% of students showing reduced sleep quality), **[2]** provided mechanistic insights by demonstrating sleep’s mediating role between smartphone addiction and depression. Specifically, **[2]** found that sleep disturbances accounted for 42.22% of the total effect. It linked smartphone addiction to depressive symptoms, with sleep latency, sleep disturbances, and daytime dysfunction contributing 18.42%, 28.95%, and 52.63% respectively to this mediating effect. In contrast, **[1]** emphasized broader biopsychosocial health implications without examining mental health outcomes. Collectively, these findings suggest that smartphone addiction not only directly impairs sleep quality across diverse stu-

dent populations but also creates a pathway to mental health deterioration through sleep-mediated mechanisms.

[1] H. Ozkaya, M. Serdar, H. Acar, S. Pekgor, and S. Gunher Arıca, "Evaluation of the frequency/addiction of smartphone use and its effect on sleep quality in university students," Annals of Medical Research, vol. 27, no. 2, pp. 657–663, 2020, doi: **10.5455/annalsmedres.2019.11.737**.

[2] W.-J. Gao, Y. Hu, J.-L. Ji, and X.-Q. Liu, "Relationship between depression, smartphone addiction, and sleep among Chinese engineering students during the COVID-19 pandemic," World Journal of Psychiatry, vol. 13, no. 9, pp. 1351–1364, Sep. 2023, doi: **10.5498/wjp.v13.i6.361.**

By showing how different pieces of evidence work together, you can build a more complete picture of your research topic. By doing so, you may also strengthen your arguments and increase your credibility as a researcher.

Citing and Referencing Sources

In-text citations are references placed within your writing to identify the source of specific information drawn from external works. Even when summarizing or paraphrasing, it is essential to (1) include in-text citations and (2) list the sources in your reference section. Depending on the citation style, in-text citations may appear immediately before or after the idea, fact, statistic, image, or even single word taken from another source. The following examples illustrate this practice.

Several studies have confirmed the relationship between smartphone use and sleep quality **[1]**, **[2]**.

or

According to **[1]** and **[2]**, excessive screen time significantly impacts sleep quality of university students.

In addition to providing in-text citations, you must include each source in a reference list at the end of your work. The reference list provides complete bibliographic details, allowing readers to locate and verify your sources. This two-part system ensures that proper credit is given to original authors and upholds the integrity of your research. To do this effectively, always track which ideas come from which sources, even when summarizing or paraphrasing. This not only guarantees accurate citation but also strengthens the credibility of your work by clearly distinguishing your ideas from those of others.

Writing Annotated Bibliographies

While a bibliography is a list of sources or works cited in a study, an annotated bibliography lists sources along with brief paragraphs that summarize and evaluate them. It explains the content of each source and how it contributes to your research. The process of crafting an annotated bibliography helps you better understand your materials and shows readers how each source supports your work.

Your annotation may include a summary, an evaluation, and a note on the source's relevance to your research. Depending on your purposes, you might include one or all of these components.

To summarize, consider:

- What is the purpose of the study?
- What are the main arguments?

To evaluate, consider:

- Is it a useful or credible source?
- Is the information reliable and objective?

To assess relevance, consider:

- How does it shape your argument?
- How will you use it in your research project?

Let's look at an example to see how these elements come together in a clear and helpful annotation:

[1] W.-J. Gao, Y. Hu, J.-L. Ji, and X.-Q. Liu, "Relationship between depression, smartphone addiction, and sleep among Chinese engineering students during the COVID-19 pandemic," *World Journal of Psychiatry*, vol. 13, no. 9, pp. 1351–1364, Sep. 2023, doi: 10.5498/wjp.v13.i9.1351.

The main aim of **[1]** was to evaluate sleep as a mediating factor in the relationship between smartphone addiction and depression among engineering undergraduates during the COVID-19 pandemic. The authors conducted a cross-sectional survey with 692 students using validated tools, such as the Smartphone Addiction Scale–Short Version and the Pittsburgh Sleep Quality Index. Their analysis showed that smartphone addiction was positively correlated with depression, and sleep played a significant mediating role, accounting for 42.22% of the total effect. Specific factors, such as sleep latency, disturbances, and daytime dysfunction, contributed significantly to this relationship.

Since this study was conducted using a large sample and published in the peer-reviewed *World Journal of Psychiatry*, it is a credible and reliable source of information. The authors provided clear data and analysis that help explain how poor sleep links smartphone addiction to mental health outcomes.

This resource is helpful for my research project, which explores the impact of excessive smartphone use on sleep and cognitive performance among engineering students. The findings offer a valuable framework for examining sleep-related variables and support my study's argument that addressing sleep issues can mitigate the broader consequences of digital overuse.

Writing a Review of Library Sources

Once you find relevant, non-biased, and current sources for your research question and categorize them according to their themes, the next step involves structuring the review. A well-structured review has four essential parts: title, introduction, discussion, and conclusion.

User-Related and Technology-Related Vulnerabilities in Smart Homes: A Review of Library Sources

Smart home technologies refer to internet connected devices used for managing and remotely controlling household functions, such as locks, lights, cameras, and thermostats. While these tools enhance convenience and efficiency, they also introduce cybersecurity risks. Many smart homes rely on networks, cloud services, and remote access, which can expose users to threats such as hacking and surveillance. As more households adopt these technologies, it becomes essential to understand their associated security challenges. This review examines common cybersecurity problems in smart homes, focusing on risks from user behavior and from technology.

User-Related Vulnerabilities in Smart Homes

Poor authentication practices remain one of the most identified weaknesses in smart-home environments. **[1]** found that many users leave default credentials unchanged or create overly simple passwords, making devices especially vulnerable to unauthorized access. **[2]** further observed that password reuse across multiple smart-home services is widespread, enabling a single compromised credential to open several attack paths. Their findings suggest that these everyday habits significantly reduce the overall security posture of smart homes. Together, the studies reveal that even when devices offer secure features, the failure to adopt strong authentication practices continues to create critical risks for users.

In addition to poor authentication practices, limited user awareness significantly contributes to security risks in smart homes. **[2]** reported that many households possess only a basic understanding of their devices security settings and rarely consult manufacturer guidance, leaving default configurations untouched. **[3]** found that the anomaly detection tools bundled with many smart home systems remain on default settings because users rarely adjust them, which sharply limits the devices' ability to recognise emerging attack patterns. **[4]** observed that users rarely monitor network traffic and often neglect built-in protections such as encryption or two-factor authentication, leaving their systems vulnerable to exploitation. Taken together, the evidence suggests that low digital knowledge is a pivotal yet often overlooked cause of smart-home insecurity.

Finally, smart home users often lack control over how third-party services access and manage their data, creating serious privacy and security risks. **[2]** found that many smart-home devices automatically share user information with external servers without offering clear consent options or opt-out mechanisms. **[5]** likewise observed that traffic routed through centralized hubs exposes user metadata to outside platforms with minimal transparency, leaving homeowners unaware of when and

how their data are being accessed. This convergence in the literature points to user agency and data-flow transparency as missing pillars in today's smart-home ecosystem.

Technology-Related Vulnerabilities in Smart Homes

While user behavior contributes to security issues, structural design choices in smart-home systems also create significant risks. [6] note that many platforms rely on centralized architectures in which a single cloud server or hub manages all device interactions. This setup introduces a single point of failure, meaning a successful attack on the central node could compromise the entire system. [7] further showed that dependence on external service providers for identity management and data routing limits user oversight and magnifies the impact of any cloud-side breach. This evidence underscores centralization as a pivotal factor that shapes both the visibility and resilience of smart-home ecosystems.

Smart-home security is frequently undermined by poor maintenance of device firmware, which can leave systems exposed to known threats. [8] revealed that many popular devices still rely on outdated, password only update procedures that transmit files without verifying their authenticity. In addition, [5] found that many commercial hubs lack secure, authenticated update channels, allowing attackers to block or replay critical patches. [4] further noted that homeowners often receive no meaningful alerts or lack the technical skills to apply fixes manually, prolonging device vulnerability. Collectively, the literature shows inconsistent firmware upkeep as a persistent gap that both increases the likelihood of unauthorized access and erodes user confidence in the reliability of smart-home technologies.

Absence of regulatory frameworks for smart-home cybersecurity is also a major concern. [6] pointed out that existing performance standards such as TS 621 for smart locks focus narrowly on physical robustness and leave cyber-specific attack vectors largely unaddressed. Assessing a broader spectrum of consumer IoT, [2] observed that national legislation is still fragmented, resulting in inconsistent requirements for encryption, vulnerability disclosure, and data-handling practices across manufacturers. Echoing this gap from an emerging-economy perspective, [4] noted that low-cost devices often bypass certification entirely, entering the market without any compliance audit. Clearly, the current regulatory patchwork allows insecure products to proliferate, leaving end-users to absorb the residual cyber-risk.

Conclusion

This review examined cybersecurity risks in smart home environments, focusing on vulnerabilities resulting from both user behavior and system design. The findings reveal three main user-related vulnerabilities—weak authentication practices, limited cybersecurity awareness, and poor control of third-party data access—and four system-level vulnerabilities—centralized architectures, unpatched firmware, insecure communication protocols, and lack of regulatory frameworks. While current research provides important insights into these challenges, a significant gap remains in understanding how these risks develop and interact over extended periods in everyday home settings. Future research should include real-world studies that evaluate decentralized security models, automated

firmware update systems, and emerging regulatory standards to strengthen smart home resilience and user trust.

References

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[8] A. Huszti, S. Kovács, and N. Oláh, "Scalable, password-based and threshold authentication for smart homes," *Int. J. Inf. Secur.*, vol. 21, no. 4, pp. 707–723, Aug. 2022, doi: 10.1007/s10207-022-00578-7.

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Informative Titles

The title serves as your reader's first impression and establishes the foundation for their understanding. An effective title clearly identifies the focus of your report while reflecting the core topic you are investigating. A vague, too general, too detailed, too informal, or unprofessional title may confuse the reader or fail to clearly communicate the focus and purpose of your report. Let's read the following titles to see what to avoid:

Poor Example: Technology in Engineering

This title is too broad and vague. It doesn't indicate what kind of technology, what area of engineering, or what aspect is being reviewed.

Poor Example: A Review of the Use of Deep Learning-Based Predictive Maintenance Algorithms for Fault Detection in Electric Motor Bearings in Aerospace Systems Operating at High Altitudes

This title is overly long and specific. It overwhelms the reader and makes it difficult to grasp the focus quickly.

Poor Example: How Cool AI Tools Can Help Engineers

Informal language like "cool" undermines the credibility of the paper and doesn't reflect an academic tone.

Poor Example: A Literature Review on Biomedical Implants (when the paper is actually about AI in mechanical engineering)

This title misrepresents the content. Titles must accurately reflect the scope and focus of the review. Therefore, you might consider crafting a title that is brief yet precise. This offers readers immediate insight into what your review will explore.

Good Example: The Role of Artificial Intelligence in Improving Structural Health Monitoring: A Review of Library Sources

This title immediately conveys the topic, target population, and document type to the reader.

The Introduction

The introduction sets the stage for your entire review and shows readers how you will analyze the topic. It works best when you clearly explain the problem you're researching, define any important terms your readers might not know, and state the purpose of your report.

A strong introduction defines the main topic or problem and explains its significance. You can also give readers a brief overview of how your discussion will be organized so that they know what to expect. Including a clear statement of purpose helps readers follow your analysis and understand the goals of your review.

The Discussion

The discussion forms the analytical heart of your review, where your critical thinking and synthesis skills become most evident. In this section, you organize and synthesize your sources based on how they help explain or solve the problem you're researching. Group similar studies or findings together so your readers can see how each contributes to your understanding of the topic. For example, in the review titled *User-Related and Technology-Related Vulnerabilities in Smart Homes: A Review of Library Sources*, the sources are organized under two main themes: user-related vulnerabilities and technology-related vulnerabilities in smart homes.

When developing your arguments, it can be helpful to organize your writing into paragraphs to keep your ideas focused. Ideally, each paragraph should cover just one main point. You might also find it useful to further group the sources within each paragraph. Once your sources are organized under main headings (such as user-related vulnerabilities and technology-related vulnerabilities in smart homes, as in the example), you can discuss each point in its own paragraph for clarity. To illustrate, in the example review, the first paragraph under *User-Related Vulnerabilities in Smart Homes* focuses on poor authentication practices, the second on limited user awareness, and the third on lack of control over third-party data risks. Similarly, under *Technology-Related Vulnerabilities in Smart Homes* the first paragraph focuses on poor structural design choices in smart-home systems, the second on poor maintenance of device firmware, and the third on absence of regulatory frameworks for smart-home cybersecurity.

A good way to begin each paragraph is with a topic sentence that clearly states the main idea or point of argument. This sentence usually connects to how your sources contribute to understanding the research problem. Think of it as a mini-summary that guides the reader on what to expect. For instance, if your paragraph is about poor structural design choices in smart-home systems, you could start with, "Structural design choices in smart-home systems also create significant risks." This sets the focus, and the rest of the paragraph should provide evidence from your sources to support that idea.

Once you have introduced your topic, the next step involves supporting your main idea with evidence from multiple sources through effective synthesis. This process requires more than simply presenting basic factual information to inform the reader or providing summaries of what each study found. Instead, you weave together findings from different sources to build a compelling argument that supports your claim. Effective synthesis demonstrates how studies relate to one another and to your research problem, highlighting areas of agreement, disagreement, or complementarity.

Poor example: Smart homes face many security problems related to authentication. Users often set weak passwords or leave default credentials unchanged. Sometimes, people also reuse the same passwords across different accounts. These practices create risks for smart-home systems. Strong authentication is important to keep devices safe.

The paragraph is weak because it simply lists facts without supporting a clear argument. No evidence or studies are provided, just general information. It lacks synthesis, which makes it a disconnected summary rather than a meaningful discussion.

Poor example: **[1]** studied authentication in smart-home devices and found that users often failed

to change default passwords. Their research highlighted that weak passwords allowed unauthorized access to systems. [2] examined password practices in smart-home environments and reported that users reused credentials across platforms.

The paragraph is weak because it simply lists study details without connecting the findings or explaining their significance. There's no analysis or synthesis of how these dimensions interact or how they support the main idea of the paragraph.

Poor example: Poor authentication practices remain one of the most commonly identified weaknesses in smart-home environments. [1] showed that many users rely on default or simple passwords. [2] reported that password reuse is common across smart-home services. These studies indicate that authentication is a problem for smart-home devices.

The paragraph is also weak because it merely summarizes each study individually without drawing any meaningful connections between them. It lacks deeper analysis, synthesis, and insight into how the studies relate to one another or contribute to a broader argument. Instead of building toward a clear conclusion, it ends with a vague generalization that fails to support a focused claim.

Good example: Poor authentication practices remain one of the most commonly identified weaknesses in smart-home environments. [1] found that many users leave default credentials unchanged or create overly simple passwords, making devices especially vulnerable to unauthorized access. [2] further observed that password reuse across multiple smart-home services is widespread, enabling a single compromised credential to open several attack paths. Their findings suggest that these everyday habits significantly reduce the overall security posture of smart homes. Together, the studies reveal that even when devices offer secure features, the failure to adopt strong authentication practices continues to create critical risks for users.

This is a better example because it starts with a clear topic sentence, uses evidence from multiple studies, and shows how their findings connect. Instead of just listing results, it explains what they mean together: that weak authentication habits remain a critical vulnerability in smart homes.

Remember: when supporting your arguments with evidence, synthesis means moving beyond individual summaries of sources. Instead, critically evaluate how each source contributes to your overall argument. Look for points of alignment and divergence, and consider what these patterns reveal about your research problem. Rather than treating each study as an isolated finding, show how the collective evidence builds a fuller understanding of your topic.

Notice how the good example paragraph demonstrates this approach. It starts with a clear topic sentence that highlights the main issue—*poor authentication practices in smart homes*. From there, it weaves together evidence from two studies, showing how everyday habits like leaving default passwords or reusing them across

accounts can open the door to serious security risks. Instead of just listing what each study found, the paragraph connects the findings to show the bigger picture: *weak authentication consistently undermines smart-home security*. It also explains why this matters, pointing out that even strong device features can't protect users if their behavior leaves systems exposed. In the end, the paragraph doesn't just summarize research; it uses the evidence to build a strong argument about why authentication remains such a critical vulnerability.

The Conclusion

The conclusion summarizes the key points of your literature review without introducing new arguments or ideas. Start by paraphrasing your introduction's purpose statement, rephrasing it to reflect what the review has accomplished. This reminds readers of your original goals and signals your intent to wrap up your key arguments. If your introduction examined common cybersecurity problems in smart homes, focusing on risks from user behavior and from technology, your conclusion might state, "This review examined cybersecurity risks in smart home environments, focusing on vulnerabilities resulting from both user behavior and system design."

Next, summarize the key themes and patterns that emerged from your source synthesis. Consider what the collective evidence reveals about your research problem and how studies work together to build understanding.

Finally, identify any unanswered questions that future research should address. Point out areas where literature remains incomplete or contradictory. You might also suggest directions for future research or recommend actions for practitioners.

Key Takeaways



Even if you don't conduct academic research, you will often spend days or weeks on applied research—gathering information to solve real-world problems or support engineering decisions. In this process, it is essential to gather reliable and credible sources and use them to back up your arguments with solid evidence. You can organize your work by

- categorizing sources according to their type and relevance;
- summarizing and paraphrasing to capture key points accurately in your own words;
- synthesizing sources to show connections and patterns; and
- citing and referencing to give proper credit and maintain academic integrity.

Once you have gathered, organized, and analyzed your research materials, you can move on to writing a review of sources. Your review may include the following:

- **Title**—Use a precise and informative title.
- **Introduction**—Explain the problem and why it needs to be addressed.
- **Discussion**—Organize and synthesize your sources to show how they help explain or solve the problem.
- **Conclusion**—Summarize the key points without introducing new arguments or ideas.

Practice Task



Your engineering design team is preparing an innovation proposal for your company. Before you can design a solution, you need a solid understanding of the problem you're addressing. The project manager has asked each member of the team to prepare a *Review of Library Sources*. This report will help your group establish the technical and contextual background for your project, identify gaps in existing knowledge, and resolve any conflicting findings from prior work.

To prepare this review, you will explore and evaluate sources from

- Academic journals
- Trade magazines
- Books, handbooks, and encyclopedias
- Websites
- Other relevant resources

Your task is to categorize these sources based on their contributions to understanding the problem your proposal attempts to solve. Beyond summarizing prior work, you must take an evaluative stance. You should

- Link each source to your research problem.
- Assess how well each source contributes to understanding that problem.
- Identify gaps, unknowns, or conflicts in the body of knowledge.

The finished report should

- Be 750–1000 words in length.
- Include at least eight sources in IEEE format.

Consider structuring your report as follows.

Title

- Use a title that clearly identifies the focus of the report on library research. (Be brief, but precise.)

Introduction

- Establish context for the problem you are researching.
- Define key terms (if necessary).
- Include a clear statement of purpose that establishes the scope and goals of the report.
- Provide a "road map" indicating the order in which you approach ideas in the body of the report.

Body

- Categorize your sources according to the contribution they make to understanding the problem.
- Develop your arguments in paragraph form.
- Present and elaborate on one main idea per paragraph.
- Tie the content of sources that you review to the scope and focus established in the introduction.

(i.e., Establish why given sources are relevant to understanding the problem.)

- Identify gaps/unknowns/conflicts in the body of knowledge.
- Use transitions to signal the progression of ideas.
- (Optional) Include diagrams, charts, or images—properly referenced—to help explain key points.

Conclusion

- Restate the key findings from the review.
- Suggest directions for future research (based on sources reviewed) or recommendations for action.
- Do not introduce new ideas in the conclusion.
- References
- Provide at least eight references in IEEE format.

References

[1] J. P. Forgas, "Affect and Cognition," *Perspect Psychol Sci*, vol. 3, no. 2, pp. 94–101, Mar. 2008, doi: **10.1111/j.1745-6916.2008.00067.x**.

[2] W.-J. Gao, Y. Hu, J.-L. Ji, and X.-Q. Liu, "Relationship between depression, smartphone addiction, and sleep among Chinese engineering students during the COVID-19 pandemic," *World J Psychiatry*, vol. 13, no. 6, pp. 361–375, Jun. 2023, doi: **10.5498/wjp.v13.i6.361.**

Chapter 13: Proposals

Chapter ContentsCrafting Effective Proposals Structuring the Proposal Writing the Letter of Transmittal Writing the Executive Summary Writing the Introduction Writing the Background/Problem Statement Proposing a Solution Detailing the Plan of Action Detailing the Budget Writing the Qualifications Section Conclusion Section Key Takeaways Practice Task

Crafting Effective Proposals

Your team has developed a brilliant engineering solution — one that could reduce waste, improve efficiency, or even save lives. But before your idea can make an impact, it must first persuade someone to say yes: a client, a supervisor, a funding agency. That's where the engineering proposal comes in. More than just a technical document, a proposal is your chance to make a case — not only clearly and logically, but persuasively and ethically. Successful engineers know how to present their ideas with integrity, tailoring their message to the needs and values of their audience, while staying true to their responsibilities as professionals. This chapter will teach you how to craft proposals that are not only effective, but also ethical — that is, grounded in honesty, transparency, and respect for those you aim to serve.

Structuring the Proposal

Most engineering proposals follow a predictable structure — not because creativity is discouraged, but because a clear, logical format helps readers quickly find the information they need to make decisions. Each section plays a distinct role in guiding the reader from problem to solution, building a persuasive case along the way. Table 13.1 outlines the typical sections of an engineering proposal.

Table 13.1 Typical sections of an engineering proposal.

Section	Purpose
Executive Summary	Gives a concise overview of the proposal's key points and recommendations
Introduction	Defines the problem or need and establishes context
Background/Problem Statement	Provides detailed context and justifies the need for action
Objectives	States what the proposal aims to achieve
Proposed Solution	Describes the design, method, or approach to solving the problem
Plan of Action	Explains how the solution will be implemented, step by step
Timeline	Lays out a schedule for project tasks and milestones
Budget	Breaks down the costs and justifies the resources needed
Qualifications	Demonstrates the credibility and capabilities of the project team
Conclusion	Reinforces the proposal's value and calls for action

Writing the Letter of Transmittal

When you send a proposal to a client, it should be accompanied by a letter of transmittal. This document introduces your proposal, highlights its purpose and key points, and accompanies the proposal as a stand-alone document (which is why it is not included in Table 13.1).

A letter of transmittal is much like the cover letter for a job application. Just as a cover letter highlights the most important points in your résumé, the letter of transmittal briefly explains what your proposal is about and why you have prepared it. It should summarize the proposal's purpose, point out key recommendations that may interest the reader, and explain the action you would like them to take. The letter also lists the materials you are sending and provides your contact information in case the reader has questions.

The organization of a letter of transmittal is straightforward. It begins with the sender's and recipient's names and addresses, followed by a salutation and an introduction that states the proposal's title and purpose. The body summarizes key persuasive points, while the closing paragraph thanks the recipient, offers to answer questions, and ends on a positive note. The letter concludes with a formal closing, the sender's signature and full name, and a note about any enclosures.

Writing the Executive Summary

The executive summary is one of the most important parts of an engineering proposal — especially when your audience includes busy decision-makers who may read only this section before making a judgment. Its purpose is to provide a concise but complete overview of the entire proposal, highlighting the problem, your proposed solution, the benefits, and key details such as cost and timeline. Think of it as a stand-alone summary that tells the reader what you're proposing and why it matters, without requiring them to read the full document. For

example, if you're proposing a campus-wide energy-saving system for your class project, your executive summary should briefly explain the energy problem, outline your proposed system, mention its environmental and financial benefits, and give a rough estimate of cost and implementation time. Although it appears at the beginning of the proposal, the executive summary should be written last so you can accurately reflect the content.

The language in an executive summary should be clear, direct, and professional. Avoid overly technical jargon unless you're certain your audience is familiar with it. In most cases, assume the reader is knowledgeable but not specialized in your specific area. Use plain language to explain complex ideas, and keep your tone confident but objective. Your goal is to inform and persuade efficiently, so choose precise words, use active voice, and keep sentences concise.

Remember too that the executive summary should be "stand-alone," meaning that it doesn't direct the reader to other sections of the proposal. All necessary information must be found within the summary itself.

Task: Read through the example executive summary below. Try to match each sentence (or sentence pair) to a section of the proposal it reflects.

Executive Summary

This proposal seeks funding to develop a modular, solar-powered water purification system designed for use in remote and disaster-affected regions. Around the world, millions of people lack reliable access to clean drinking water, especially in areas where infrastructure is damaged or nonexistent. The proposed system combines photovoltaic technology with a compact membrane filtration unit to produce clean drinking water without reliance on grid power or fuel. Initial field tests have demonstrated the unit's ability to purify up to 500 liters of water per day using only solar energy, making it both sustainable and scalable. With funding, our team will refine the design for mass production, conduct broader field trials, and partner with NGOs for deployment in high-need communities. The total project budget is $150,000 over 12 months, with anticipated impact including improved public health, reduced reliance on bottled water, and enhanced resilience in off-grid areas.

Writing the Introduction

The introduction to the proposal plays a critical role in setting the stage for readers, guiding them from a broader context to a specific problem in need of a solution. It sets the persuasive foundation for the rest of the proposal by 1) making the reader care about the problem and 2) building trust in the proposers' ability to solve it.

To persuade the reader that the problem deserves attention, the introduction should include evidence of its urgency or impact — preferably backed by plausible evidence and mention of real-world consequences. At the same time, the writers work to establish credibility by demonstrating a solid grasp of the issue and, where appropriate, referencing relevant expertise, experience, or previous work. A strong introduction also appeals to the values of the reading audience. This could mean aligning the need for a solution with broader goals such as sustainability, equity, or technological advancement. Finally, while the bulk of the solution will be outlined in subsequent parts of the proposal, the introduction will likely hint at the proposed innovation to provide direction.

Writing the Background/Problem Statement

The Background or Problem Statement section of an engineering proposal expands on the introduction by pro-

viding a deeper, evidence-based explanation of the problem the proposal aims to solve. Its primary purpose is to demonstrate that the problem is real, well-defined, and significant — one that requires a practical and innovative response. This section typically includes technical details, data, prior research, and examples that show how the problem has developed, why current solutions are insufficient, and who is affected. It also helps define the scope and boundaries of the proposed solution, clarifying what is and isn't included.

Functionally, this section strengthens the proposal's logical appeal (logos) by grounding it in facts and data, and it often reinforces credibility (ethos) by showing that the writer has done thorough research and understands the complexities involved. A well-written problem statement sets up the reader to fully appreciate the relevance and effectiveness of the proposed solution that follows.

Step 1: Provide context and background to the problem

Begin by establishing the need for a solution through clear, well-developed background information. A helpful strategy is to think like a journalist: reporters often rely on a set of "wh" questions — what, who, when, where, and why — to uncover the full context of a story. You can use these same questions to examine the problem you're addressing. What exactly is the problem? Who is affected by it? When and where does it occur? Why does it matter? Provide data, observations, or examples that show the scale or urgency of the issue. Answering these questions will help you frame the issue clearly, highlight its significance, and lay a solid foundation for your proposal.

Step 2: Establish realistic constraints and criteria for success

Defining clear constraints and criteria for success is the next crucial step in any engineering proposal. Constraints set boundaries — including limits on cost, size, energy use, materials, etc. — to ensure your solution is grounded in real-world conditions. Criteria for success, on the other hand, provide measurable goals that guide the design of the solution. Both constraints and criteria for success must be based on background knowledge and previous research. Together, these elements show that you have considered practical limitations and are committed to delivering a solution that meets predefined needs.

Some examples for the solar-powered water filter introduced earlier are as follows:

Constraints

- **Power Source —** Must operate entirely on solar energy with no dependency on grid electricity or fuel.
- **Portability —** The unit must be compact and lightweight enough for transport by two people.
- **Water Quality Standards —** Must meet or exceed WHO guidelines for safe drinking water.
- **Cost Limit —** Production cost must not exceed $500 per unit to ensure affordability for NGOs.
- **Maintenance —** System must be low-maintenance and operable with minimal technical training.

Criteria for Success

- **Output Capacity —** Can purify at least 500 liters of water per day under average sunlight conditions.
- **Deployment Readiness —** Can be set up and operational within one hour in the field.
- **User Feedback —** Receives positive feedback (satisfaction rating of 85% or higher) from field testers in target communities.
- **Durability —** Operates reliably for at least one year in outdoor conditions without major repairs.
- **Scalability —** Design is adaptable for production at scale (1,000+ units) without major redesign.

Consider the following tips and strategies as you craft the problem statement.

- **Be Specific and Focused —** Clearly define one central problem or need. Avoid vague or overly broad descriptions. For example, instead of "energy is wasted," write "municipal buildings in Region X lose an estimated 25% of heating energy due to outdated insulation systems [3]."
- **Use Evidence to Support Your Claims —** Back up the problem with relevant data, statistics, or case studies. Cite credible sources or provide results from prior assessments, surveys, or pilot studies. This builds logical appeal (logos) and strengthens your argument.
- **Show Why It Matters —** Explain the consequences of not addressing the problem — economic, environmental, social, or operational. Frame the problem in a way that aligns with your reader's priorities or mission (e.g., efficiency, safety, accessibility, innovation) and tailor the urgency to your audience's interests (e.g., cost savings, sustainability for NGOs).
- **Acknowledge Limitations of Current Solutions —** Briefly identify existing approaches and explain why they fall short. This justifies the need for your proposed innovation without going into your solution just yet.
- **Define the Scope —** Clarify what aspects of the problem your proposal addresses and what it does not. This helps manage expectations and keeps the proposal focused.
- **Use a Professional, Objective Tone —** Write clearly and without emotional language. Keep the tone respectful, even when critiquing existing methods.

Proposing a Solution

This section is the heart of your engineering proposal. It's where you explain how you plan to solve the problem you've defined. This is where your creativity, technical understanding, and practical thinking come together to offer a clear, actionable response to the need you've established. The goal is not just to describe *what* you intend to do, but to show *why* this solution is the best fit given the problem's context, constraints, and goals.

From a technical perspective, your description should be precise, feasible, and grounded in sound engineering principles. You should explain the main features of your proposed design or method, supported by diagrams or references to existing research or models where appropriate. Anticipate practical questions a reviewer might ask: How does this work? What makes it different from existing options? Can it be implemented with available resources?

From a persuasive perspective, this section must do more than inform. It must convince. Your audience needs

to believe that your solution is not only technically sound but also appropriate, cost-effective, and aligned with their values or priorities. To achieve this, use clear and confident language, anticipate counterarguments, and frame your proposal in terms of the benefits it delivers. Highlight how your solution meets the **criteria for success**, stays within the **constraints**, and addresses the needs of those affected by the problem. If multiple solutions were considered, briefly explain why the chosen one is superior.

A strong proposed solution section blends technical accuracy with rhetorical awareness — showing that you understand the problem, have thought carefully about your approach, and are offering a practical, responsible, and persuasive answer.

Detailing the Plan of Action

The Plan of Action outlines how you will carry out your proposed solution — step by step. While the previous section explains what you plan to do, this section focuses on how you will do it. It typically includes a breakdown of tasks, a timeline for completion, roles and responsibilities (if working in a team), and any necessary resources such as tools, facilities, or partnerships. The goal is to give your reader confidence that your project is not just a good idea but a well-thought-out and executable plan.

When writing this section, clarity and structure are essential. Organize your plan logically, often in phases (e.g., design, prototyping, testing, implementation), and use tools like Gantt charts or task lists if appropriate. Be realistic about the time and resources each step will require, and avoid vague or overly optimistic descriptions. Specificity helps establish your credibility.

From a persuasive standpoint, the Plan of Action demonstrates your reliability and preparedness. A strong plan shows that you've anticipated challenges, accounted for dependencies, and created a roadmap that makes the proposal feel not only possible but likely to succeed. Readers — especially those considering whether to approve funding or support — want to see that their investment will be used effectively. Consider the concerns of your audience: Are the steps logical? Are the milestones measurable? Does the timeline make sense given the scope of the project? Addressing these questions head-on strengthens your proposal by showing not only that your ideas are innovative but also that you are organized, responsible, and ready to deliver results.

Using Gantt Charts to Visualize the Timeline

A **Gantt chart** is a visual tool used to map out a project's timeline by showing when each task will occur, how long it will take, and how tasks relate to one another. Named after mechanical engineer Henry Gantt, this type of chart is especially useful in engineering proposals because it presents complex project plans in a clear and accessible format.

Each row in a Gantt chart represents a **specific task**, and horizontal bars show the **start and end dates** of that task. Tasks are typically arranged in chronological order, and dependencies (e.g., Task B can only start after Task A is complete) can also be represented.

Important: Labels in the Gantt Chart must exactly match the wording used in the plan of action.

Key Considerations for Creating a Gantt Chart

When mapping out your project timeline, keep the following key considerations in mind for creating an effective Gantt chart:

- **Break the project into phases and tasks** — Identify major phases (e.g., research, design, testing) and break them into specific, actionable tasks.
- **Sequence tasks logically** — Make sure the order of tasks reflects real-world dependencies (e.g., you can't test a prototype before it's built).
- **Show overlapping tasks if appropriate** — Some tasks may be done in parallel; Gantt charts help visualize these overlaps.
- **Use milestones** — Mark major events (e.g., "Prototype Completed") to track progress.
- **Keep it simple and readable** — Especially for class projects or short proposals, avoid excessive detail—focus on the big picture.

Figure 13.1 shows a simplified Gantt Chart for a project.

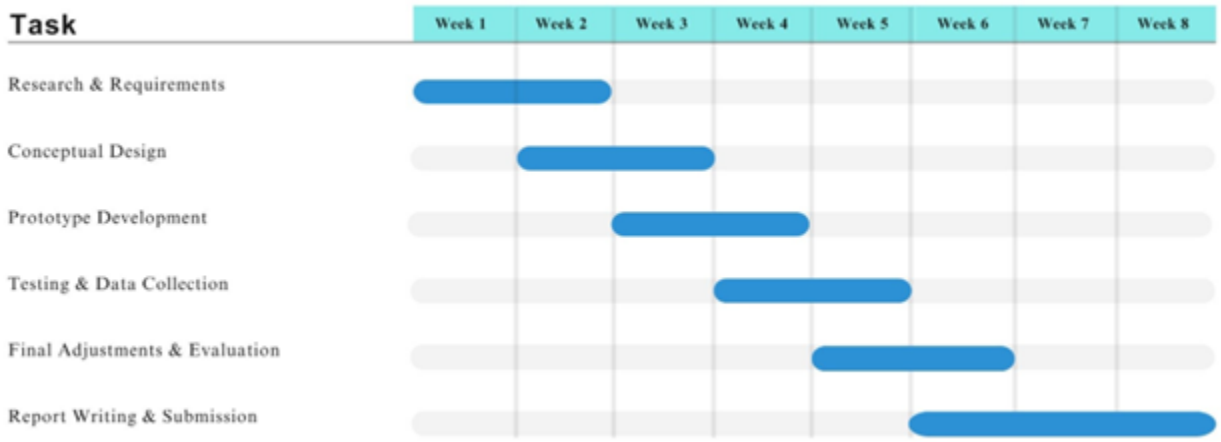


Fig. 13.1 Timeline for the proposed research project.

Detailing the Budget

The Budget section of an engineering proposal outlines the financial resources required to carry out the proposed project. It serves two main purposes: to show that your plan is financially feasible and to justify each expense clearly and reasonably. Even in undergraduate class projects — where funding may be hypothetical — crafting a thoughtful budget helps develop essential project planning and communication skills.

The budget must project professionalism, realism, and responsibility. Reviewers are more likely to approve a project if the budget is

- **Well-researched** (showing you've done your homework);
- **Transparent** (suggesting nothing is hidden or excessive); and
- **Aligned with project goals** (showing every item clearly contributes to success).

Avoid padding the budget, underestimating costs, or omitting essential items. These can all raise red flags about the viability of the project. A persuasive budget says to the reader, "We know what we're doing, we know what it will cost, and we're ready to make it happen."

Key Considerations When Writing the Budget Section

When writing the budget section of your proposal, keep the following considerations in mind to ensure clarity and accuracy:

- **Be specific and itemize costs —** Break down costs into clear categories (e.g., materials, equipment, labor, software, testing). Avoid vague lump sums.
- **Use a table format —** Present your budget in a clean, organized table with columns for *item*, *quantity*, *unit cost*, *total cost*, and *justification* if space allows.
- **Include a total —** Sum all costs at the bottom, and round appropriately to reduce clutter.
- **Justify expenses —** If unclear, briefly note why expenses are necessary. This builds credibility and prevents the budget from seeming inflated or arbitrary.
- **Include contingency, if appropriate —** For real-world proposals, a small contingency (typically 5–10%) may be included to account for unforeseen expenses. For student projects, this can be mentioned as a best practice.

Finding Realistic Budget Figures

Use the following sources to ensure your cost estimates are accurate and believable:

- **Manufacturer websites and catalogs —** Find component pricing from websites of companies like DigiKey, McMaster-Carr, Home Depot, or Adafruit.
- **Online marketplaces —** Find approximate costs for basic tools or kits on Amazon, eBay, and Alibaba.
- **University resources —** If the project proposes the use of lab space or university equipment, check internal documentation or ask instructors for estimated usage costs.
- **Past projects —** Review sample budgets from previous student work or ask your instructor for examples.
- **Vendor quotes (optional) —** For ambitious projects, request quotes from suppliers or distributors.

Example Budget Table with Labor Costs

Project Title: Solar-Powered Water Purification System
Team: Undergraduate Engineering Capstone Group
Estimated Hourly Rate for Labor: $20.00/hour

Table 13.2 Proposed Budget for Solar-Powered Water Purification System

Item / Task	Quantity / Hours	Unit Cost	Total Cost (CAD)	Justification
Materials & Equipment				
Solar panel (50W)	1	$80.00	$80.00	Powers the purification system.
Water pump (DC, submersible)	1	$45.00	$45.00	Pumps water through the filtration unit.
Filtration cartridges (5-stage)	2	$25.00	$50.00	Multi-stage filtration for safe water.
Microcontroller (e.g., Arduino)	1	$35.00	$35.00	Controls system operation.
Battery storage (12V, 10Ah)	1	$60.00	$60.00	Stores solar power.
Enclosure materials (plastic)	1 set	$30.00	$30.00	Weather-resistant housing.
Misc. electronics (wiring, etc.)	1 set	$25.00	$25.00	Circuitry, connectors, switches, etc.
3D printing (casing)	5 hrs	$10.00/hr	$50.00	Fabrication of external housing.
Water testing kit (basic)	1	$40.00	$40.00	Measures water quality before and after purification.
Labor / Work Time				
Research and requirement analysis	10 hrs	$20.00/hr	$200.00	Background work, constraints, and benchmarking.
Design and system planning	15 hrs	$20.00/hr	$300.00	Schematic design, component selection.
Prototyping and assembly	20 hrs	$20.00/hr	$400.00	System build and hardware integration.
Software programming/testing	10 hrs	$20.00/hr	$200.00	Microcontroller coding and debugging.
Testing and evaluation	12 hrs	$20.00/hr	$240.00	Water testing, performance assessment.
Report writing and documentation	10 hrs	$20.00/hr	$200.00	Final report, presentation, and supporting documents.
Contingency (5%)	–	–	$89.75	Safety buffer for small unexpected costs.
Total Estimated Cost	–	–	**$2,069.75**	

Writing the Qualifications Section

This section highlights the strengths of the team and demonstrates that the people involved have the skills, knowledge, and experience necessary to successfully complete the proposed project.

The most important goal in this section is to show a strong alignment between each person's qualifications and the tasks they are responsible for. For example, in a proposal that is part of coursework, if one team member is leading the system design, the paragraph should emphasize relevant coursework (like circuits or fluid mechanics), past projects, or technical skills (such as CAD or Arduino programming). If another member is handling testing and data collection, their paragraph might highlight strengths in experimentation, data analysis, or lab experience. The following example illustrates how a qualification paragraph can effectively emphasize relevant expertise and contributions.

Daniel Kim — Water Systems Engineering Lead

Daniel Kim is an environmental engineer with over eight years of experience in sustainable water treatment and resource management. He specializes in designing portable purification systems that combine renewable energy with low-cost filtration technologies. His work focuses on bringing reliable access to clean drinking water in disaster zones, rural communities, and regions lacking traditional infrastructure.

For the CleanWater initiative, Daniel led the design of a solar-powered purification system capable of producing up to 500 liters of potable water per day. He integrated advanced filtration units with off-grid solar technology, ensuring the system remains effective in diverse field conditions without relying on fuel or grid power. Under his technical leadership, the prototype achieved a 40% reduction in operating costs compared to conventional portable units, while maintaining WHO standards for drinking water quality. In this project, Daniel will oversee system design, ensure compliance with water quality standards, and guide the integration of sustainable technologies to optimize performance.

Each team member can write a short paragraph about themselves, focusing on the specific contributions they'll make and how their background supports that work. This isn't a full résumé. It's a targeted summary that reinforces credibility and shows the team is well prepared. Writing this section well shows not only that you have the right expertise, but also that you've thoughtfully organized the work based on your team's collective strengths.

Conclusion Section

The Conclusion of a proposal is your final opportunity to persuade the reader and reinforce the value of your project. While it may be brief, it plays a crucial role in summarizing the key points and leaving a strong, confident impression. A well-crafted conclusion should **restate the problem**, **highlight the proposed solution**, and **emphasize the benefits or impact** of the project — especially how it meets the criteria for success and aligns with the reader's goals or values. From a persuasive standpoint, the tone should be clear, positive, and forward-looking. Avoid introducing new technical details; instead, focus on affirming that your team is ready, capable, and committed to delivering results. A strong conclusion may also include a **call to action** — normally a request for approval, support, or funding — so that the reader knows exactly what you're asking for. In short, the conclusion should wrap up the proposal with clarity, confidence, and purpose. The following example demonstrates how an effective conclusion can reinforce the proposal's key points and leave the reader with a clear final message.

Conclusion

Access to clean drinking water remains a critical challenge in remote and disaster-affected regions, where traditional infrastructure is unreliable or nonexistent. Our proposed solution — a portable, solar-powered water purification system — offers a sustainable, low-cost, and easy-to-deploy response to this urgent need. Designed to operate independently of fuel or grid power, the system is capable of purifying up to 500 liters of water per day using only sunlight and replaceable filtration units. Our design is grounded in engineering principles, shaped by real-world constraints, and supported by a well-organized plan of action. With the necessary funding and support, our team is fully prepared to build, test, and evaluate the system within a structured eight-week timeline. We respectfully request your approval to move forward with this project, which has the potential to make a meaningful impact on public health and sustainability in underserved communities.

This is a strong conclusion because it restates the main problem — access to clean drinking water — and connects it directly to the proposed solution. It highlights why the system is practical and sustainable, while also showing that the design is grounded in engineering principles and realistic constraints. The paragraph builds confidence in the team by outlining a clear timeline and plan of action. It ends with a respectful call for approval. Together, these elements make the conclusion persuasive and memorable.

Key Takeaways



As an engineer, you and your team will design many products and develop a wide range of solutions. However, for these ideas to have an impact, you need to convince others — clients, stakeholders, or the public — that what you are proposing is both feasible and effective. Simply claiming that your solution is "the best" is not enough. In this process, ethical practice is essential. Your proposal should be grounded in research, honesty, transparency, and respect for the people you aim to serve. At the same time, clear organization helps your audience focus on your ideas rather than struggling to understand the structure of your document. A well-structured proposal typically includes the following sections:

- Executive Summary — A concise overview of the proposal's key points and recommendations.
- Introduction — Defines the problem or need and establishes context.
- Background/Problem Statement — Provides detailed context and justifies the need for action.
- Objectives — States what the proposal aims to achieve.
- Proposed Solution — Describes the design, method, or approach to solving the problem.
- Plan of Action — Explains how the solution will be implemented, step by step.
- Timeline — Lays out a schedule for project tasks and milestones.
- Budget — Breaks down costs and justifies the resources required.
- Qualifications — Demonstrates the credibility and capabilities of the project team.
- Conclusion — Reinforces the proposal's value and calls for action.

By grounding your proposal in research, practicing ethical communication, and structuring your document clearly, you increase the likelihood that your engineering solution will be understood, trusted, and ultimately adopted.

Practice Task



In Chapter 12, you researched a real problem that exists in society and prepared a *Review of Library Sources* to understand the issue in depth. Now, it's time to take the next step: proposing a solution.

Your engineering design team has been asked to prepare an Innovation Proposal. Unlike a *solicited* proposal, this one is *unsolicited*—meaning that no company or funding agency has directly asked for it. This makes your task more challenging: you must not only describe the problem clearly but also persuade your reader that the problem is worth solving and that your proposed solution is well thought out. Introduction (introducing your team and the purpose of the proposal)

You may choose to propose a new product or system. You could also propose a solution to make an existing technology greener, safer, faster, cheaper, smarter, more user-friendly, or more efficient. To do this, you will argue for and defend

- a refinement or improvement;
- a new combination of technologies; or
- the adaptation of an existing technology to a new context or environment.

In all cases, you are expected to carefully research the problem and survey the "state of the art" to propose a convincing solution. Note, too, that the innovation process rarely jumps from proposed solution to full implementation. Therefore, you will likely be proposing one of the following intermediary steps:

- a research project to more fully understand constraints and requirements;
- construction of a prototype with accompanying evaluation report;
- a design report to more fully develop the concept;
- a feasibility study; or
- any other deliverable that makes sense given the context and scope of the proposal.

So, your goal will be to convince the proposal receiver to move to one of these subsequent steps — tasks that you and your team can presumably complete.

Important: The proposal is NOT an advertisement. It must clearly demonstrate that your team understands the problem and can successfully complete the tasks you are proposing. Problems should be sufficiently complex to justify a formal proposal.

The document should be structured as follows:

Front matter

- Letter of transmittal
- Cover page
- Table of contents
- List of figures
- Executive summary

Body

- Introduction (introducing your team and the purpose of the proposal)
- Background (statement of need / requirements and constraints on the solution based on research)

- Solution: including
- A description and figure representing components of the proposed innovation
- A plan of action with schedule of work (in the form of a Gantt Chart)
- Itemized budget
- Qualifications of team members
- Conclusion

End matter

- Information sources

Formatting for the written proposal

Please

- follow the style guide in Appendix B; and
- number the pages. (Note: Start with Roman numerals [e.g., “i, ii, iii”] for the front matter and then switch to Arabic numerals [e.g., “1, 2, 3”] for the body of the proposal.)

Chapter 14: Presentations

Chapter ContentsThe Art of Effective Presentation Planning and Organizing Your Presentation Creating Effective Slides Delivering with Confidence Final Thoughts Key Takeaway Practice Task

The Art of Effective Presentation

Imagine this: You've developed a breakthrough innovation—an energy-saving solution that could reshape an entire industry. But when you stand up to present it, your message falls flat. The audience squints at your crowded slides. Your voice wavers. The passion you feel doesn't shine through. A great idea is only as powerful as your ability to communicate it. Your ability to convey a vision clearly, confidently, and persuasively can make the difference between an innovation that gathers dust and one that sparks change. This chapter guides you through key strategies to help you present with confidence and impact.

Strong presentations support:

- **Collaboration:** helping teams align around shared goals
- **Decision-making:** enabling stakeholders to act on clear information
- **Innovation:** convincing others to back new ideas

A great presentation isn't just about delivering facts—it's about framing those facts in a way that resonates.

Planning and Organizing Your Presentation

Effective presentations start with a blueprint—just like any solid engineering design.

Define Your Purpose

Ask yourself: *What am I trying to achieve?* Are you reporting findings, persuading decision-makers, teaching a process, or pitching an idea?

Know Your Audience

Consider their technical background, expectations, and what they care about. Presenting to engineers? Dive into data. Presenting to executives? Focus on implications for the company and the bottom line.

Example: If you're presenting a water filtration system to a non-technical municipal council, you would likely skip the equations and instead explain how households could benefit and how much money the system could save over time.

Structure with Purpose

Your presentation needs a clear beginning, middle, and end:

- **Introduction** – Outline your topic and explain why it matters.
- **Main Body** – Present your key arguments, evidence, and results.
- **Conclusion** – Recap your main points and highlight their significance.

In other words, presentations are much like essays: both have an introduction, body, and conclusion.

The **introduction** sets the stage and grabs attention. So, establish context, state your purpose, and capture attention early. In engineering contexts, this means briefly identifying the problem or design challenge, explain-

ing its relevance or impact, and outlining what the audience will learn. Table 14.1 provides sample phrases that you can use to frame the introduction to your presentation.

Table 14.1 Elements of the Introduction with Example Phrases and Tips

Purpose	Example Phrase	Tip
Opening remarks and greetings	"Good afternoon, everyone, and thank you for joining me today."	Start with a warm, confident tone—it sets the atmosphere for the whole talk.
Introducing yourself	"Let me briefly introduce myself—I am … and my focus is on …"	Keep it short; the goal is to establish credibility without losing attention.
Stating the focus of your talk	"As the title suggests, I'll be speaking about …"	State the topic clearly so your audience knows exactly what to expect.
Explaining the importance of your subject	"The topic is timely and relevant because …"	Link the subject to your audience's interests or needs to grab attention.
Clarifying your aim or goals	"The purpose of this talk is to highlight …"	Use action verbs (explain, highlight, demonstrate) to make your objectives clear.
Outlining the structure of the talk	"I've organized my presentation into three main sections."	Give your audience a roadmap—it helps them follow along more easily.
Showing the order of points	"First, I'll start with …, then I'll move on to …, and finally, I'll discuss …"	Signal transitions between points to keep your talk smooth and structured.
Mentioning the duration	"The presentation will take about 15–20 minutes."	Manage expectations and show respect for the audience's time.
Providing supporting material	"I'll share a copy of the slides at the end of the presentation."	Don't overload listeners—handouts work best as a support, not a substitute.
Inviting questions	"Please feel free to ask questions during the talk if anything is unclear."	Decide beforehand whether you'll take questions during or after the presentation—then make it clear to your audience.

In the **body** of the presentation, organize your main points into clear, sequential subsections. Start each by establishing the issue or topic, and then provide data, evidence, or results. Use transitions and signposts ("Next, we'll examine…") to guide listeners through the logic of your argument or design process. Table 14.2 presents example phrases that you can use to frame the body of the presentation.

Table 14.2 Elements of the Presentation Body with Example Phrases and Practical Tips

Purpose	Example Phrase	Tip
Introducing the main idea	“Firstly, I’d like to focus on …”	Present your topic sentence clearly, presenting the main idea.
Expanding with details and evidence	“To illustrate this point, let me share some findings from …”	Support each idea with facts, data, or examples rather than general statements.
Concluding the main idea	“This brings me to the end of my point on …”	Signal clearly when one main idea is complete before moving forward.
Bridging to the following main idea	“Now, let’s move on to …”	Use smooth transitions to keep your presentation logical and easy to follow.

Repeat this pattern for each of your main ideas until you have presented them all.

In the **conclusion**, just like in an essay, signal that you’re wrapping up, and then summarize and synthesize what you have already discussed. Highlight key findings, implications, or next steps, and end with a memorable takeaway—such as the broader engineering relevance or a call to action for future work. It is your last opportunity to tie everything together and leave a lasting impression. Table 14.3 presents example phrases for concluding the presentation.

Table 14.3 Elements of a Conclusion with Example Phrases and Tips

Purpose	Example Phrase	Tip
Signaling the end of your talk	“This brings us to the end of my presentation.”	Signal clearly that you’re closing so that your audience stay focused for your final remarks.
Recapping the main ideas	“So, to quickly go over the main points: first we looked at …, then we discussed …, and finally …”	Keep your summary short and focus on the key ideas.
Offering suggestions or recommendations	“Based on these results, I recommend that we consider …”	Use recommendations only if they are relevant and actionable for your audience.
Thanking the audience	“Thank you very much for your time and attention today.”	End politely; showing appreciation leaves a positive impression.
Opening the floor for questions	“If anyone has questions, I’d be happy to answer them now.”	Invite questions clearly and confidently to encourage interaction.

Creating Effective Slides

Poorly designed slides distract from your message and weaken your presentation.

Keep it Simple

When designing slides, simplicity is key—clear visuals and minimal text make it easier for your audience to focus. Consider the following strategies:

- Convey one key idea per slide.
- Use a plain white or simple background.
- Limit text. Slides that are overloaded with text are ineffective, so stick to keywords only.
- Remove unnecessary visual elements—extra text, colors, logos, or decorations that don't directly support your message.
- Avoid crowding a slide with both images and text—too much content can easily overwhelm your audience.
- In graphs, remove unnecessary grid lines and other redundant visual elements.
- Avoid full sentences unless quoting a standard or regulation.

Lead with the Message

Effective slides lead with the message—starting each one with a clear, meaningful title helps guide your audience. Consider the following strategies:

- Start each slide with a clear, full-sentence message as the title. For example, don't use the title "Test Results" or "Conclusion." Instead, provide a message such as "The redesigned turbine blade reduced drag by 18% in wind tunnel tests" or "Finite element analysis shows maximum stress occurs at the bolt junction" as the title.
- Adjust templates if needed to allow space for a longer, meaningful title (up to 12 words).
- Design slides to support messages visually—with graphs, images, or diagrams.
- Don't choose visuals first and then try to explain them. Decide what you want to say, then choose or design visuals to reinforce that point.

Delivering with Confidence

This is your moment to connect. Let your words bring life to your ideas.

Speak, Don't Read

Use your slides as cues only. That way, you can make eye contact with the audience and engage the room.

Use Your Body to Reinforce Your Message

Body language matters. Consider these tips to reinforce your message:

- Stand with purpose—shoulders open, feet grounded.
- Use gestures naturally to emphasize key points.

- Avoid pacing or fidgeting.

Modulate Your Voice

Your voice affects how your audience receives your message. Consider these tips to reinforce your message:

- Vary pitch and tone for interest and to emphasize key ideas.
- Pause for impact after important points.
- Avoid filler words (“um,” “like”).

Engage Your Audience

How you engage your audience affects how they receive your message. Consider these strategies to keep them involved:

- Ask rhetorical questions to provoke thought.
- Invite questions at the end or throughout, depending on context.

Rehearse, Rehearse, Rehearse

Practice aloud, ideally with a peer. Time yourself. Record yourself.

Final Thoughts

Presenting is an essential skill—and like any engineering skill, it improves with practice. When you deliver a clear, confident presentation, you don’t just inform—you inspire. Whether you’re explaining a simple circuit or a technology that could change the world, remember: your idea is only as powerful as your ability to share it.

Key Takeaways



Effective presentations do more than sharing information—they foster collaboration, support decision-making, and drive innovation. To deliver with impact, keep the following principles in mind:

- **Define your purpose**—be clear on why you are presenting.
- **Know your audience**—understand what they need and expect.
- **Structure with purpose**—organize your talk into an introduction, main body, and conclusion.
- **Keep slides simple**—avoid clutter and design with clarity.
- **Lead with the message**—start each slide with a clear, meaningful title.
- **Speak, don't read**—use slides as prompts, not scripts.
- **Use your body to reinforce your message**—stand confidently and gesture naturally.
- **Modulate your voice**—vary pitch, tone, and pace to hold attention.
- **Engage your audience**—ask questions and invite participation.
- **Rehearse, rehearse, rehearse**—practice until you can deliver with ease and confidence.

Remember, the key to a strong presentation is preparation, clarity, simplicity, and confident delivery.

Practice Task



Presenting Your Innovation Proposal

Now it is time to share your work. Your team will prepare a 12-15-minute oral presentation that presents the key content of an innovation proposal. Before beginning the presentation, ask the audience to imagine they are the recipients of the written proposal. These are the decision makers with the authority to accept or reject your proposal. Assume an educated audience that may not be familiar with the more technical details of your group's innovation. That means you will have to adapt the content so that the audience clearly understands what you are proposing.

Use visuals to support key ideas and refer to them directly during the presentation.

Structure

While structuring your presentation, consider the following points:

- Begin with a brief introduction in which you introduce the team and the innovation you are proposing. Think of a way to hook the audience.
- Lay out the background to the problem. Where and under what circumstances does the problem exist? Provide data or factual evidence. Establish requirements for a solution that would effectively address the problem.
- Lay out what you plan to do. You will probably start with a description of the form of your innovation (mechanism or system). Then discuss your plan of action, proceeding in a logical and intuitive sequence. Give as much information as necessary—no less, no more.
- Conclude by summarizing and restating the key "take-away" message—the most important or convincing ideas that you want the audience to remember.

Length

When planning the length of your presentation, consider the following points:

- Aim for a presentation that lasts **12–15 minutes**.
- Each team member should contribute. (Around **3 minutes per person** is a good guide.)

Appendix A: Digital Tools for Writing and Research

Readability and Editing Tools

The WebFX Readability Test	**Readability Test**
Microsoft Word's built-in readability statistics	**Instructions to Use**
Hemingway Editor	**Hemingway Editor**
The Writer's Diet	**The Writer's Diet**

Reference Management Tools

ZoteroBib	**ZoteroBib**
Zotero Reference Manager	**Zotero Reference Manager**
IEEE Reference Style Guide for Authors	**IEEE Reference Style Guide for Authors**

Appendix B: Technical Writing Style Guide

This style guide provides formatting and style standards for all assignments submitted in *ENCS 282 Technical Writing and Communication* at Concordia University.

General Format

This section provides essential formatting guidelines to ensure your documents are both professional and consistent. It includes details on layout, font, text formatting, sentence length, headings, and lists.

Font Family	• Use '**Arial Bold'** for titles and headings. • Use 'Times New Roman' for the body text.
Font Size and Type-style	• Title: Arial 16 black bold • Heading 1: Arial 14 black bold • Heading 2: Arial 12 black bold • Heading 3: Arial 12 dark gray bold • Body text: Times New Roman 12 • Captions: Arial 10 black
Text	• Left align all body text. • Maintain consistent spacing between content elements, including titles, headings, paragraphs, tables, figures, and lists.
Sentence Length	• Aim for a maximum of two messages in a sentence. • Avoid lengthy sentences.
Headings	• Ensure headings are grammatically parallel. • Write descriptive headings. • Don't use colons after headings. • Don't underline headings or titles.
Lists	• Ensure all list elements are grammatically parallel. • Use consistent punctuation. • Use bullets for non-sequential lists, such as equipment and tools. • Use numbered lists for sequences, such as steps to complete a task.

Language and Style

This section provides essential guidelines on language and style to ensure clear communication of ideas. It includes details on the use of acronyms and abbreviations, strategies for clarity and conciseness, the use of contractions, selection of gender-neutral terms, and the appropriate tone, voice, and word choice.

Acronyms and Abbreviations	• Spell out abbreviations and acronyms in full upon first use, followed by the abbreviations and acronyms in parentheses. • Use the abbreviation/acronym only on second and subsequent use.
Clarity	• Avoid vague pronouns and imprecise terms. • Avoid broad statements.
Conciseness	• Eliminate wordy phrases. • Remove filler words.
Contractions	• Avoid contractions for a formal tone.
Gender-Neutral Terms	• Use neutral pronouns (use *they* instead of *s/he*).
Tone	• Maintain a professional tone.
Voice	• Privilege active voice for clarity and conciseness. • Use passive voice when only when required by format or flow.
Word Choice	• Privilege shorter, well-known terms.

Numerical Information

This section provides essential tips on presenting numerical information in your documents.

Numbers

- For quantity, spell out single-digit numbers (0-9) and use numerals for numbers 10 and greater.
- Always express measurements as numerals.
- Don’t start sentences with numerals.

Visuals

This section provides guidelines on using visuals in your documents. It includes details on the placement of tables and figures, the use of captions, and how to reference visuals in the text.

Placement

- Avoid placing tables and figures immediately after headings. Instead, introduce them with text.
- Include tables or figures as near as possible to first mention in the document.
- Do not split figures or tables across pages.
- Maintain consistent size and style for multiple figures or tables.

Captions

- Use Arial for captions.
- Write descriptive captions for all tables and figures.
- Place table titles and captions above tables.
- Place figure captions below figures.
- Number tables and figures sequentially in the document.
- Tables or figures that are not central to the discussion can be placed in an appendix at the end of the article with a note directing the reader to them (e.g., “See Appendix A”).

Text references

- Always refer to tables/figures in the text before they appear.

References

This section offers guidelines for managing references in your documents. It includes details on in-text citations, the reference list, and citation styles.

In-text citations	• Cite all sources within the text using square brackets [1] inline with text, and inside punctuation. Use one number per ences.)
Reference list	• Use **Zotero** or **ZoteroBib** to generate the reference list.
Citation style	• Set Zotero to IEEE citation style.

Versioning History

This page provides a record of edits and changes made to this book since its initial publication. If the change is minor, the version number increases by 0.1. If the edits involve substantial updates, the version number increases to the next full number. Due to the nature of the open textbook being continuously updated, the addition or removal of a resource is not recorded on this page.

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