

Technical Writing U1

Made by Pranav G K

1. Introduction to Technical Communication

What is Technical Communication?

- Technical communication is the process of discovering, shaping, and transmitting information to help people interact with technology and solve complex problems.
- It needs to be technically accurate, focused on the audience group and easy to understand.
- It's not just about the final document—like a report, email, or user manual—but also about the entire process, which begins with listening, speaking, and reading.
- four basic communication skills used in technical communication
 - listening, speaking, reading, writing.
 - to analyze a problem, find and evaluate evidence and draw conclusions

Technical vs. Academic Writing

The biggest difference between technical communication and other forms of writing, like academic essays, lies in its focus on

audience and purpose.

- **Academic Writing:** The audience is typically an instructor, and the purpose is to demonstrate mastery of a subject. The goal is usually not to create new knowledge or motivate a specific action beyond getting a good grade.
- **Technical Writing:** The audience can include peers, supervisors, and people outside your company. The purpose is often to change attitudes, motivate actions, or help others perform work-related tasks.

Typical Kinds of Technical Documents

Technical communication takes many forms, including:

- **Instructions:** For assembling a product like a lawn mower.
 - **User Manuals:** For operating equipment, such as medical devices.
 - **Reports:** Analyzing a problem or issue.
 - **Memos:** Answering questions about a project's progress.
 - **Procedures:** For complying with regulations.
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2. Key Characteristics of Effective Technical Communication

Questions we ask ourselves to make our research and information meaningful:

1. Which info is relevant to this situation?
2. Can i verify the accuracy of this source?
3. What does this info mean?
4. What action does it suggest?
5. How does this info affect me or my colleagues?
6. With whom should i share it?
7. How might others interpret this info?

Employers seek skills like -

- write and speak efficiently
- research accurate info and shape it according to need
- work with a team of diverse backgrounds
- listen well and motivate others
- flexible to adapt to rapid changes in business conditions and technology
- market oneself and their ideas
- always ready to learn and improve



Use a Programmable Thermostat Properly

A programmable thermostat is ideal for people who are away from home during set periods of time throughout the week. Through proper use of pre-programmed settings, a programmable thermostat can save you about \$180 every year in energy costs.

- Overview information summarizes the document's main point

How Do You Choose the Right One for You?

To decide which model is best for you, think about your schedule and how often you are away from home for regular periods of time—work, school, other activities—and then decide which of the three different models best fits your schedule:

- Heading is phrased as the main question readers will ask

7-day models are best if your daily schedule tends to change; for example, if children are at home earlier on some days. These models give you the most flexibility and let you set different programs for different days—usually with four possible temperature periods per day.

- Paragraphs and sentences are short

5+2-day models use the same schedule every weekday, and another for weekends.

- Color is used to highlight key items

5-1-1 models are best if you tend to keep one schedule Monday through Friday and another schedule on Saturdays and Sundays.

Programmable Thermostat Settings

You can use the table below as a starting point for setting energy-saving temperatures, and then adjust the settings to fit your family's schedule and stay comfortable.

Setting	Time	Setpoint Temperature (Heat)	Setpoint Temperature (Cool)
Wake	6:00 a.m.	< 70° F	> 78° F
Day	8:00 a.m.	Setback at least 8° F	Setup at least 7° F
Evening	6:00 p.m.	< 70° F	> 78° F
Sleep	10:00 p.m.	Setback at least 8° F	Setup at least 4° F

- Table provides easy-to-read comparative data

Features of technical communication:

- Reader-centered - Very less focus on writer's personal thoughts and feelings.
- Accessible and efficient - clear cut instructions and answers all possible questions. Should be worthwhile, sensible, readable, effective visuals, effective page design, supplements like abstract, appendix, glossary, linked pages etc.
- Often produced by teams - People from different domains work on this to provide a wide aspect of understanding.
- Paper and digital versions - all kinds of soft and hard copies depending on requirement.

What is Technical Writing?

- **Definition:** Technical writing is the process of documenting, explaining, and communicating complex technical information clearly, concisely, and accurately to a specific audience.
- **Key Characteristics:**
 - **Clarity:** The information must be easy to understand.
 - **Accuracy:** The information must be factually correct.
 - **Conciseness:** Avoids unnecessary words and jargon.
 - **Audience-Oriented:** Tailored to the knowledge level and needs of the reader.
 - **Purposeful:** Serves a specific goal (e.g., to instruct, to inform, to persuade).

Every report, lab entry and email helps in improving technical writing. Pay attention to how others write and learn do's and donts. Take input and feedback from more experienced people and learn from mistakes. Tech writing is a tool towards effective engineering.

There are four pillars of effective technical communication:

Clarity, Conciseness, Accuracy, and Audience Focus.

I. Clarity

Clarity is the quality of being easy to understand, ensuring the message is unmistakable.

- **How to Achieve It:**

- Use simple, direct language and define jargon if you must use it.
- Structure information logically with headings, subheadings, and lists.
- Use strong, active verbs (e.g., "The technician repaired the motor" instead of "The motor was repaired by the technician").
- Explain complex ideas with examples or analogies.

Example (Bad): "The project's synergistic functionalities necessitate a paradigm shift in our operational methodologies."

Example (Good): "To complete this project, we need to change our workflow and collaborate more effectively."

II. Conciseness

Conciseness means saying what needs to be said in the fewest words possible without sacrificing clarity.

- **How to Achieve It:**

- Eliminate wordy phrases (e.g., change "due to the fact that" to "because").
- Remove redundant information.
- Get straight to the point, starting with the most important information first.
- **Example:** "If the power fails, save your work and turn off your computer immediately" is more concise than "In the event that the power supply happens to fail, it is a requirement that all users should save their work immediately and turn off their computers".

III. Accuracy

Accuracy is the quality of being correct and free from errors. In engineering, mistakes can lead to structural failure, equipment damage, or injury.

- **How to Ensure It:**

- Verify all data, facts, and figures.
- Cite your sources to give credit to original data.
- Proofread meticulously for typos and factual mistakes.
- Have a peer or supervisor review your work.

IV. Audience Focus

This involves tailoring your communication to the knowledge level, needs, and expectations of your reader. Before writing, ask yourself:

- Who is my audience?
- What do they already know?
- What do they need to know to accomplish their goal?
- What is their purpose for reading this?

Adapt your writing depending on audience:

- level of detail
- terminology
- format

Case Study: A Project Report

- Let's apply these four pillars to a typical task: writing a project report.
- **Clarity:** Use a clear structure with sections like "Introduction", "Methodology", "Results" and "Conclusion." Use charts and diagrams to explain data.
- **Conciseness:** Get to the point in the executive summary. Avoid long, rambling paragraphs. Use bullet points for key findings.
- **Accuracy:** Double-check all measurements, calculations, and data points. Cite any external research or standards (e.g., ISO, ASTM).
- **Audience Focus:**
 - **For your professor:** Include detailed methodology and theoretical basis.
 - **For an industry partner:** Focus on the practical applications, cost-effectiveness, and commercial viability.

Summary

- **Clarity:** Make it easy to understand.
 - **Conciseness:** Be brief but comprehensive.
 - **Accuracy:** Ensure every detail is correct.
 - **Audience Focus:** Write for your reader, not for yourself.
 - **The takeaway:** Mastering these four characteristics will make you a more effective engineer, a more respected professional, and a better communicator.
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3. The Importance of Technical Writing in Engineering

Technical writing is a **foundational professional skill** for engineers, not a "soft skill". An engineer's career is dedicated as much to communication as it is to designing and building.

Consequences of Poor Communication

Failure to communicate effectively can lead to:

- Misunderstanding of project requirements.
- Delays in project timelines.
- Loss of funding or support.
- Safety risks from unclear instructions.

The Roles of Technical Writing for Engineers

1. **Documenting the Design & Process:** This includes engineering notebooks, design specifications, and test reports to protect intellectual property and ensure benchmarks are met.

2. **Communicating within the Team:** This involves internal memos, project proposals, and presentations to convey information and secure funding.
3. **Communicating with External Stakeholders:** This includes user manuals for end-users, reports for clients, and academic papers for the scientific community.

Career Impact

Strong writing skills are directly linked to **credibility, professionalism, and career advancement**, as senior roles require more communication. Clear communication is also an **ethical responsibility**, as it can prevent accidents and ensure safety.

4. The Technical Communication Process

- **A Blueprint for Your Words**
- **The Challenge:** You've completed a complex engineering project. Now, how do you translate that work into a clear, effective report, manual, or proposal?
- **The Analogy:** Just as you follow a structured process to design and build a circuit or a bridge, you must follow a process to build a successful document.
- **The Goal:** To move beyond just "writing" and adopt a systematic, repeatable process that ensures your communication is accurate, efficient and impactful.
- **Today, we will break down this process into four essential phases:**
 - **Planning:** The foundation of your document.
 - **Drafting:** Getting the ideas on paper.
 - **Revising:** Restructuring and refining the content.
 - **Editing:** Polishing for clarity and correctness.

Phase 1: Planning (The Blueprint)

This foundational phase saves significant time later.

- **Key Activities:**
 - **Analyze Audience and Purpose:** Determine who you're writing for and what you want them to do.
 - **Define Scope and Format:** Decide what information to include and the required format (e.g., report, manual).
 - **Brainstorm and Outline:** Jot down key points and create a detailed outline to ensure logical flow.
 - **Gather Resources:** Collect all necessary data, figures, and references.

Example: Slide no. 33 to 41

Phase 2: Drafting (The First Build)

The goal of this phase is to get your ideas from the outline onto the page without worrying about perfection.

- **Key Activities:**

- **Follow the Outline:** Write section by section, letting your outline guide you.
- **Turn Off Your Inner Editor:** Don't stop to fix grammar or spelling; focus on capturing the core message.
- **Focus on Data:** For engineering writing, present your methods and results clearly, even if the prose is rough. It's often helpful to start with the "Methodology" or "Results" section, where you have the most content to share.

Example: Slide no. 43 to 46

Phase 3: Revising (The Structural Overhaul)

Revision means "to see again". In this phase, you look at the big picture, not line-by-line editing.

- **Key Activities:**

- **Check for Clarity and Flow:** Is the main point easy to find? Do paragraphs transition smoothly?
- **Verify Audience Focus and Completeness:** Is the level of detail appropriate for the reader? Is anything missing?
- **Get a Fresh Perspective:** Step away from the document for a while, read it aloud, or ask a peer for feedback.

Example: Slide no. 49 to 50

Phase 4: Editing (The Final Polish)

This is the final, line-by-line check for errors and consistency.

- **Key Activities:**

- **Check Grammar, Punctuation, and Spelling.**
- **Refine Word Choice:** Replace wordy phrases with concise alternatives.
- **Verify Formatting:** Ensure headings, lists, and citations are consistent.
- **Confirm Numbers and Units:** Double-check that all numerical data and units (e.g., MPa, V, °C) are accurate.

Summary

- **Planning:** Define audience, purpose, scope, and create an outline.
- **Drafting:** Focus on getting ideas down without worrying about perfection.
- **Revising:** Check the big picture for clarity, flow, and audience focus.
- **Editing:** Fine-tune the details for grammar, spelling, and consistency.
- **The takeaway:** This systematic process transforms technical writing from a daunting task into a manageable series of steps. It allows you to produce high-quality, professional documents that reflect the quality of your engineering work.

5. Audience and Purpose Analysis

The core of effective writing is understanding who you're writing for and why:

- Who is the main audience for this document?
- Who else is likely to read it?
- What is your relationship with the audience?
- Are multiple types of relationships involved?
- What information does this audience need?
- How familiar might the audience be with technical details?
- Do these readers have varying levels of expertise?
- What culture or cultures does your audience represent?
- How might cultural differences shape readers' expectations and interpretations?
- Will the material be viewed on a computer? On a phone or tablet? On paper?

The Three Tiers of Audience

1. **Primary Audience:** The direct recipients who use the document to take action or make decisions. Your document should be tailored specifically to them.
2. **Secondary Audience:** People who review or advise on the document, such as a supervisor or legal team. They look for accuracy, detail, and compliance.

3. **Tertiary Audience:** A distant group that may access the document later for reference, such as future employees or auditors. They need a well-organized and easily searchable document.

Case Study - Slide no. 62 to 63

What Audience Need:

Crisp info, no more no less:

- Focus on "so what?"
- Action-oriented - user manual, proposal, report, self-correction
- Audience expertise based complexity of writing - expert, novice, mixed.
- Structure and Organization - logical flow, headings and subheadings, visuals
- Tone and Formality - formal, informal
- Completeness - Answers all questions and provide all data that audience is looking for.

The Three Primary Purposes

Most technical communication serves one or more of these purposes: (Often overlapping purposes)

1. **To Inform:** To anticipate and answer questions for your readers.
2. **To Instruct:** To enable people to perform a task or follow a procedure
3. **To Persuade:** To influence people's thinking and encourage them to take a desired action

6. Adapting Tone and Style

Tone

Tone is the "persona" or personality that takes shape between the lines. It is determined by the distance you create between yourself and the reader and your attitude toward the subject.

- **Levels of Formality:**

- **Formal:** Used for superiors, clients, or academic reports. It is serious and impersonal (e.g., "Manager trainees... are responsible for duties...").
 - **Semiformal:** Used for colleagues and internal memos. It is professional yet approachable (e.g., "As a manager trainee... you will work for many managers").
 - **Informal:** Used for conversational or friendly communication with close colleagues. It is personal and direct but should always remain professional.
- **Guidelines for Tone:**
- Strive for a professional yet friendly tone depending on the audience tier. (senior, same tier colleague or junior). Obviously avoid substandard terms (ain't, bogus), profanity (sucks, pissed off) and colloquialisms(O.K, snooze) as these could easily offend.
 - Address readers directly with "you" and "your" when appropriate.
 - Using contractions like I'm and you're are usually not encouraged in technical writing, especially when the message required emphasis, but allowed in more informal tones.
 - Use "I" and "we" instead of awkward, impersonal phrasing to show your presence occasionally.
 - Prefer the active voice, which is more direct and economical.
 - Emphasize the positive to be encouraging rather than critical.
 - Avoid personal bias by presenting facts objectively and without judgmental words.
 - Avoid sexist language by using neutral terms (e.g., "chairperson" instead of "chairman")

Style

Style is the blend of how you construct sentences, your word choice, and your tone. An inefficient style makes readers work harder than they should and can even be unethical if it misleads or confuses them. A readable style requires correct grammar and punctuation but also clarity and conciseness to ensure your message is understood. Your style should be a blend of:

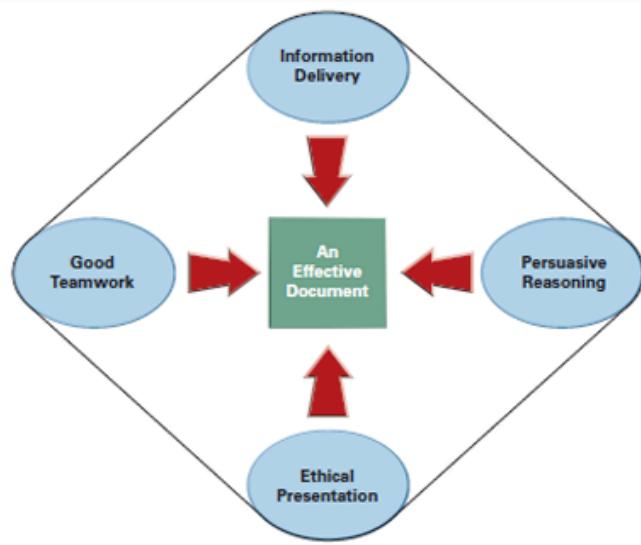
- the way in which you construct each sentence
- the length of your sentences
- the way in which you connect sentences
- the words and phrases you choose
- the tone you convey

Inefficient style involves more vocabulary and less focus on what is important, this makes it hard for the reader to understand what is happening:

- makes the writing impossible to interpret
- takes too long to make the point
- reads like a story from primary school
- uses imprecise or needlessly big words
- sounds stuffy and impersonal
- becomes unethical when the writer is trying to purposefully mislead the reader with lots of bloat.

Preparing Effective Technical Documents

- Producing an effective document typically requires that you complete the four basic tasks depicted in Figure.



- Deliver information readers can use—because different people in different situations have different information needs.
- Use persuasive reasoning—because people often disagree about what the information means and what action should be taken.
- Weigh the ethical issues—because unethical communication lacks credibility and could alienate readers.
- Practice good teamwork—because working in teams is how roughly 90 percent of U.S. workers spend some part of their day.

Technical Writing

- Made by Pranav S Bhat

Procedural Stages

1. Searching for information
2. Recording your findings
3. Documenting your sources
4. Writing the document

Critical Thinking Stages

1. Asking the right questions
2. Exploring a balance of views
3. Achieving adequate depth in your search
4. Evaluating your findings
5. Interpreting your findings

Balance of Views-> getting a full range of facts while accuracy means to get at facts

Adequate research-> Surface level by media , little more deep via blogs and full depth with specialized literature and publications on that paper.

Evaluate findings by :

1. Checking reliability
2. Do facts verify claim
3. Is it useful
4. is it the whole story
5. Is there a need for more information.
6. does it make you reconsider old facts
7. are there any conflicts

Primary vs Secondary Sources

Aspect	Primary Research	Secondary Research
Definition	Getting information directly from the source by conducting interviews, surveys,	Information obtained second-hand by reading what other

Aspect	Primary Research	Secondary Research
	or observing people/events/processes in action.	researchers have compiled in books, articles, or online.
Examples	- Interviews - Surveys - Direct observation	- Books - Journal articles - Newspapers - Online encyclopedias
Internet Sources	Rarely considered primary unless it's original content such as survey data or firsthand accounts.	Most internet information is secondary. Reliability varies: • A high school student's webpage may be less reliable. • A reputable site (encyclopedia, index, journal) is more reliable.
Usage in Research	Adds originality and credibility. Expands upon what others have learned.	Provides background understanding and context. Usually the starting point of research.
Best Practice	Don't neglect to add your own findings through primary research.	Start with secondary sources for background, then move to primary for deeper insights.
Applied Example	Surveying and interviewing people who use your company's new product.	Consulting sales reports and published print/online reviews of the product.

Other secondary sources

- General commercial and academic websites (.org or .edu)
- Government Web sites
- Blogs
- Wikis
- Facebook, Twitter, and Online groups
- Digital libraries
- Periodical database

Traditional sources

- Books and Periodicals
- Reference Works
- Bibliographies -> Bibliographies are lists of books and/or articles categorized by subject

- Indexes-> Periodical indexes citation indexes , technical and patent indexes
- Encyclopedias

Other Primary Sources

- Informational Interviews
- Unsolicited Inquiries
- Informational Interviews
- Surveys

Guidelines for research

- Expect limited results from any one search engine or subject directory
- select keywords or search phrases that are varied and technical rather than general
- check out the footnotes and other citations
- Identify the site's purpose and sponsor
- Assess the author's credentials and assertions.
- Download only what you need; use it ethically; obtain permission; and credit your sources

Evaluate Sources.

- How old is the study
- Assess the reputation of the source
- Consider the possible motives of those who have funded the study
- Cross-check the source against other, similar sources

Evaluate Evidence

- Determine the sufficiency of the evidence
- Differentiate hard from soft evidence.
- Decide whether the presentation of evidence is balanced and reasonable
- Consider how the facts are being framed -> A frame of reference is a set of ideas, beliefs, or views that influences our interpretation or acceptance of other ideas.

Assumptions are notions we take for granted, ideas we often accept without proof.

Avoid Distorted Or Unethical Reasoning

Three major reasoning errors that can distort our interpretations are faulty generalization, faulty causal reasoning, and faulty statistical analysis.

Faulty Generalization-> jump from a limited observation to a sweeping conclusion

Faulty Statistical Analysis: TYPES

The Sanitized Statistic

1. The mean is the result of adding up the values of items in a set of numbers, and then dividing that total by the number of items in the set.
2. The median is the result of ranking all the values from high to low, then identifying the middle value (or the 50th percentile, as in calculating SAT scores).
3. The mode is the value that occurs most often in a set of numbers.

The Distorted Percentage Figure

- Percentages are often reported without explanation of the original numbers used in the calculation
 - Another fallacy in reporting percentages occurs when the margin of error is ignored

The Bogus Ranking

- This distortion occurs when items are compared on the basis of ill-defined criteria

Confusion Of Correlation With Causation.

- Correlation is a numerical measure of the strength of the relationship between two variables (say smoking and increased lung cancer risk, or education and income).
- Causation is the demonstrable production of a specific effect (smoking causes lung cancer).

The Biased Meta-analysis

- In a meta-analysis, researchers examine a whole range of studies that have been done on one topic (say, high-fat diets and cancer risk)

The Fallible Computer Model

- Computer models process complex assumptions to predict or estimate costs, benefits, risks, and probable outcomes
 - Assumptions might be influenced by researcher bias or the sponsors' agenda.

Misleading Terminology

- The terms used to interpret statistics sometimes hide their real meaning.

Obstacles To Validity And Reliability

Validity and reliability determine the dependability of any research. Valid research produces correct findings.

A survey, for example, is valid when

1. it measures what you want it to measure,
2. it measures accurately and precisely, and
3. its findings can be generalized to the target population

Dunning Kruger effect is also an obstacle

Reliable research produces findings that can be replicated. Reliable survey questions can be interpreted identically by all respondents.

Deceptive Reporting

Taking Notes

Paraphrasing, quoting, and summarizing are essential to ensure accurate note-taking and to use sources responsibly without plagiarism.

Stuff to skim in a book

- The preface and introduction
- The acknowledgments section
- The table of contents
- The notes at the ends of chapters or at the end of the book
- The index
- A few paragraphs from different portions of the text

Stuff to skim in an article

- The abstract
- The introduction
- The notes and references
- The headings and several of the paragraphs

Information to record for a book

- author

- title
- publisher
- place of publication
- year of publication
- call number or URL

Information to record for an article

- author
- title of article
- title of periodical
- volume
- number
- date of publication
- pages on which article appears
- call number or URL of periodical

Paraphrasing

A paraphrase is a restatement, in your own words, of someone else's words

Quoting is not paraphrasing. If using exact source material , word for word, its called quoting and it needs to have " " enclosing that part of text.

Accurately paraphrasing steps:

- Study the original until you understand it thoroughly
- Rewrite the relevant portions of the original
- Title the information so that you'll be able to identify its subject at a glance
- Include the author's last name, a short title of the article or book, and the page number (if any) of the original

Quoting

To add an explanatory word or phrase to a quotation, use brackets:

- As Nelson states, “It [the oil glut] will disappear before we understand it.”

Summarizing

Summarizing is the process of rewriting a passage in your own words to make it shorter while still retaining its essential message

Most long technical documents contain several kinds of summaries:

- a letter of transmittal that provides an overview of the document

- an abstract, a brief technical summary
- an executive summary, a brief nontechnical summary directed to the manager
- a conclusion that draws together a complicated discussion

How to summarize

- Read the passage carefully several times
- Underline key ideas
- Combine key ideas
- Check your draft against the original for accuracy and emphasis
- Record the bibliographic information carefully

Why Documenting Sources is good:

- It helps you acknowledge your debt to your sources
- It helps you establish credibility
- It helps your readers find your source in case they want to read more about a particular subject

What should be documented

- Any quotation from a written source or an interview, even if it is only a few words
- Any graphic from a written or an electronic source

APA (American Psychological Association)

It is meant for textual citations

Has 2 elements

1. Summarized or Paraphrased Material

- For material or ideas that you have summarized or paraphrased, include the author's name and the publication date in parentheses immediately following the borrowed information
Example: This phenomenon was identified more than 50 years ago (Wilkinson, 1948)
- If your sentence already includes the source's name, do not repeat it in the parenthetical notation

2. Quoted Material or Specific Fact

- If the reference is to a specific fact, idea, or quotation, add the page number(s) from the source to your citation

3. Source with Multiple Authors

- For a source written by two authors, cite both names. Use an ampersand (&) in the parenthetical citation itself, but use the word and in regular text.

Example : (Tyshenko & Paterson, 2012) Tyshenko and Paterson (2012) argued . . .

4. For a source written by three, four, or five authors, include all the names the first time you cite the reference; after that, include only the last name of the first author followed by et al

First Text Citation

Cashman, Walls, and Thomas (2013) argued . . .

Subsequent Citations

Cashman et al. (2013) found . . .

5. For a source written by six or more authors, use only the first author's name followed by et al.

6. Source Authored by an Organization:

- If the author is an organization rather than a person, use the name of the organization.

Example: There is currently ongoing discussion of the scope and practice of nursing informatics (American Nurses Association, 2010).

7. Source with an Unknown Author:

- If the source does not identify an author, use a shortened version of the title in your parenthetical citation.

Example: Hawking made the discovery that under precise conditions, thermal radiation could exit black holes ("World Scientists," 2009).

8. Multiple Authors with the Same Last Name::

- Use first initials if two or more sources have authors with the same last name.

Example :B. Porter (2012) created a more stable platform for database transfers, while A.L. Porter (2012) focused primarily on latitudinal peer-to-peer outcome interference.

9. Multiple Sources in One Citation:

- When you refer to two or more sources in one citation, present the sources in alphabetical order, separated by a semicolon.

10. Personal Communication

- When you cite personal interviews, phone calls, letters, memos, and emails, include the words personal communication and the date of the communication

APA Reference List

A reference list provides the information your readers will need in order to find each source you have cited in the text. It should not include sources you read but did not use.

1. Arrange the entries alphabetically by author's last name. If two or more works are by the same author, arrange them by date, earliest to latest. If two or more works are by the same author in the same year, list them alphabetically by title and include a lowercase letter after the date
2. Italicize titles of books. Capitalize only the first word of the book's title, the first word of the subtitle, and any proper nouns.
3. For books, give the publisher's name in as brief a form as is intelligible; retain the words Books and Press
4. Italicize titles of periodicals and capitalize all major words.
5. Do not italicize titles of articles or place them in quotation marks. Capitalize only the first word of the article's title and subtitle and any proper nouns.
6. Include as much information as you can about electronic sources, such as author, date of publication, identifying numbers, and retrieval information. Include the digital object identifier (DOI) when one exists.
7. Use a hanging indent, with the first line of each entry flush with the left margin and all subsequent lines indented one-half inch: Example Sokolova, G. N. (2010). Economic stratification in Belarus and Russia: An experiment in comparative analysis. *Sociological Research*, 49(3), 25–26.
8. Double-space the entire reference list. Do not add extra space between entries.
9. Follow the format year, month, day, with a comma after only the year: (2011, October 31)

IEEE Style

- **IEEE Style Components:**
 - Consists of in-text citations and a reference list at the document's end.
 - In-text citations use bracketed numbers, corresponding to a numbered reference list.
- **In-Text Citations:**
 - Use bracketed numbers placed immediately after the author's name, before punctuation.
 - Example: A study by Goldfinkel [5] shows inefficiencies.
 - Use bracketed numbers as nouns when needed.
 - Example: [5] shows inefficiencies; however, [8]–[10] differ.
 - For three or more authors, use et al. after the first author's name.
 - Example: Murphy et al. [8]–[10] reached a different conclusion.
- **Reference List Arrangement:**
 - Arrange entries in the order they are cited in the text, numbered sequentially.
 - Place numbers in square brackets, flush left, in a separate column without indents for turnovers.
- **Author Formatting:**

- List author's first initial(s), followed by last name (e.g., J. K. Rowling).
 - For multiple authors, include all names; use et al. only if names are not given after the first author.
 - For editors or translators, add Ed., Eds., or Trans. after the name.
- **Book Titles:**
 - Italicize book titles.
 - Capitalize the first word and all major words in English titles; for foreign languages, follow their capitalization rules.
 - **Publication Information:**
 - For books, include city, country (if not USA), abbreviated publisher name, and year.
 - Use only the first city listed; include state/province abbreviation if the city is not well-known.
 - **Periodical Titles:**
 - Italicize and abbreviate periodical titles.
 - Capitalize all major words in the title.
 - **Article Titles:**
 - Place print article titles in quotation marks; do not use quotation marks for electronic article titles.
 - Capitalize only the first word of the title and subtitle, unless proper nouns.
 - **Electronic Sources:**
 - Use a different sequence: date follows author, year before month.
 - Do not use quotation marks for article titles; use periods to separate sections.
 - Include medium and access information (e.g., URL).
 - **Spacing and Formatting:**
 - Single-space the reference list with no extra space between entries.
 - Use p. or pp. for page numbers, written in full (e.g., 152–159).
 - For print sources, use format: month (abbreviated, except May, June, July), day, year (e.g., Apr. 3, 2010).
 - For electronic sources, use format: year, month (abbreviated), day (e.g., 2011, Oct. 14).

MLA Style Summary

- **MLA Style Components:**
 - Consists of in-text citations and a works cited list at the document's end.
 - In-text citations typically include the author's name and page number.
- **In-Text Citations:**
 - Include the author's last name and page number, varying by source type and context.

- Example: (Smith 23).

- **Works Cited List:**

- Lists only sources cited in the text, not those consulted for background.
- Arrange entries alphabetically by author's last name; for multiple works by the same author, sort by title.
- Alphabetize organizations by the first significant word in their name.

- **Book Titles:**

- Italicize book titles and capitalize all major words; do not capitalize prepositions.

- **Publication Information:**

- Shorten publisher's name where possible.
- For non-U.S. cities, include province (Canada) or country (abbreviated) unless well-known (e.g., Tokyo, London).

- **Periodical Titles:**

- Italicize periodical titles, capitalize major words, and omit initial articles.

- **Article Titles:**

- Place article titles in quotation marks and capitalize major words.

- **Electronic Sources:**

- Include author, publication date, identifying numbers, and retrieval information.
- Record retrieval date due to frequent changes in electronic content.
- Use N.p. for no publisher, n.d. for no date, and Web before retrieval date.
- Start with the website title if no author is known; italicize entire website titles.
- Include URL in angle brackets only if the source is hard to locate via search engines.

- **Formatting:**

- Use hanging indent: first line flush left, subsequent lines indented 0.5 inches.
- Double-space the entire works cited list with no extra space between entries.
- For page numbers, omit p. or pp.; use last two digits for ranges (e.g., 243–47) if prior digits match.
- Use a plus sign (+) for articles continuing on non-consecutive pages.
- Format dates as day month year (e.g., 20 Feb. 2009); abbreviate most months (first three letters plus period), except May, June, July, and Sept.

- **Medium:**

- List the medium of publication at the end of each entry (e.g., Print, Web, Radio, Television, DVD, PDF file, MP3 file).

Ethical Considerations in Technical Writing

- **Intellectual Property (IP):**

- Refers to creations of the mind, treated as ownable property.

- Copyright is a primary form of IP relevant to technical writing.
- Other IP types:
 - **Patents:** Protect inventions (e.g., a new circuit or machine).
 - **Trademarks:** Protect brand names, logos, and slogans (e.g., "Google" or Apple logo).
 - **Trade Secrets:** Protect confidential business information (e.g., formulas, processes, client lists).
- Ethical use requires avoiding unauthorized use of competitors' designs or logos.
- **Copyright:**
 - Grants creators exclusive rights to original works for a limited time, including literary, dramatic, musical, and artistic works.
 - **Protected by Copyright:**
 - Original expressions (e.g., specific wording in a document).
 - Code (e.g., specific lines of written code).
 - Illustrations and diagrams (e.g., drawings in manuals).
 - Reports and documents (e.g., full text of a report).
 - **Not Protected by Copyright:**
 - Ideas and concepts (e.g., the concept of a self-driving car).
 - Facts and data (e.g., "water boils at 100°C" or scientific data).
- **Copyright Violations and Plagiarism:**
 - **Plagiarism:** Presenting someone else's work or ideas as your own; a serious offense in academic and professional settings, potentially leading to lawsuits or career damage.
 - **Avoiding Plagiarism:**
 - **Proper Citation:** Always credit sources for images, facts, or text.
 - **Paraphrasing:** Rewrite information in your own words and style, but still cite the source.
 - **Quoting:** Use quotation marks for direct quotes and cite the source immediately.
 - **Permission:** Obtain explicit permission for copyrighted material, especially images or lengthy text.
 - Ethical goal: Maintain integrity and respect others' work, as your reputation for professionalism is a valuable asset.

Plagiarism and Academic Integrity

- **Academic Integrity:**
 - Commitment to five core values: honesty, trust, fairness, respect, and responsibility.

- Essential for all academic work, including technical writing and engineering (e.g., lab reports, research papers, design documents, technical proposals).
- Involves:
 - Producing original work.
 - Accurately reporting data, even if results are unexpected.
 - Giving proper credit to others' contributions.
- **Plagiarism: A Violation of Integrity:**
 - Presenting someone else's work, ideas, or words as your own without acknowledgment.
 - Considered intellectual theft and a serious breach of academic and professional ethics.
 - Types of plagiarism:
 - **Direct Plagiarism:** Copying text word-for-word without quotation marks or citation.
 - **Paraphrasing Plagiarism:** Rewriting ideas without citing the source.
 - **Self-Plagiarism:** Reusing your own previously submitted work without permission.
 - **Mosaic Plagiarism:** Combining phrases from multiple sources without proper citation.
 - Accidental plagiarism (e.g., missing citations) is still a violation; responsibility lies with the writer to follow rules.
- **How to Avoid Plagiarism:**
 - **Always Cite Sources:**
 - Cite any information not considered common knowledge, including facts, statistics, data, ideas, opinions, direct quotes, images, charts, and diagrams.
 - **Master Paraphrasing:**
 - Rewrite ideas in your own words, changing both sentence structure and vocabulary.
 - Always cite the original source.
 - Example:
 - Original: "The rapid advancement of artificial intelligence has raised concerns about data privacy and job displacement."
 - Incorrect: "The swift development of AI has caused worries about people's data privacy and the loss of jobs." (Too similar, no citation.)
 - Correct: "Concerns about data privacy and employment are growing as artificial intelligence technology evolves at a rapid pace (Source, Year)." (Rewritten and cited.)
 - **Use Quotation Marks:**
 - Enclose exact words from a source in quotation marks and provide a citation.

- Use quotes sparingly; paraphrasing demonstrates understanding.
- **Manage Research:**
 - Keep detailed notes on source origins.
 - Use a consistent citation style (e.g., IEEE, APA) from the start to avoid last-minute source tracking.
- **Why It Matters for Engineers:**
 - **Safety Risks:** Plagiarizing data or designs can lead to product or system failures, potentially endangering lives.
 - **Loss of Trust:** Misrepresenting work damages credibility with colleagues, clients, and employers, potentially ending a career.
 - **Legal Action:** Copying patented designs or copyrighted material can result in costly lawsuits for individuals and companies.

Version Control

- **What is Version Control:**
 - Definition: A system that records changes to files over time, allowing recall of specific versions later.
 - Acts as an "undo" button with a complete history of changes, tracking who made what changes, when, and why.
- **Why It's Essential:**
 - Enables collaboration: Multiple team members can work simultaneously without overwriting each other's contributions.
 - Facilitates tracking: Allows reverting to earlier, stable versions if new changes cause issues.
 - Provides backup: Stores project history, protecting against data loss.

Centralized vs. Distributed Version Control Systems

Aspect	Centralized Version Control Systems (CVCS)	Distributed Version Control Systems (DVCS)
How It Works	Single central server stores all project versions. Developers check out files, make changes, and check in new versions.	Every developer has a full copy of the project history locally. Changes are shared between local repositories.
Pros	Simpler to set up.	No single point of failure; supports offline work.
Cons	Single point of failure; downtime prevents saving changes.	Steeper initial learning curve.

Aspect	Centralized Version Control Systems (CVCS)	Distributed Version Control Systems (DVCS)
Examples	CVS, SVN	Git, Mercurial

Key Version Control Concepts

- **Repository (Repo):**
 - A database storing all project files and their complete history.
- **Commit:**
 - A snapshot of the repository at a specific point in time.
 - Each commit has a unique ID and a descriptive message explaining changes.
- **Branching:**
 - A parallel version of the repository.
 - Allows isolated work on features or bug fixes without affecting the main project.
- **Merging:**
 - Combines changes from one branch into another (e.g., integrating a feature branch into the main project).
- **Conflict:**
 - Occurs when multiple branches modify the same file section, requiring manual resolution.
- **Introduction to Git:**
 - **What is Git?**: A widely-used Distributed Version Control System created by Linus Torvalds.
 - **Why Git?**:
 - **Speed**: Fast due to local operations.
 - **Flexibility**: Excellent for branching and merging in collaborative projects.
 - **Community**: Large support base with extensive documentation.
 - **Industry Standard**: Used by most tech companies.
- **Basic Git Workflow:**
 - **Initialize**: Create a new Git repository (`git init`).
 - **Add**: Stage files for tracking (`git add <filename>`).
 - **Commit**: Save changes with a message (`git commit -m "Your message here"`).
 - **Branch**: Create a new branch for features (`git checkout -b <branch-name>`).
 - **Push/Pull**:
 - **Pull**: Download and integrate remote repository changes (`git pull`).
 - **Push**: Upload local commits to a remote repository (`git push`).
- **Best Practices for Engineers**:

- Commit frequently with purpose, using small, logical commits for easier tracking and debugging.
 - Write clear commit messages explaining what and why changes were made.
 - Use branches for all work; avoid modifying the main branch directly.
 - Resolve merge conflicts promptly to avoid complications.
 - Leverage remote repositories (e.g., GitHub, GitLab) for collaboration and backups.
- **Why Master Version Control:**
 - Essential skill for modern engineers, used in nearly all professional settings.
 - Enhances teamwork through seamless collaboration and professionalism.
 - Protects work by preserving project history, preventing data loss.

Types of Collaborative Tools

- **Overview:**
 - Collaborative tools are categorized by function: Document-Centric, Communication, Project Management, and Version Control Systems.
 - Used to enhance teamwork, streamline workflows, and manage revisions in technical environments.
- **Document-Centric Tools:**
 - Focus on shared documents with real-time editing and commenting for a single source of truth.
 - Examples:
 - **Google Docs:** Free, supports real-time co-authoring, commenting, and revision history; ideal for simple documents.
 - **Microsoft Word (with OneDrive/SharePoint):** Cloud-based word processor with simultaneous editing, change tracking, and commenting.
 - **Confluence:** Designed for knowledge bases, meeting notes, and technical documentation; effective for complex projects.
- **Key Features:**
 - Real-time co-authoring.
 - Commenting and suggestion capabilities.
 - Version history/revision tracking.
- **Communication Tools:**
 - Enable real-time or asynchronous communication for discussions and decision-making.
 - Examples:
 - **Slack/Microsoft Teams:** Chat-based platforms with channels for quick questions, file sharing, and transparent communication.

- **Zoom/Google Meet:** Video conferencing tools for virtual meetings, brainstorming, and live discussions.
- **Email:** Formal, asynchronous method for sharing final documents or detailed explanations.
- **Key Features:**
 - Instant messaging.
 - Video and audio calls.
 - File sharing.
- **Project Management Tools:**
 - Organize tasks, manage workflows, and monitor project progress.
 - Examples:
 - **Trello:** Uses kanban boards (boards, lists, cards) for visual task tracking; great for managing workflows.
 - **Jira:** Robust tool for software development, tracking bugs, tasks, and sprints; used for documentation tasks.
 - **Asana:** Flexible for simple to complex projects, offering list and calendar views.
- **Key Features:**
 - Task assignment and tracking.
 - Progress monitoring.
 - Workflow automation.
- **Version Control Systems (VCS):**
 - Manage changes to documents, especially code-heavy ones like API documentation.
 - Examples:
 - **Git (with GitHub/GitLab):** Tracks revisions, supports branching/merging; ideal for documentation in code repositories.
 - **SVN (Subversion):** Centralized system for checking out and committing changes to a central repository.
- **Key Features:**
 - Revision history.
 - Branching and merging.
 - Rollback to previous versions.
- **Choosing the Right Tools:**
 - Combine tools for optimal collaboration:
 - Example: Use Confluence for documentation, Slack for communication, Jira for task tracking, and Git for version control.
 - Understanding tool functions enhances efficiency and collaboration in technical writing.



PES
UNIVERSITY

TECHNICAL WRITING

UNIT 3

Structuring and Drafting Technical Documents

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Overview

- Principles of Document Design and Organization: Headings, subheadings, lists, and paragraphs for readability; Cohesion and coherence in technical writing; Using transitions effectively; Technical Descriptions and Instructions; Writing clear, concise, and accurate descriptions of technical objects or processes; Developing effective step-by-step instructions; Visual Communication; Importance of visuals in technical documents; Types of visuals: tables, graphs (bar, line, pie), flowcharts, diagrams, photographs; Principles of effective visual design; Integrating visuals with text (placement, labeling, referencing); Creating effective captions and titles.
- Hands-on sessions: Creation of a sample report in LATEX

Writing Clear, Informative Titles

- The title of a document is crucial because it is your first chance to define your subject and purpose for your readers, giving them their first clue to whether the document contains the information they need.
- The title is an implicit promise to readers: “This document is about Subject A, and it was written to achieve Purpose B.”
- Everything that follows has to relate clearly to the subject and purpose defined in the title; if it doesn’t, either the title is misleading or the document has failed to make good on the title’s promise.

Writing Clear, Informative Titles

- You might want to put off giving a final title to your document until you have completed the document, because you cannot be sure that the subject and purpose you established during the planning stages will not change.
- However, you should jot down a working title before you start drafting; you can revise it later.
- To give yourself a strong sense of direction, make sure the working title defines not only the subject of the document but also its purpose.
- The working title “Snowboarding Injuries” states the subject but not the purpose. “How To Prevent Snowboarding Injuries” is better because it helps keep you focused on your purpose.
- An effective title is precise.
- For example, if you are writing a feasibility study on the subject of offering free cholesterol screening at your company, the title should contain the key terms *free cholesterol screening* and *feasibility*.
- The following title would be effective:
- Offering Free Cholesterol Screening at Thrall Associates: A Feasibility Study

Writing Clear, Informative Titles

- If your document is an internal report discussing company business, you might not need to identify the company.
- In that case, the following would be clear:
Offering Free Cholesterol Screening: A Feasibility Study
- Or you could present the purpose before the subject:
A Feasibility Study of Offering Free Cholesterol Screening
- Avoid substituting general terms, such as *health screening* for *cholesterol screening* or *study* for *feasibility study*; the more precise your terms, the more useful your readers will find the title.
- An added benefit of using precise terms is that your document can be more accurately and effectively indexed in databases and online libraries, increasing the chances that someone researching your subject will be able to find the document.

Writing Clear, Informative Titles

- Before settling on a title, test its effectiveness by asking whether readers will be able to paraphrase it in a clear, meaningful sentence.
- For instance, “A Feasibility Study of Offering Free Cholesterol Screening to Employees of Thrall Associates” could be paraphrased as follows:

“This document reports on a project to determine whether it is feasible to offer free cholesterol screening to employees of Thrall Associates.”

Writing Clear, Informative Titles

- But notice what happens when the title is incomplete: “Free Cholesterol Screening.”
- With only those three words to go on, the reader has to guess about the document’s purpose.
- The reader knows that the document has something to do with free cholesterol screening, but is the writer recommending that screening be implemented, modified, or discontinued?
- Or is the writer reporting on the success of an existing screening program?
- Clear, comprehensive titles can be long.
- If you need eight or ten words to say what you want to say about your subject and purpose, use them.

Writing Clear, Informative Headings

- Headings, which are lower-level titles for the sections and subsections in a document, do more than announce the subject that will be discussed in the document.
- Collectively, they create a *hierarchy of information*, dividing the document into major sections and subdividing those sections into subsections.
- In this way, coherent headings communicate the relative importance and generality of the information that follows, helping readers recognize major sections as *primary* (likely to contain more-important or more-general information) and subsections as *secondary* or *subordinate* (likely to contain less-important or more-specific information).

Writing Clear, Informative Headings

- Clear, informative headings communicate this relationship not only through their content but also through their design.
- For this reason, make sure that the design of a primary heading (sometimes referred to as a level 1 heading, 1 heading, or A heading) clearly distinguishes it from a subordinate heading (a level 2 heading, 2 heading, or B heading), and that the design of that subordinate heading clearly distinguishes it from yet a lower level of subordinate heading (a level 3 heading, 3 heading, or C heading).
- Notice that the example uses both typography and indentation to distinguish one heading from another and to communicate visually how information at one level logically relates to information at other levels.

Level 1 Heading

Level 2 Heading

Level 3 Heading

Writing Clear, Informative Headings

- The best way to make sure you use typefaces and indentation consistently is to use the Styles function.
- A style is a set of formatting instructions that you can apply to all titles, headings, lists, or other design elements that you want to look alike.
- Because you create a style only once but then apply it to any number of headings or other design elements, you're far more likely to format these items consistently than if you were to format each one individually.
- Styles also speed up the process of changing the appearance of titles, headings, and lists.
- As you revise, you might notice that two levels of headings are insufficiently distinct.
- You can easily use the Styles function to change the design of one of those headings so that it is distinct and therefore does a better job of helping readers follow the discussion and understand where they are in the document.
- In addition, you can create new styles to ensure consistency when, for instance, you further subdivide a subsection of a document or introduce bulleted lists into the discussion.

Writing Clear, Informative Headings

- For instance, a clear, informative heading is crucial because it announces the subject and purpose of the discussion that follows it, just as a title does for the whole document.
- Announcing the subject and purpose in a heading helps readers understand what they will be reading or, in some cases, helps them decide whether they need to read the section at all.
- For the writer, a heading eliminates the need for awkward transitional sentences such as “Let us now turn to the advantages of the mandatory enrollment process” or “The next step in replacing the saw blade is to remove the arbor nut from the drive shaft.”

Writing Clear, Informative Headings

- Effective headings help both reader and writer by forecasting not only the subject and purpose of the discussion that follows but also its scope and organization.
- When readers encounter the heading “Three Health Benefits of Yoga: Improved Muscle Tone, Enhanced Flexibility, Better Posture,” they can reasonably assume that the discussion will consist of three parts (not two or four) and that it will begin with a discussion of muscle tone, followed by a discussion of flexibility and then posture.

Writing Clear, Informative Lists

- Technical documents often contain lists.
- Lists are especially effective in conveying information that can be itemized (such as three physical conditions that frequently lead to patients' developing adult-onset diabetes).
- Lists also work well for presenting information that can be expressed in a sequence (such as the operation of a four-stroke gasoline engine: *intake, compression, ignition, exhaust*).

Writing Effective Paragraph Lists

- Technical documents often contain lists.
- Lists are especially effective in conveying information that can be itemized (such as three physical conditions that frequently lead to patients' developing adult-onset diabetes).
- Lists also work well for presenting information that can be expressed in a sequence (such as the operation of a four-stroke gasoline engine: *intake, compression, ignition, exhaust*).
- A paragraph list is a list in which the bulleted or numbered items are paragraphs, not merely phrases or sentences.
- Next slide shows the same information presented in traditional paragraphs and in a paragraph list.
- For readers, the chief advantage of a paragraph list is that it makes the information easier to read and remember.
- Readers see the structure of the discussion—often in a single glance—before they read the details.

Writing Effective Paragraph Lists

TRADITIONAL PARAGRAPHS

Although there are several theories of human conformity, Kelman's model (1935) is still popular. Kelman described three main types of conformity.

The first type of conformity is called compliance. A person who conforms out of compliance changes his or her behavior but not his or her attitudes, thoughts, and feelings. In effect, the person is simply copying someone else's behavior in order to satisfy some external norm.

The second type of conformity is called identification. A person who conforms by identification wants to be like that other person, but he or she might not yet have succeeded in changing his or her attitudes, thoughts, and feelings.

The third type of conformity is called internalization. A person who conforms by internalization has undergone a complete change in public behavior and private attitudes, thoughts, and feelings. A member of a cult has conformed by internalizing.

PARAGRAPH LIST

Although there are several theories of human conformity, Kelman's model (1935) is still popular. Kelman described three main types of conformity:

- *Compliance.* A person who conforms out of compliance changes his or her behavior but not his or her attitudes, thoughts, and feelings. In effect, the person is simply copying someone else's behavior in order to satisfy some external norm.
- *Identification.* A person who conforms by identification wants to be like that other person, but he or she might not yet have succeeded in changing his or her attitudes, thoughts, and feelings.
- *Internalization.* A person who conforms by internalization has undergone a complete change in public behavior and private attitudes, thoughts, and feelings. A member of a cult has conformed by internalizing.

Writing Effective Paragraph Lists

- Once they start reading the list, they can more easily follow the discussion because its design mirrors its logic.
- For example, a paragraph-list discussion of the four stages of mitosis (*prophase, metaphase, anaphase, telophase*) would arrange the stages in the order in which they occur and would use bullets or numbers to distinguish one stage from another.
- As a result, the paragraph-list format enables readers to navigate the discussion easily and confidently, if only because they can see where the discussion of prophase ends and the discussion of metaphase begins.

As a writer, turning paragraphs into lists has four advantages:

1. It forces you to look at the big picture.

- While drafting a document, you can easily lose sight of the information outside the paragraph you are writing.
- Turning traditional paragraphs into paragraph lists expands your perspective beyond a single paragraph, increasing your chances of noticing that an important item is missing or that an item is unclear.
- It also increases the chances that you'll think more deeply about how items and key ideas are related to one another.

2. It forces you to examine the sequence.

- As you write paragraph lists, you get a chance to reconsider whether the sequence of the information is logical.
- Sometimes, the visual dimension that lists add to the text will reveal an illogical sequence you might have overlooked in traditional paragraphs.

As a writer, turning paragraphs into lists has four advantages:

3. It forces you to create a helpful lead-in.

- Every list requires a *lead-in*, or introduction to the list; without one, readers are left to guess at how the list relates to the discussion and how the items in the list relate to each other.
- In the lead-in, you can add a number signal that further forecasts the content and organization of the material that follows:

Auto sales declined last year because of four major factors:

4. It forces you to tighten and clarify your prose.

- When you make a list, you look for a word, phrase, or sentence that identifies each item.
- Your focus shifts from weaving sentences together in a paragraph to highlighting key ideas, giving you an opportunity to critically consider those key ideas and revise accordingly.

Write Effective Sentence Lists

- A sentence list is a list in which the bulleted or numbered items are words, phrases, or single sentences.
- Next slide shows a traditional sentence and a list presenting the same information.
- If you don't have enough space to list the items vertically or if you are not permitted to do so, number the items within the sentence:
- We recommend that more work on heat-exchanger performance be done (1) with a larger variety of different fuels at the same temperature, (2) with similar fuels at different temperatures, and (3) with special fuels such as diesel fuel and shale-oil-derived fuels.

Write Effective Sentence Lists

TRADITIONAL SENTENCE

We recommend that more work on heat-exchanger performance be done with a larger variety of different fuels at the same temperature, with similar fuels at different temperatures, and with special fuels such as diesel fuel and shale-oil-derived fuels.

SENTENCE LIST

We recommend that more work on heat-exchanger performance be done

- with a larger variety of different fuels at the same temperature
- with similar fuels at different temperatures
- with special fuels such as diesel fuel and shale-oil-derived fuels

Writing Clear, Informative Paragraphs

- There are two kinds of paragraphs—body paragraphs and transitional paragraphs—both of which play an important role in helping you emphasize important information.
- A *body paragraph*, the basic unit for communicating information, is a group of sentences (or sometimes a single sentence) that is complete and self sufficient and that contributes to a larger discussion.
- In an effective paragraph, all the sentences clearly and directly articulate one main point, either by introducing the point or by providing support for it.
- In addition, the whole paragraph follows logically from the material that precedes it.
- A *transitional paragraph* helps readers move from one major point to another.
- Like a body paragraph, it can consist of a group of sentences or be a single sentence.
- Usually it summarizes the previous point, introduces the next point, and helps readers understand how the two are related.
- The following example of a transitional paragraph appeared in a discussion of how a company plans to use this year's net proceeds.

Writing Clear, Informative Paragraphs

- The following example of a transitional paragraph appeared in a discussion of how a company plans to use this year's net proceeds.

Our best estimate of how we will use these net proceeds, then, is to develop a second data center and increase our marketing efforts. We base this estimate on our current plans and on projections of anticipated expenditures. However, at this time we cannot precisely determine the exact cost of these activities. Our actual expenditures may exceed what we've predicted, making it necessary or advisable to reallocate the net proceeds within the two uses (data center and marketing) or to use portions of the net proceeds for other purposes. The most likely uses appear to be reducing short-term debt and addressing salary inequities among software developers; each of these uses is discussed below, including their respective advantages and disadvantages.

Structure Paragraphs Clearly

- Most paragraphs consist of a topic sentence and supporting information.
- **The Topic Sentence** Because a topic sentence states, summarizes, or forecasts the main point of the paragraph, put it up front.
- Technical communication should be clear and easy to read, not suspenseful.
- If a paragraph describes a test you performed, include the result of the test in your first sentence:

The point-to-point continuity test on Cabinet 3 revealed an intermittent open circuit in the Phase 1 wiring.

- Then go on to explain the details. If the paragraph describes a complicated idea, start with an overview. In other words, put the “bottom line” on top:

Mitosis is the usual method of cell division, occurring in four stages: (1) prophase, (2) metaphase, (3) anaphase, and (4) telophase.

- Putting the bottom line on top makes the paragraph much easier to read.

Structure Paragraphs Clearly

- Make sure each of your topic sentences relates clearly to the organizational pattern you are using.
- In a discussion of the physical condition of a building, for example, you might use a spatial pattern and start a paragraph with the following topic sentence:

On the north side of Building B, water damage to about 75 percent of the roof insulation and insulation in some areas in the north wall indicates that the roof has been leaking for some time. The leaking has contributed to . . .

Structure Paragraphs Clearly

TOPIC SENTENCE AT THE END OF THE PARAGRAPH

A solar panel affixed to a satellite in distant geosynchronous orbit receives about 1400 watts of sunlight per square meter. On Earth, cut this number in half, due to the day/night cycle. Cut it in half again because sunlight hits the Earth obliquely (except exactly on the equator). Cut it in half again due to clouds and dust in the atmosphere. *The result: eight times the amount of sunlight falls on a solar panel in sun-synchronous orbit as falls on the same size area on Earth.*

TOPIC SENTENCE AT THE START OF THE PARAGRAPH

Eight times the amount of sunlight falls on a solar panel in distant geosynchronous orbit as falls on the same size area on Earth. A solar panel affixed to a satellite in sun-synchronous orbit receives about 1400 watts of sunlight per square meter. On Earth, cut this number in half, due to the day/night cycle. Cut it in half again because sunlight hits the Earth obliquely (except exactly on the equator). Cut it in half again due to clouds and dust in the atmosphere.

Structure Paragraphs Clearly

- Your next paragraph should begin with a topic sentence that continues the spatial organizational pattern:

On the east side of the building, a downspout has eroded the lawn and has caused a small silt deposit to form on the neighboring property directly to the east. Riprap should be placed under the spout to . . .
- Note that the phrases “on the north side” and “on the east side” signal that the discussion is following the points of the compass in a clockwise direction, further emphasizing the spatial pattern.
- Readers can reasonably assume that the next two parts of the discussion will be about the south side of the building and the west side, in that order.
- Similarly, if your first topic sentence is “First, we need to . . . ,” your next topic sentence should refer to the chronological pattern: “Second, we should . . .”
- (Of course, sometimes well-written headings can make such references to the organizational pattern unnecessary, as when headings are numbered to emphasize that the material is arranged in a chronological pattern.)

Paragraph Length

How long should a paragraph be?

- In general, 75 to 125 words are enough for a topic sentence and four or five supporting sentences.
- Long paragraphs are more difficult to read than short paragraphs because they require more focused concentration.
- They can also intimidate some readers, who might skip over them.
- But don't let arbitrary guidelines about length take precedence over your own analysis of the audience and purpose.
- You might need only one or two sentences to introduce a graphic, for example.
- Transitional paragraphs are also likely to be quite short. If a brief paragraph fulfills its function, let it be.
- Do not combine two ideas in one paragraph simply to achieve a minimum word count.
- You may need to break up your discussion of one idea into two or more paragraphs. An idea that requires 200 or 300 words to develop should probably not be squeezed into one paragraph.

Dividing Long Paragraphs

Three techniques for dividing long paragraphs:

1. Break the discussion at a logical place.

- The most logical place to divide this material is at the introduction of the second factor.
- Because the paragraphs are still relatively long and cues are minimal, this strategy should be reserved for skilled readers.

2. Make the topic sentence a separate paragraph and break up the supporting information.

This version is easier to understand than the one above because the brief paragraph at the start clearly introduces the information.

In addition, each of the two main paragraphs now has a clear topic sentence.

Dividing Long Paragraphs

3. Use a list.

- This is the easiest of the three versions for all readers because of the extra visual cues provided by the list format.

Use Coherence Devices Within and Between Paragraphs

- For the main idea in the topic sentence to be clear and memorable, you need to make the support—the rest of the paragraph—coherent.
- That is, you must link the ideas together clearly and logically, and you must express parallel ideas in parallel grammatical constructions.
- Even if the paragraph already moves smoothly from sentence to sentence, you can strengthen the coherence by adding transitional words and phrases, repeating key words, and using demonstrative pronouns followed by nouns.

Use Coherence Devices Within and Between Paragraphs

Adding Transitional Words and Phrases

- Transitional words and phrases help the reader understand a discussion by explicitly stating the logical relationship between two ideas.
- Most common logical relationships between two ideas and some of the common transitions that express those relationships are as follows:

TABLE 9.1 Transitional Words and Phrases

RELATIONSHIP	TRANSITION
addition	also, and, finally, first (second, etc.), furthermore, in addition, likewise, moreover, similarly
comparison	in the same way, likewise, similarly
contrast	although, but, however, in contrast, nevertheless, on the other hand, yet
illustration	for example, for instance, in other words, to illustrate
cause-effect	as a result, because, consequently, hence, so, therefore, thus
time or space	above, around, earlier, later, next, soon, then, to the right (left, west, etc.)
summary or conclusion	at last, finally, in conclusion, to conclude, to summarize

Use Coherence Devices Within and Between Paragraphs

- Transitional words and phrases benefit both readers and writers.
- When a transitional word or phrase explicitly states the logical relationship between two ideas, readers don't have to guess at what that relationship might be.
- Using transitional words and phrases in your writing forces you to think more deeply about the logical relationships between ideas than you might otherwise.

Use Coherence Devices Within and Between Paragraphs

To better understand how transitional words and phrases benefit both reader and writer, consider the following pairs of examples:

- Demand for flash-memory chips is down by 15 percent. We have laid off 12 production-line workers. - **Weak**
- Demand for flash-memory chips is down by 15 percent; *as a result*, we have laid off 12 production-line workers. - **Improved**
- The project was originally expected to cost \$300,000. The final cost was \$450,000. - **Weak**
- The project was originally expected to cost \$300,000. *However*, the final cost was \$450,000. - **Improved**

Use Coherence Devices Within and Between Paragraphs

The next sentence pair differs from the others in that the weak example *does* contain a transitional word, but it's a weak transitional word:

- According to the report from Human Resources, the employee spoke rudely to a group of customers waiting to enter the store, *and* he repeatedly ignored requests from co-workers to unlock the door so the customers could enter. - **Weak**
- According to the report from Human Resources, the employee spoke rudely to a group of customers waiting to enter the store; *moreover*, he repeatedly ignored requests from co-workers to unlock the door so the customers could enter. - **Improved**

Use Coherence Devices Within and Between Paragraphs

- In the weak version, *and* implies simple addition: the employee did this, and then he did that.
- The improved version is stronger, adding to simple addition the idea that refusing to unlock the door compounded the employee's rude behavior, elevating it to something more serious.
- By using *moreover*, the writer is saying that speaking rudely to customers was bad enough, but the employee *really* crossed the line when he refused to open the door.
- Whichever transitional word or phrase you use, place it as close as possible to the beginning of the second idea.
- As shown in the examples above, the link between two ideas should be near the start of the second idea, to provide context for it.

Use Coherence Devices Within and Between Paragraphs

Repeating Key Words

- Repeating key words—usually nouns—helps readers follow the discussion.

- In the following example, the first version could be confusing:

For months the project leaders carefully planned their research. The cost of the work was estimated to be over \$200,000. - **unclear**

- What is *the work*: the planning or the research?

For months the project leaders carefully planned their research. The cost of the research was estimated to be over \$200,000. - **clear**

Use Coherence Devices Within and Between Paragraphs

- From a misguided desire to be interesting, some writers keep changing their important terms.
- *Plankton* becomes *miniature seaweed*, then *the ocean's fast food*. Avoid this kind of word game; it can confuse readers.
- Of course, too much repetition can be boring. You can vary nonessential terms as long as you don't sacrifice clarity.
- The purpose of the new plan is to *reduce* the *problems* we are seeing in our accounting operations. We hope to see a *reduction* in the *problems* by early next quarter. - **sluggish**
- The purpose of the new plan is to *reduce* the *problems* we are seeing in our accounting operations. We hope to see an *improvement* by early next quarter. - **better**

Use Coherence Devices Within and Between Paragraphs

Using Demonstrative Pronouns Followed by Nouns

- Demonstrative pronouns—*this*, *that*, *these*, and *those*—can help you maintain the coherence of a discussion by linking ideas securely.
- In almost all cases, demonstrative pronouns should be followed by nouns, rather than stand alone in the sentence.
- In the following examples, notice that a demonstrative pronoun by itself can be vague and confusing.

Use Coherence Devices Within and Between Paragraphs

- New screening techniques are being developed to combat viral infections. *These* are the subject of a new research effort in California. - **unclear**
- What is being studied in California: *new screening techniques* or *viral infections*?
- New screening techniques are being developed to combat viral infections. *These techniques* are the subject of a new research effort in California. - **clear**
- The task force could not complete its study of the mine accident. *This* was the subject of a scathing editorial in the union newsletter. - **unclear**
- What was the subject of the editorial: *the mine accident* or the task force's *inability to complete its study* of the accident?
- The task force failed to complete its study of the mine accident. *This failure* was the subject of a scathing editorial in the union newsletter. - **clear**

Use Coherence Devices Within and Between Paragraphs

- Even when the context is clear, a demonstrative pronoun used without a noun might interrupt readers' progress by forcing them to refer back to an earlier idea.
- The law firm advised that the company initiate proceedings. This caused the company to search for a second legal opinion. - **interruptive**
- The law firm advised that the company initiate proceedings. *This advice* caused the company to search for a second legal opinion. - **fluid**

Structure of a Technical Description

A well-structured description moves from general to specific.

Section

Introduction

Body (Partition)

Conclusion

Content

Definition: Classify the object (e.g., "A wrench is a hand tool...").

Purpose/Function: What does it do?

Overall Description: Briefly describe its main parts.

Detail the object's **main parts or components**. Describe each part's **function, size, materials, and appearance** in logical order (e.g., top-to-bottom, outside-to-inside).

Briefly summarize the object's **main function** and its **significance** (e.g., common applications, importance).

Purpose

Hooks the reader and provides context.

Provides comprehensive detail and clarity.

Reinforces key information

Description Techniques

- **Nomenclature & Classification:** Use precise, standard terminology and logically group the components.
 - *Example:* Classify a CPU as a "complex integrated circuit" rather than a "chip."
- **Visual Aids:** Integrate **labeled diagrams, schematics, and cross-sections** to complement the text. Visuals often communicate spatial relationships and complexity better than words alone.
- **Objective Language:** Use factual, verifiable data. Avoid subjective language (e.g., "very good," "best"). Instead, use measurable terms (e.g., "yield strength of 350 MPa," "operates at $12V\pm0.5V$ ").
- **Focus on Function:** Always link the description of a part to **what it does** in the overall system.

Technical instructions

Technical Instructions are step-by-step procedures that enable a user to perform a task safely, efficiently, and correctly. They answer the question: ***How do I do it?***

Section	Content	Key Elements
Introduction	Scope & Goal: What task is being covered and what is the final outcome? Safety & Warnings: List critical hazards (e.g., high voltage, hot surfaces). Tools & Materials: Comprehensive list of required items.	Sets the stage and ensures preparedness.
Body (Steps)	The sequential, numbered steps. Each step should be a single, manageable action. Warnings/Cautions: Interspersed <i>before</i> the relevant step to prevent errors.	The core of the procedure, ensuring successful execution.
Conclusion	Troubleshooting: Common issues and solutions. Verification: How to check if the procedure was successful. Maintenance/Cleanup: Post-procedure actions.	Provides support and a sense of completion.

Essential writing Techniques for Instructions

1. Use the Imperative Mood: Instructions must be direct commands.

•*Do:* "Connect the red wire to terminal A."

•*Don't:* "The red wire should be connected to terminal A." or "You will connect the red wire..."

2. Numbering and Sequencing: Use **numbered lists** (not bullet points) for sequential steps. Ensure the steps are in the correct chronological order.

3. One Action Per Step: Keep steps concise. If a step involves multiple actions, use lettered sub-steps.

•*Good:*

- 1.Verify the power is off.

- 2.Remove the access panel screws.

- 3.Lift the panel away.

•*Too Complex:* "Verify the power is off, remove the access panel screws, and lift the panel away."

Essential writing Techniques for Instructions

4. Emphasize Safety:

- **DANGER:** Immediate and serious hazard; will result in severe injury or death. (Use bold and often a distinct visual format).
- **WARNING:** Potential hazard; could result in serious injury or equipment damage.
- **CAUTION:** Potential minor injury or data/equipment loss.

Summary and Application

Feature	Technical Description	Technical Instructions
Purpose	To define, analyze, and explain <i>what</i> something is.	To guide the user through <i>how</i> to do a task.
Key Question	What is it? How does it work?	How do I do this?
Grammar Focus	Present tense, third person (objective observation).	Imperative mood (direct command).
Structure	Introduction → Partition/Body → Conclusion	Introduction/Safety → Numbered Steps → Conclusion/Troubleshooting

Introduction

As engineers, you will constantly design, analyze, and build complex systems. Your success often hinges on your ability to describe these creations with absolute precision.

- **Goal:** To move beyond mere definition and provide a description so clear that the reader can visualize, understand the function, and potentially replicate the object or process.
- **The Three Pillars of Technical Description:**
 1. **Clarity:** Easy to understand.
 2. **Conciseness:** Economical use of words.
 3. **Accuracy:** Factually correct and precise.

Accuracy – The Non-Negotiable Foundation

Accuracy is paramount. In engineering, an inaccurate description can lead to critical failure, safety hazards, or project delays.

I. Use Precise Terminology (Nomenclature)

- **Avoid Vague Language:** Use standard, accepted industry terms.
 - *Instead of:* "the little turning thingy on the shaft."
 - *Use:* "The **knurled adjustment knob** on the stepper motor axle."
- **Specify Materials and Properties:** Always include quantitative data where relevant.
 - *Example:* "The casing is made of **high-density polyethylene (HDPE)** with a **Shore A hardness of 80**," instead of "The casing is made of strong plastic."

Accuracy – The Non-Negotiable Foundation

II. Quantify Everything

When describing dimensions, performance, or operational limits, use exact measurements and units.

- *Do:* "The component operates at a steady-state temperature of $85^{\circ}\text{C} \pm 2^{\circ}\text{C}$."
- *Don't:* "The component gets very hot during operation."
- **Include Tolerances:** Engineers understand that absolute perfection is impossible. Specify acceptable variation (e.g., "10mm $\pm 0.1\text{mm}$ ").

Clarity – Making the Complex Understandable

Clarity ensures the reader *grasps* the information without confusion. This is achieved through structure and appropriate use of visuals.

I. The Standard Structure (Mechanism/Object)

Follow a logical flow from general to specific.

1. Introduction/Definition:

- **Classification:** What category does it belong to? (e.g., "A solenoid is an electromechanical transducer...")
- **Function/Purpose:** What does it do? (e.g., "...that converts electrical energy into linear motion.")

2. Partition (The Body):

- Systematically break the object down into its main parts.
- Describe each part in a logical order (e.g., top-to-bottom, outside-to-inside, input-to-output).
- **Crucial Rule:** Describe the **function** and **physical characteristics** of each part.

3. Conclusion:

Summarize how the parts interact to achieve the overall function.

Clarity – Making the Complex Understandable

II. Integrating Visuals

- "**A Picture is Worth 1,000 Words**": Always use **labeled diagrams, schematics, or flowcharts** to support your text.
- **Callouts/Captions**: Ensure every visual is clearly referenced in the text and has a concise, descriptive caption (e.g., "Figure 2. Exploded view showing the connection points for the 4mm fiber optic cable.").

Checklist for Effective Instructions

Before publishing, review your instructions with this checklist:

- **Completeness:** Are all tools, materials, and safety warnings listed?
- **Sequence:** Are the steps in the correct chronological order?
- **Clarity:** Is every step an active command (imperative mood)?
- **Simplicity:** Is there only **one main action per step**?
- **Visual Support:** Are visuals included and correctly placed to clarify difficult actions?
- **Verification:** Does the document tell the user how to confirm success?
- **Action Item:** Test your instructions by having a classmate (who is unfamiliar with the task) follow them *exactly* as written. Their feedback is invaluable.

Visual Communication

- In printed or online documents, in oral presentations, and in multimedia programs, visuals are a staple of communication.
- Because they focus and organize information, visuals make data easier to interpret and remember.
- By offering powerful new ways of looking at data, visuals also reveal meanings that might otherwise remain buried in lists of facts and figures.
- When people look at a visual pattern, such as a graph, they see it as one large pattern—the Big Picture that conveys information quickly and efficiently.

Importance of visuals in technical documents

Visuals offer five benefits that words alone cannot:

- **Graphics are indispensable in demonstrating logical and numerical relationships.**

For example, an organization chart effectively represents the lines of authority in an organization. And if you want to communicate the number of power plants built in each of the last 10 years, a bar graph works better than a paragraph.

- **Graphics can communicate spatial information more effectively than words alone.**

If you want to show the details of a bicycle derailleur, a diagram of the bicycle with a close-up of the derailleur is more effective than a verbal description.

- **Graphics can communicate steps in a process more effectively than words alone.**

A troubleshooter's guide, a common kind of table, explains what might be causing a problem in a process and how you might fix it. And a diagram can show clearly how acid rain forms.

Importance of visuals in technical documents

- **Graphics can save space.**

Consider the following paragraph:

In the Wilmington area, some 80 percent of the population aged 18 to 24 have watched streamed movies on their computers. They watch an average of 1.86 movies a week. Among 25- to 34-year-olds, the percentage is 72, and the average number of movies is 1.62. Among 35- to 49-year-olds, the percentage is 62, and the average number of movies is 1.19. Among the 50 to 64 age group, the percentage is 47, and the number of movies watched averages 0.50. Finally, among those people 65 years old or older, the percentage is 28, and the average number of movies watched weekly is 0.31.

Presenting this information in a paragraph is uneconomical and makes the information hard to remember. Presented as a table, however, the information is more concise and more memorable.

AGE	PERCENTAGE WATCHING STREAMING MOVIES	NUMBER OF MOVIES WATCHED PER WEEK
18-24	80	1.86
25-34	72	1.62
35-49	62	1.19
50-64	47	0.50
65+	28	0.31

Importance of visuals in technical documents

- **Graphics can reduce the cost of documents intended for international readers.**
 - Translation costs more than 10 cents per word.
 - Used effectively, graphics can reduce the number of words you have to translate.
 - As you plan and draft your document, look for opportunities to use graphics to clarify, emphasize, summarize, and organize information.

Types of visuals

Visual displays can be divided into four categories:

1. Tables
2. Graphs
3. Charts
4. Graphic illustrations

TABLES display organized data across columns and rows for easy comparison.

Numerical tables

Use to compare exact values.

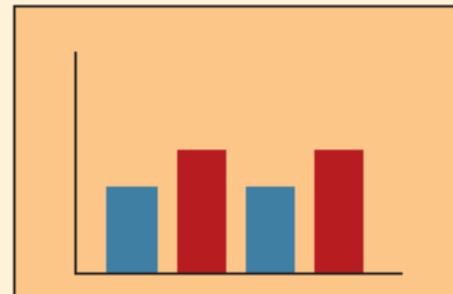
TABLE 1 Charting the Lesson

Lesson	Page	Page	Page
A	1	3	6
B	2	2	5
C	3	1	4

GRAPHS translate numbers into shapes, shades, and patterns.

Bar graphs

Use to show comparisons.



Prose tables

Use to organize verbal information.

TROUBLESHOOTING

Problem	Cause	Solution
• power	• cord	• plug-in
• light	• bulb	• replace
• flicker	• tube	• replace

Line graphs Use to show a trend over time, such as cost or other variables.



Types of visuals

CHARTS depict relationships via geometric arrows, lines, and other design elements.

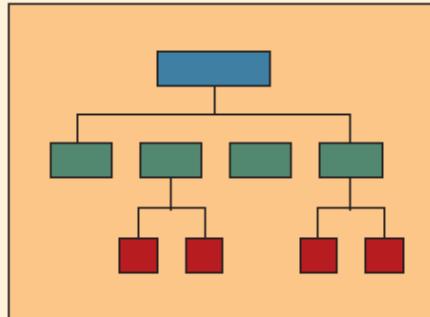
Pie charts

Use to relate parts or percentages to the whole.



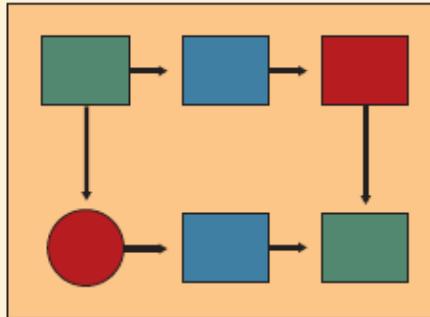
Organization charts

Use to show the hierarchy in a company.



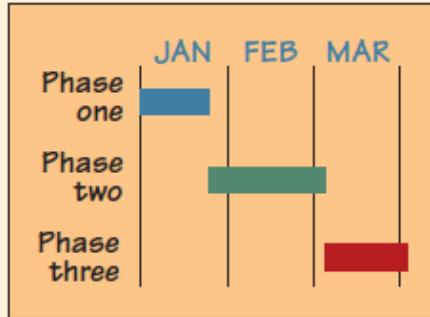
Flowcharts

Use to trace the steps (or decisions) in a procedure or process.



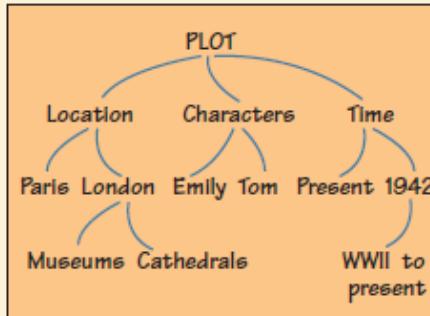
Gantt and PERT charts

Use to depict how the phases of a project relate.



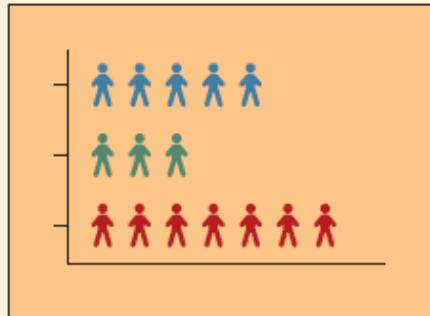
Tree charts

Use to show how the parts of an idea or concept relate.



Pictograms

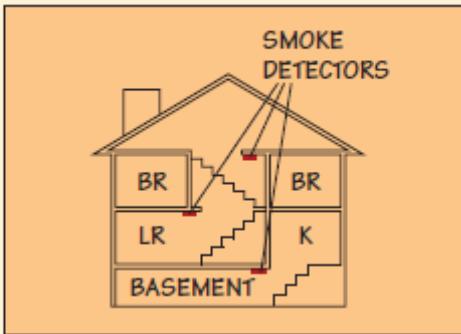
Use icons or other graphic devices that represent the displayed items.



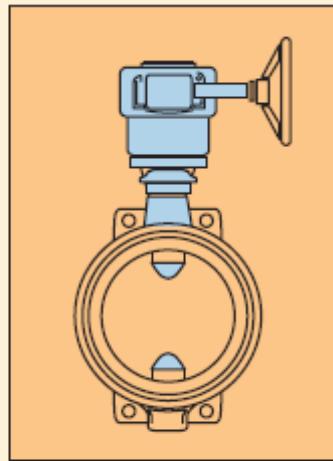
Types of visuals

GRAPHIC ILLUSTRATIONS
rely on pictures rather than on data or words.

Illustrations
Use to present a realistic but simplified view.

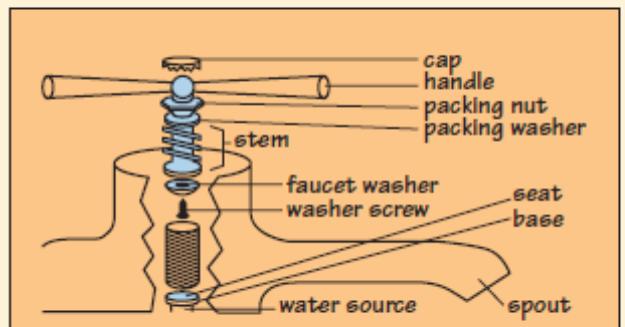


Cutaway diagrams
Use to show what is inside of a device or to help explain how a device works.



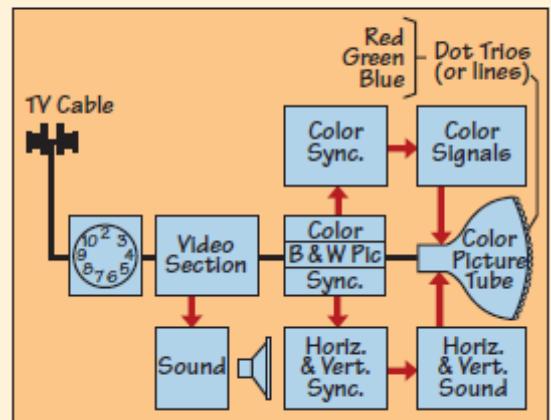
Exploded diagrams

Use to explain how an item is put together or how a reader should assemble a product.



Block diagrams

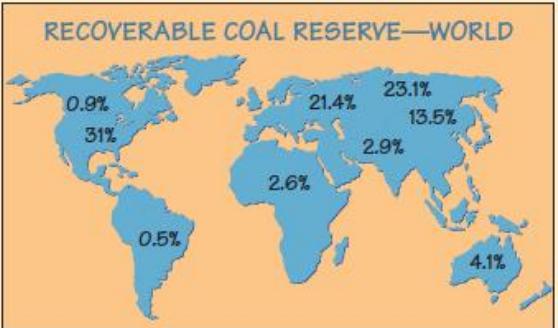
Use to present the conceptual elements of a process or system—in depicting function instead of appearance.



Types of visuals

Maps

Use to help readers visualize the position, location, and interrelationship of various data.



Photographs

Use to show exactly what something looks like.



Videos

Use to show a procedure.



Symbols and icons

Use to make concepts understandable to broad audiences, including international audiences and people who may have difficulty reading.



How to choose the right visuals

- **What is the purpose for using this visual?**

- To convey facts and figures alone, a table may be the best choice. But if I want my audience to draw conclusions from that data, I may use a graph or chart to show comparisons.
- To show parts of a mechanism, I probably want to use an exploded or cutaway diagram, perhaps together with a labeled photograph.
- To give directions, I may want to use a diagram.
- To show relationships, my best choice may be a flowchart or graph.

- **Who is my audience for these visuals?**

- Expert audiences tend to prefer numerical tables, flowcharts, schematics, and complex graphs or diagrams that they can interpret for themselves.
- General audiences tend to prefer basic tables, graphs, diagrams, and other visuals that direct their focus and interpret key points extracted from the data.
- Cultural differences might come into play in the selection of appropriate visuals.

How to choose the right visuals

- **What form of information will best achieve my purpose for this audience?**
 - Is my message best conveyed by numbers, shapes, words, pictures, or symbols?
 - Will my audience most readily understand a particular type of display?
- Regardless of type, certain requirements apply to all visuals.
These requirements include
 - using a title and number for each visual
 - keeping the design of the visual clean and easy to read
 - labeling all parts of the visual and providing legends as needed
 - placing the visual near the text it is helping to describe
 - citing the sources of your visual material (both the source of the data and, when appropriate, the source of the actual visual—for instance, the creator of the bar chart or the person who took the photograph)

Using Software to create visuals

- Spreadsheet software, such as Microsoft Excel or Numbers for Mac, can generate a variety of tables, graphs, and charts based on the data in the spreadsheet.
- Presentation and word processing software (Microsoft PowerPoint or Word; Apple Keynote or Pages) contain basic drawing tools that allow you to annotate or draw simple figures.
- For more sophisticated visuals, programs like Adobe Illustrator or CorelDRAW allow you to sketch, edit, and refine diagrams and drawings.
- High-end drawings are usually produced using computer-aided design (CAD) tools.
- Photos can be highlighted and refined using Adobe Photoshop.

But unlike the spreadsheet or word processing programs that you use every day, these tools require a good deal of practice and skill and can't be learned overnight.

Tables

- They convey large amounts of numerical data easily, and they are often the only way to present several variables for a number of items.
- For example, if you wanted to show how many people are employed in six industries in 10 states, a table would probably be most effective.
- Although tables lack the visual appeal of other kinds of graphics, they can handle much more information.
- A table is a powerful way to display dense textual information such as specifications or comparisons.

How to construct a Table

1. Number the table in its order of appearance and provide a title that describes exactly what is being measured.
2. Label stub, column, and row heads (*Number of Awards; 2005; Pell Grant*) to orient readers.
3. Specify units of measurement or use familiar symbols and abbreviations (\$, hr.). Define specialized symbols or abbreviations (\AA = *angstrom*, db = *decibel*) in a footnote.
4. Compare data vertically (in columns) instead of horizontally (rows). Columns are easier to compare. Try to include row or column averages or totals, as reference points for comparing individual values.
5. Use horizontal rules to separate headings from data. In a complex table, use vertical rules to separate columns. In a simple table, use as few rules as clarity allows.
6. List items in a logical order (alphabetical, chronological, decreasing cost). Space listed items for easy comparison. Keep prose entries as brief as clarity allows.

How to construct a Table

7. Convert fractions to decimals. Align decimals and all numbers vertically. Keep decimal places for all numbers equal. Round insignificant decimals to whole numbers.
8. Use *x*, *NA*, or a dash to signify any omitted entry, and explain the omission in a footnote (*Not available*, *Not applicable*).
9. Use footnotes to explain entries, abbreviations, or omissions. Label footnotes with lowercase letters so readers do not confuse the notation with the numerical data.
10. Cite data sources beneath any footnotes When adapting or reproducing a copyrighted table for a work to be published, obtain written permission.
11. If the table is too wide for the page, turn it 90 degrees with the left side facing page bottom. Or use two tables.
12. If the table exceeds one page, write “continues” at the bottom and begin the next page with the full title, “continued,” and the original column headings.

Graphs

- Graphs translate numbers into shapes, shades, and patterns.
- Graphs display, at a glance, the approximate values, the point being made about those values, and the relationship being emphasized.
- Graphs are especially useful for depicting comparisons, changes over time, patterns, or trends.

Bar Graphs

- Generally easy to understand, bar graphs show discrete comparisons, such as year-by-year or month-by-month.
- Each bar represents a specific quantity.
- You can use bar graphs to focus on one value or to compare values over time.

Simple Bar Graphs

A simple bar graph displays one trend or theme.

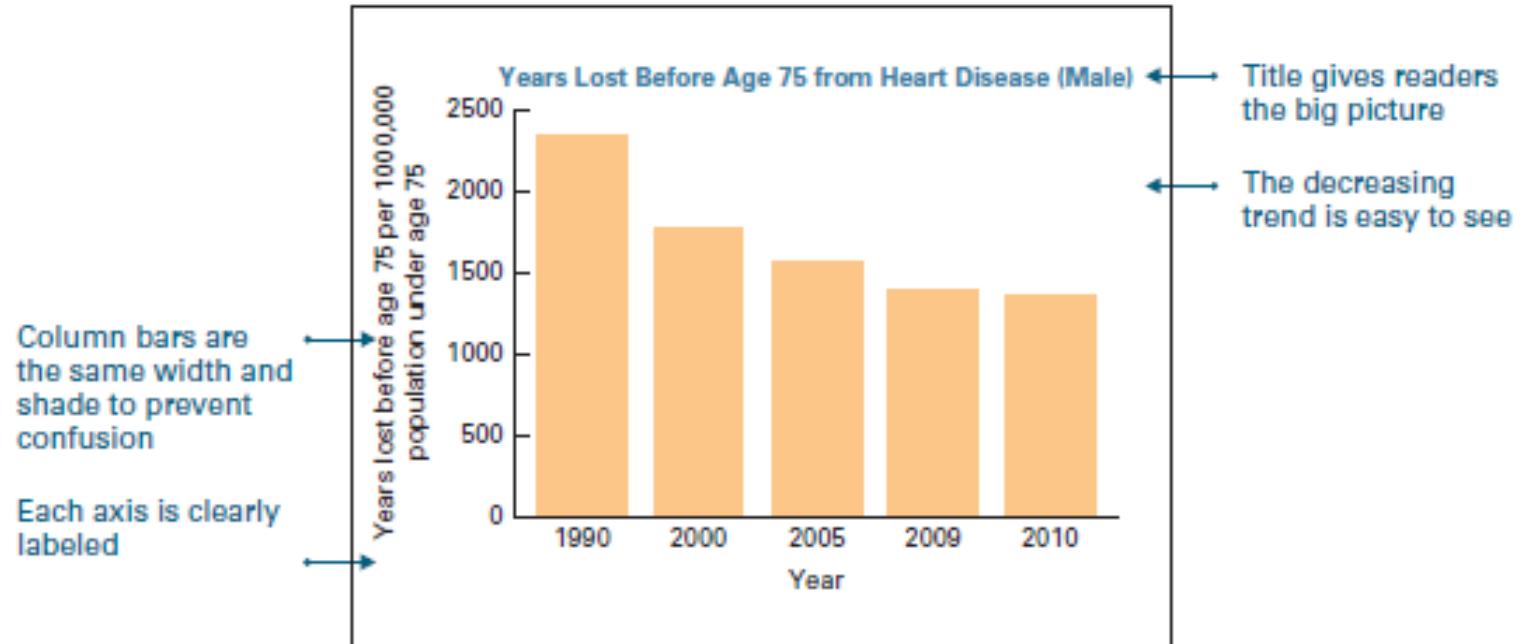


FIGURE 12.2 A Simple Bar Graph

Source: Health, United States 2012, from the U.S. National Center for Health Statistics.

Multiple-bar graph

- Multiple Bar graphs can display several relationships at the same time.
- Below Figure contrasts two data sets to show comparative trends.
- Use a different pattern or color for each data set, and include a key so readers will know which color or pattern goes with which set.
- In general, don't include more than three data sets on one graph.

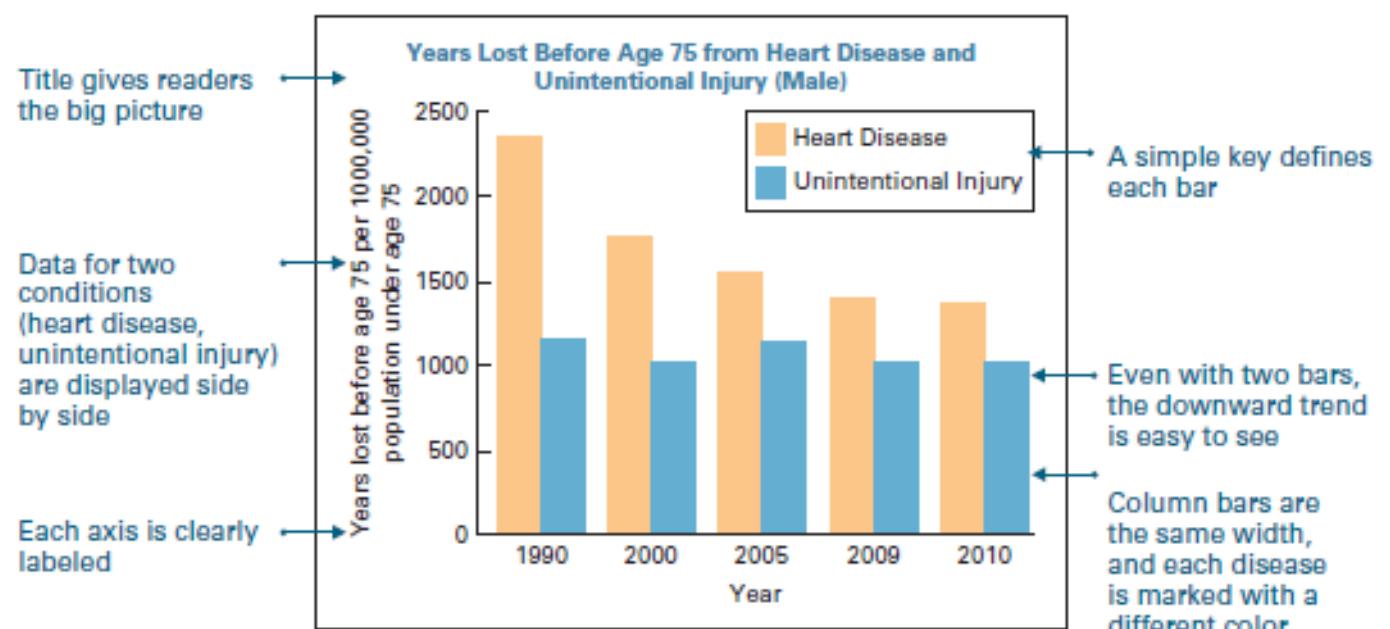


FIGURE 12.3 A Multiple-Bar Graph

Source: Health, United States 2012, from the U.S. National Center for Health Statistics.

Horizontal-bar graph

- Horizontal-bar graphs are good for displaying a large series of bars arranged in order of increasing or decreasing value, as in Figure shown below.
- This format leaves room for labeling the categories horizontally (*Doctorate*, and so on).

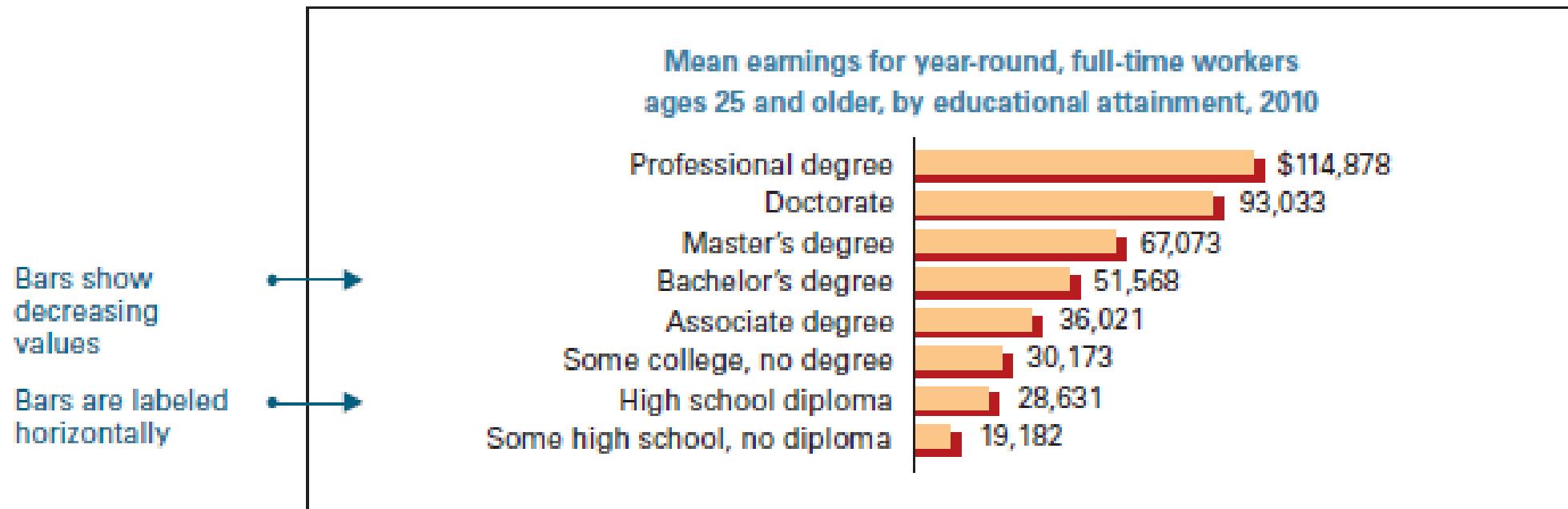


FIGURE 12.4 A Horizontal-Bar Graph Accommodates lengthy labels.
Source: Bureau of Labor Statistics.

Stacked-bar graph

- Instead of displaying bars side-by-side, you can stack them.
- Stacked-bar graphs show how much each data set contributes to the whole.
- To avoid confusion, don't display more than four or five sets of data in a single bar.

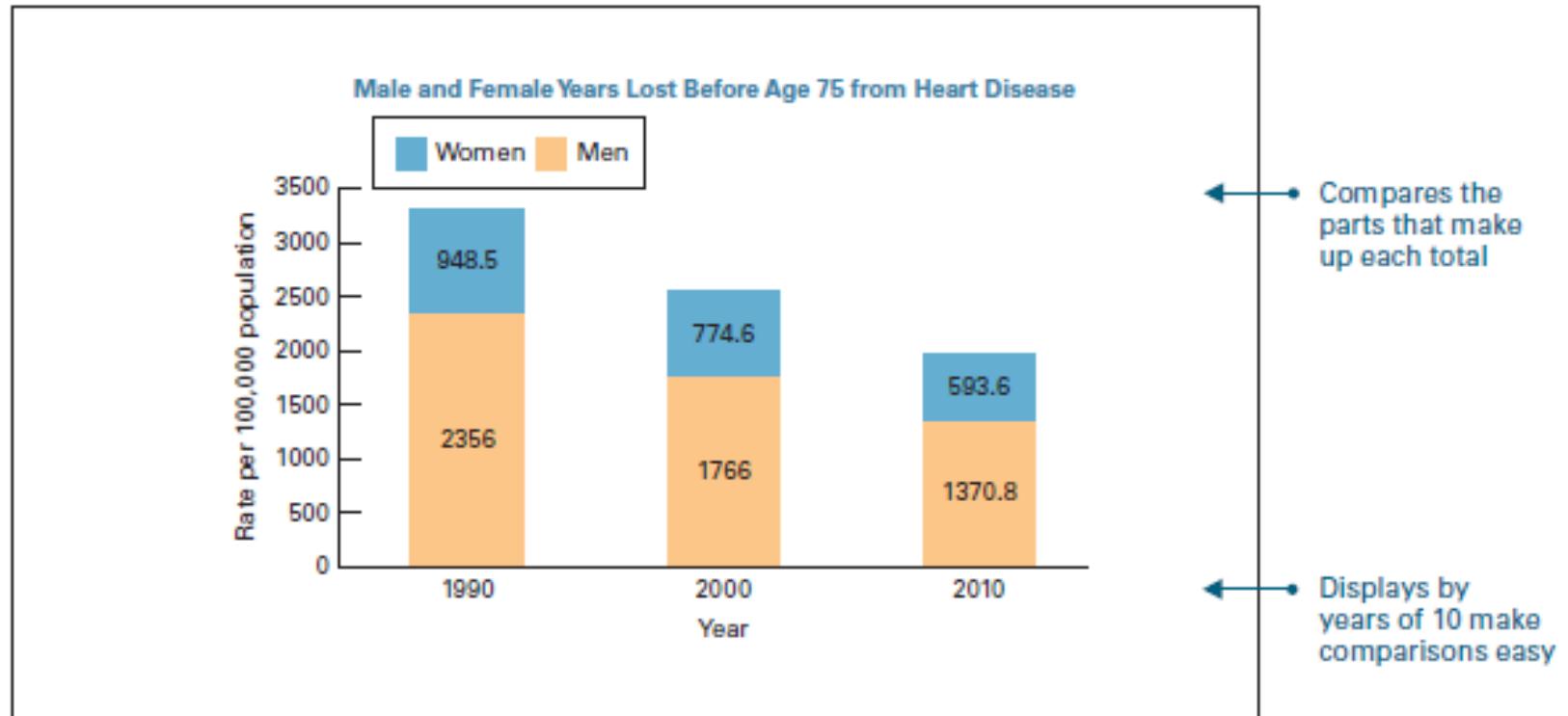


FIGURE 12.5 A Stacked-Bar Graph Displays of 10 make comparisons easy.

100 percent bar graph

- This type of bar graph shows the value of each part that makes up 100 percent shown below.
- Like any bar graph, the 100 percent graph can have either horizontal or vertical bars.
- The more data, the harder such graphs are to interpret; consider using a pie chart if that would be more readable for your audience.

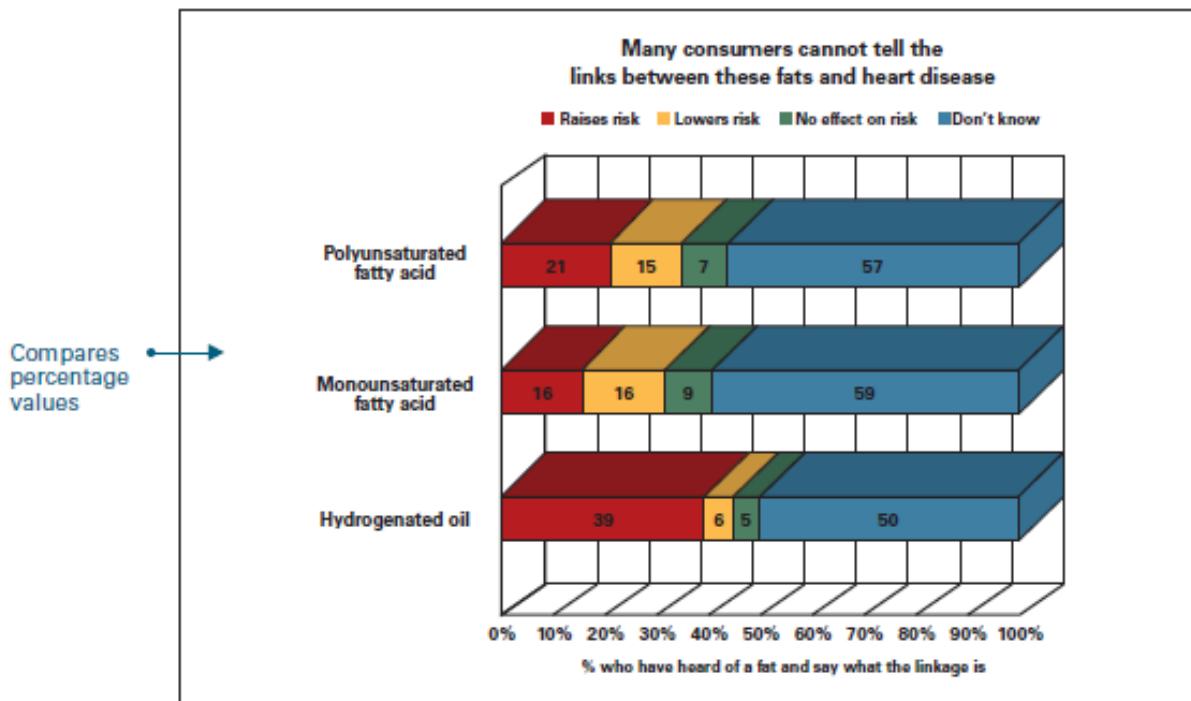


FIGURE 12.6 A 100 Percent Bar Graph

Source: Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration.

3-D bar graph

- 3-d bar graph Graphics software makes it easy to shade and rotate images for a three-dimensional view.
- The 3-D perspectives in Figure below engage our attention and visually emphasize the data.

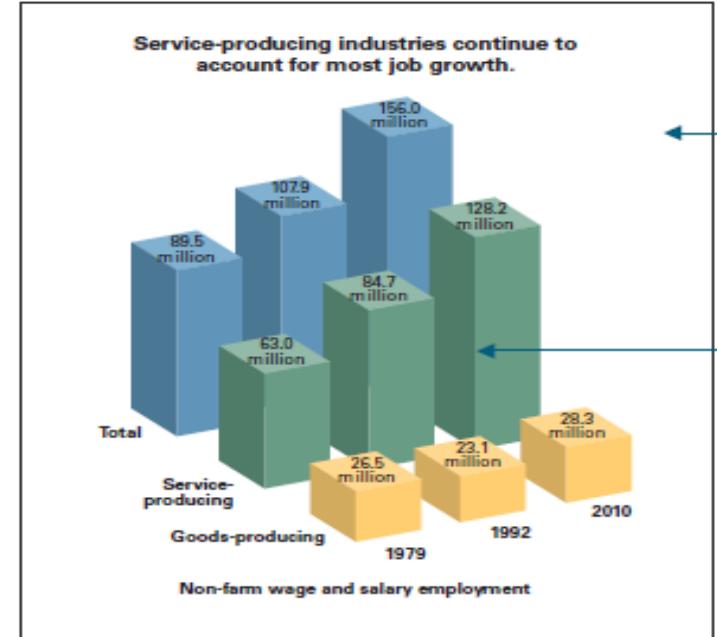
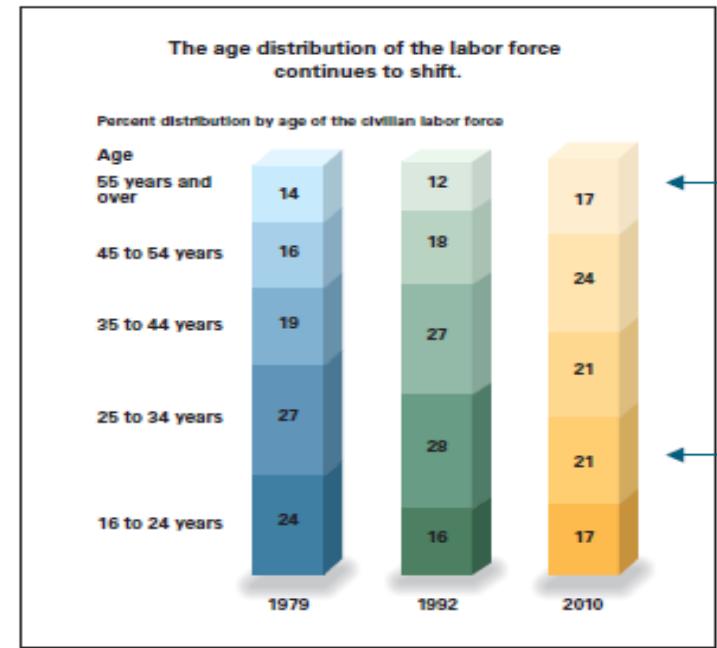


FIGURE 12.7 3-D Bar Graphs Adding a third axis creates the appearance of depth.
Source: Bureau of Labor Statistics.

Line graphs

- A line graph can accommodate many more data points than a bar graph (for example, a twelve-month trend, measured monthly).
- Line graphs help readers synthesize large bodies of information in which exact quantities don't need to be emphasized.

Simple Line Graph

A simple line graph, as in Figure shown, plots time intervals (or categories) on the horizontal scale and values on the vertical scale.

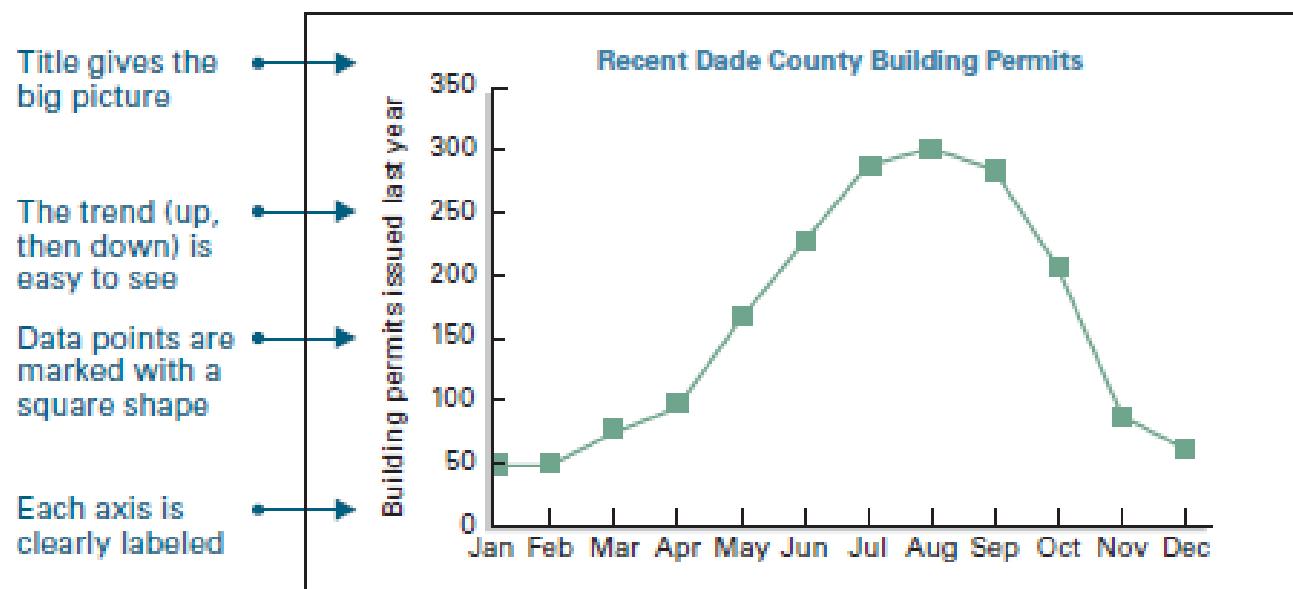


FIGURE 12.8 A Simple Line Graph Displays one relationship.

Line graphs

Multiline graph

- A multiline graph displays several relationships simultaneously, as in Figure shown.
- Include a caption to explain the relationships readers are supposed to see and the interpretations they are supposed to make.

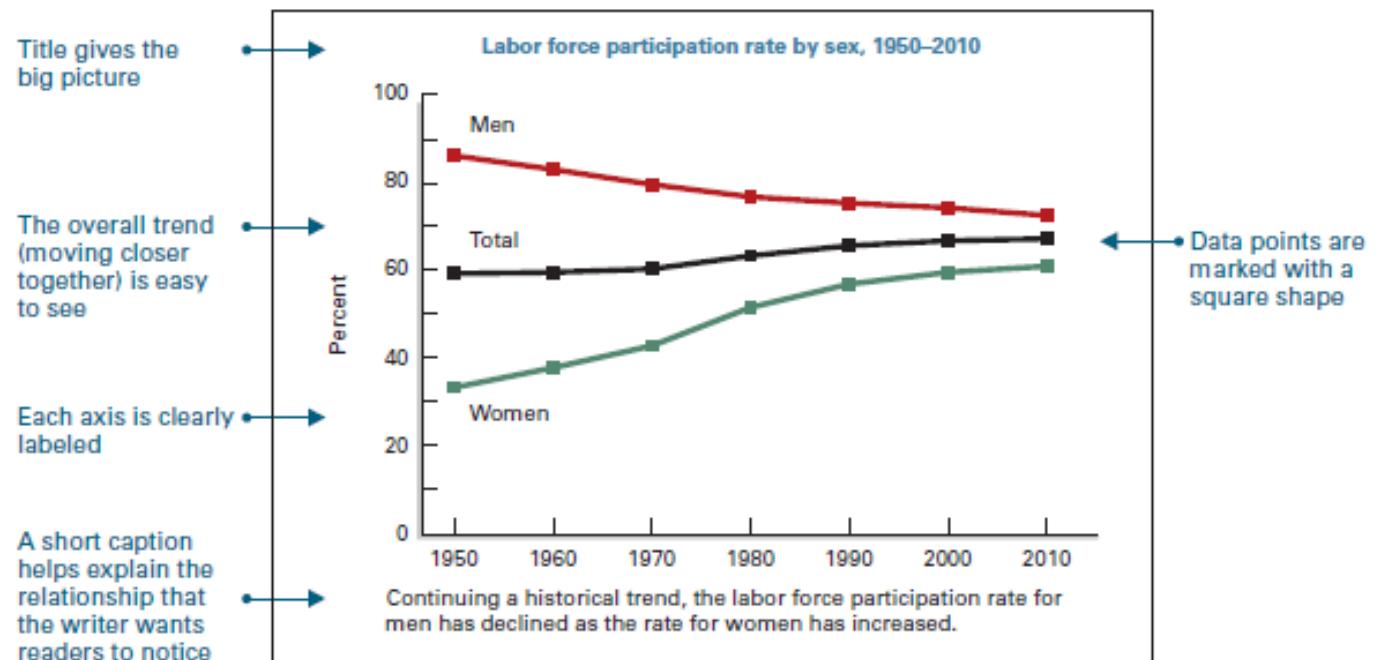


FIGURE 12.9 A Multiline Graph Displays multiple relationships.
Source: Bureau of Labor Statistics.

Line graphs

Deviation line graph

- Extend your vertical scale below the zero baseline to display positive and negative values in one graph, as in Figure shown below.
- Mark values below the baseline in intervals parallel to those above it.

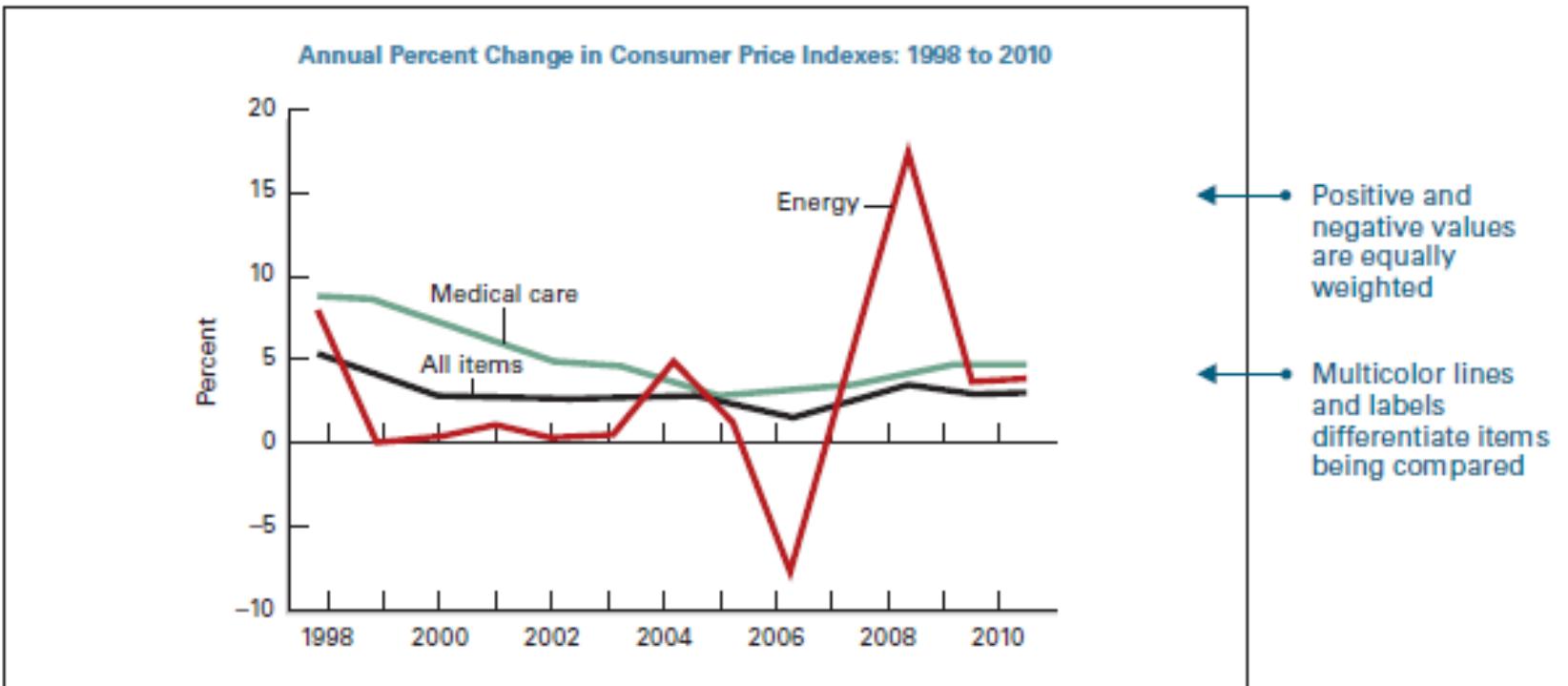


FIGURE 12.10 A Deviation Line Graph Displays negative and positive values.

Source: Chart prepared by U.S. Bureau of the Census.

Line graphs

Band or Area graph

- By shading in the area beneath the main plot lines, you can highlight specific information.
- Figure shown here is another version of the Figure 12.8 line graph.

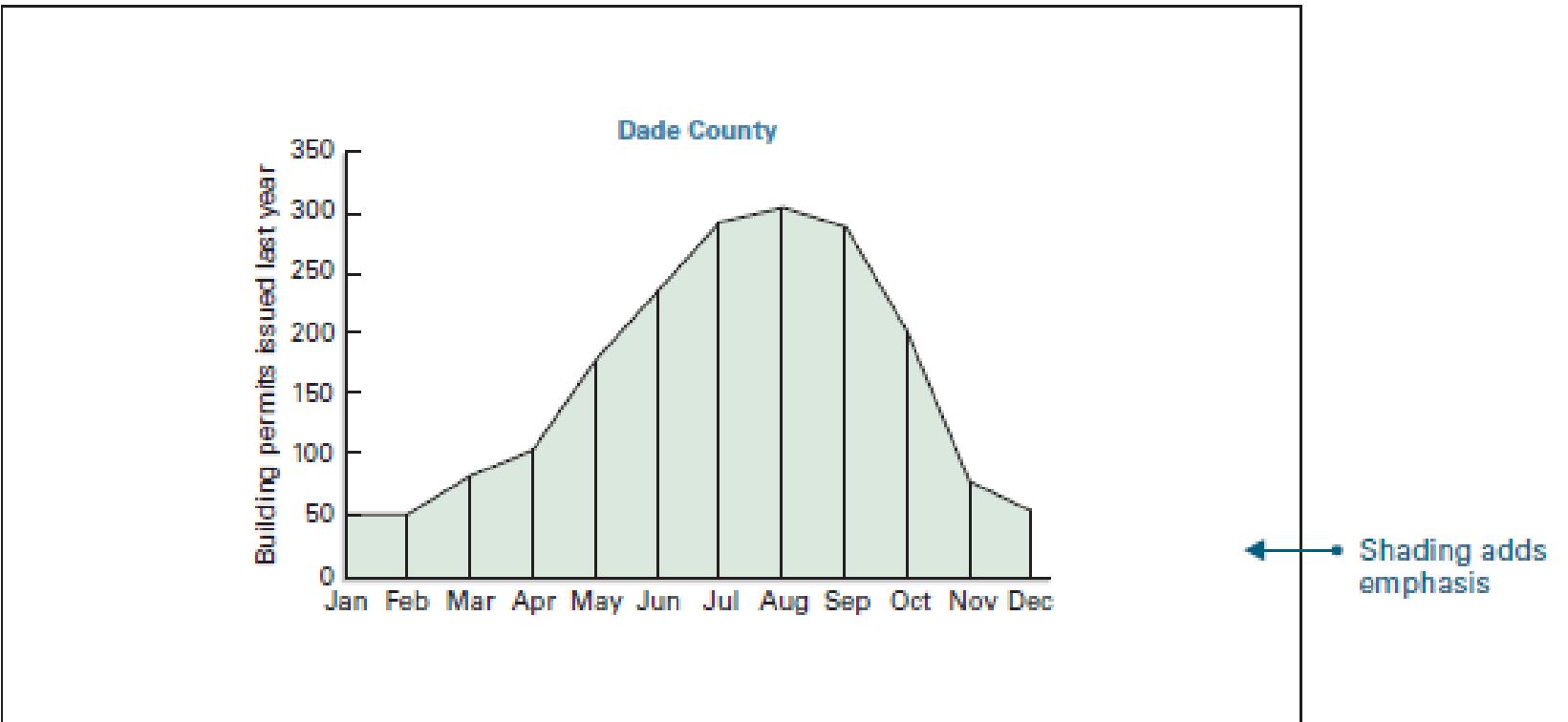


FIGURE 12.11 A Simple Band Graph Uses shading to highlight information.

Line graphs

Multiple-Band graph

- The multiple bands in Figure 12.12 depict relationships among sums instead of the direct comparisons depicted in the Figure 12.9 multiline graph.
- Despite their visual appeal, multiple-band graphs are easy to misinterpret:
In a multiline graph, each line depicts its own distance from the zero baseline.
- But in a multiple-band graph, the very top line depicts the *total* distance from the zero baseline, with each band below it being a part of that total.
- Always clarify these relationships for your audience.

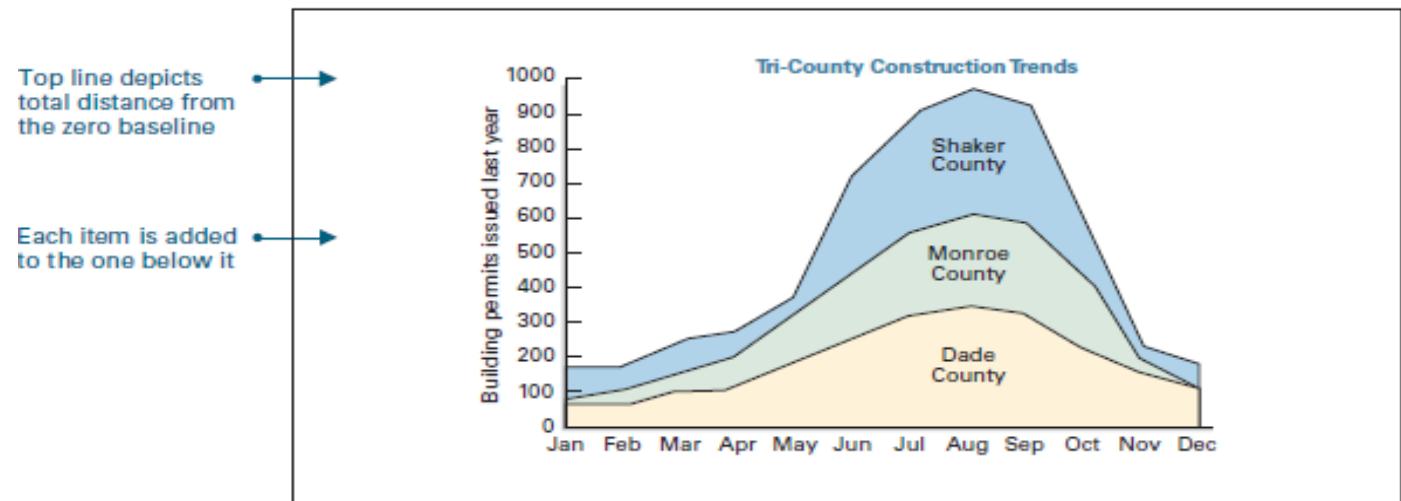


FIGURE 12.12 A Multiple-Band Graph Depicts relationships among sums instead of direct comparisons.

Guidelines for Creating Tables and Graphs

For all types of tables and graphs, provide a clear title and credit your sources.

Tables

- **Don't include too much information in a single table.**

Overly complex tables are confusing.

Limit your table to two or three areas of comparison.

Or use multiple tables.

- **Provide a brief but descriptive title.**

Announce exactly what is being compared.

- **Label the rows and columns.**

- **Line up data and information clearly.**

Use neat columns and rows and plenty of white space between items.

- **Keep qualitative information and quantitative data brief.**

When including high numbers (more than three digits), abbreviate the numbers and indicate “in thousands,” “in millions,” and so on.

When using text in a table, limit the number of words.

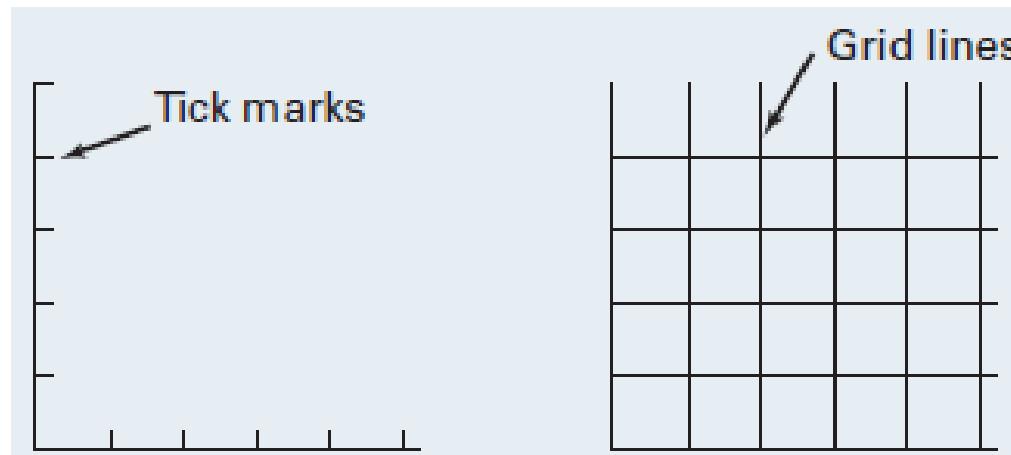
- **Provide additional information, if necessary.**

Add footnotes or a caption at the bottom of the table to explain anything readers may not understand at first glance.

Guidelines for Creating Tables and Graphs

Bar Graphs

- **Use a bar graph only to compare values that are noticeably different.**
Small value differences will yield bars that look too similar to compare.
- **Keep the graph simple and easy-to-read.**
Don't plot more than three types of bars in each cluster. Avoid needless visual details.
- **Number your scales in units familiar to the audience.**
Units of 1 or multiples of 2, 5, or 10 are best.
- **Label both scales to show what is being measured or compared.**
If space allows, keep all labels horizontal for easier reading.
- **Use tick marks to show the points of division on your scale.**
If the graph has many bars, extend the tick marks into *grid lines* to help readers relate bars to values.



Guidelines for Creating Tables and Graphs

Bar Graphs

- **Make all bars the same width** (unless you are overlapping them).
- **In a multiple-bar graph, use a different pattern, color, or shade for each bar in a cluster.**

Provide a key, or legend, identifying each pattern, color, or shade.

- **Refer to the graph by number (“Figure 1”) in your text, and explain what the reader should look for.**

Or include a prose caption with the graph.

Guidelines for Creating Tables and Graphs

Line Graphs

Follow the guidelines above for bar graphs, with these additions:

- **Display no more than three or four lines on one graph.**
- **Mark each individual data point used in plotting each line.**
- **Make each line visually distinct (using color, symbols, and so on).**
- **Label each line so readers know what the given line represents.**
- **Avoid grid lines that readers could mistake for plotted lines.**

Charts

- The terms *chart* and *graph* often are used interchangeably.
- Technically, a chart displays relationships (quantitative or cause-and-effect) that are *not* plotted on a coordinate system (*x* and *y* axes).

Pie Charts

- Easy for most people to understand, a pie chart displays the relationship of parts or percentages to the whole.
- Readers can compare the parts to each other as well as to the whole (to show how much was spent on what, how much income comes from which sources, and so on).
- Figure 12.13 shows a simple pie chart.
- Figure 12.14 is an exploded pie chart. Exploded pie charts highlight various pieces of the pie.

Charts

Simple pie chart

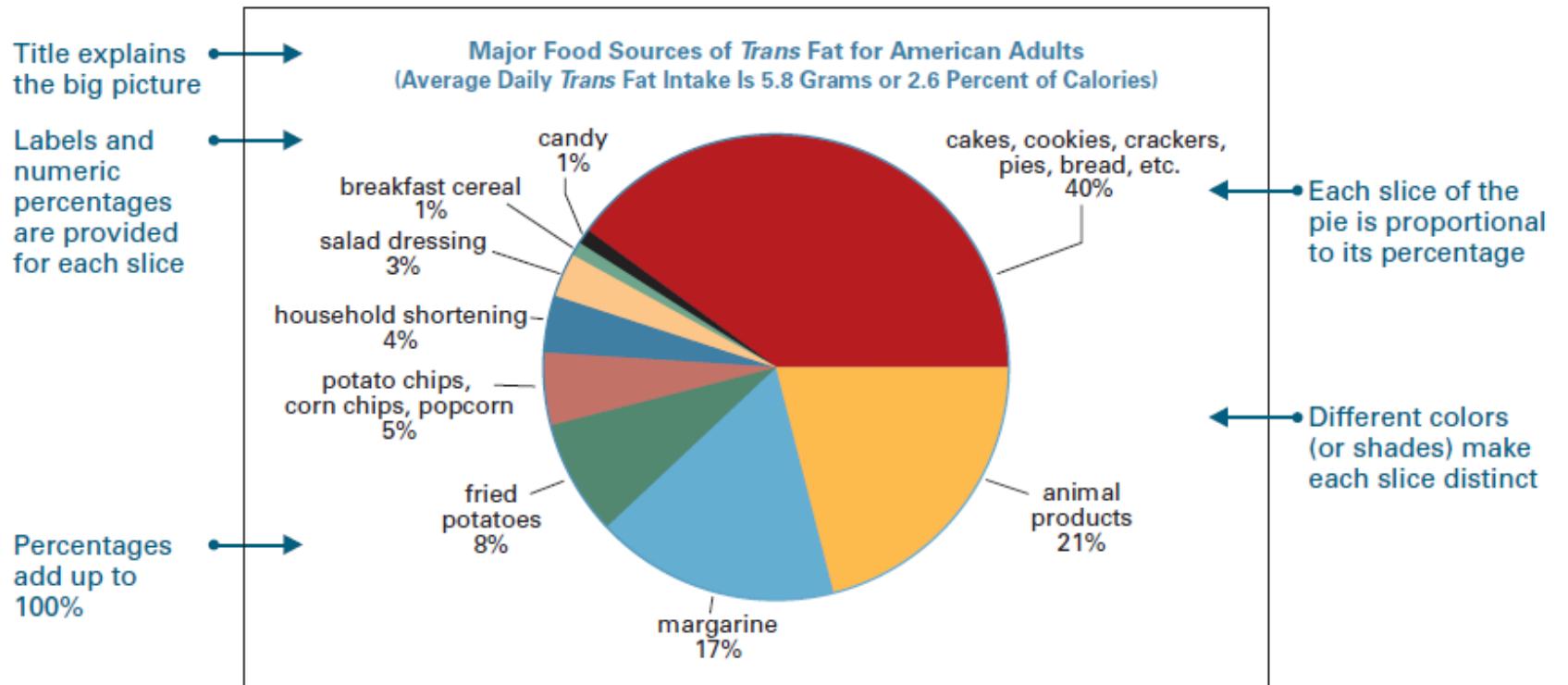


FIGURE 12.13 A Simple Pie Chart Shows the relationships of parts or percentages to the whole.

Source: U.S. Food and Drug Administration.

Charts

Exploded pie chart

They highlight various pieces of the pie.

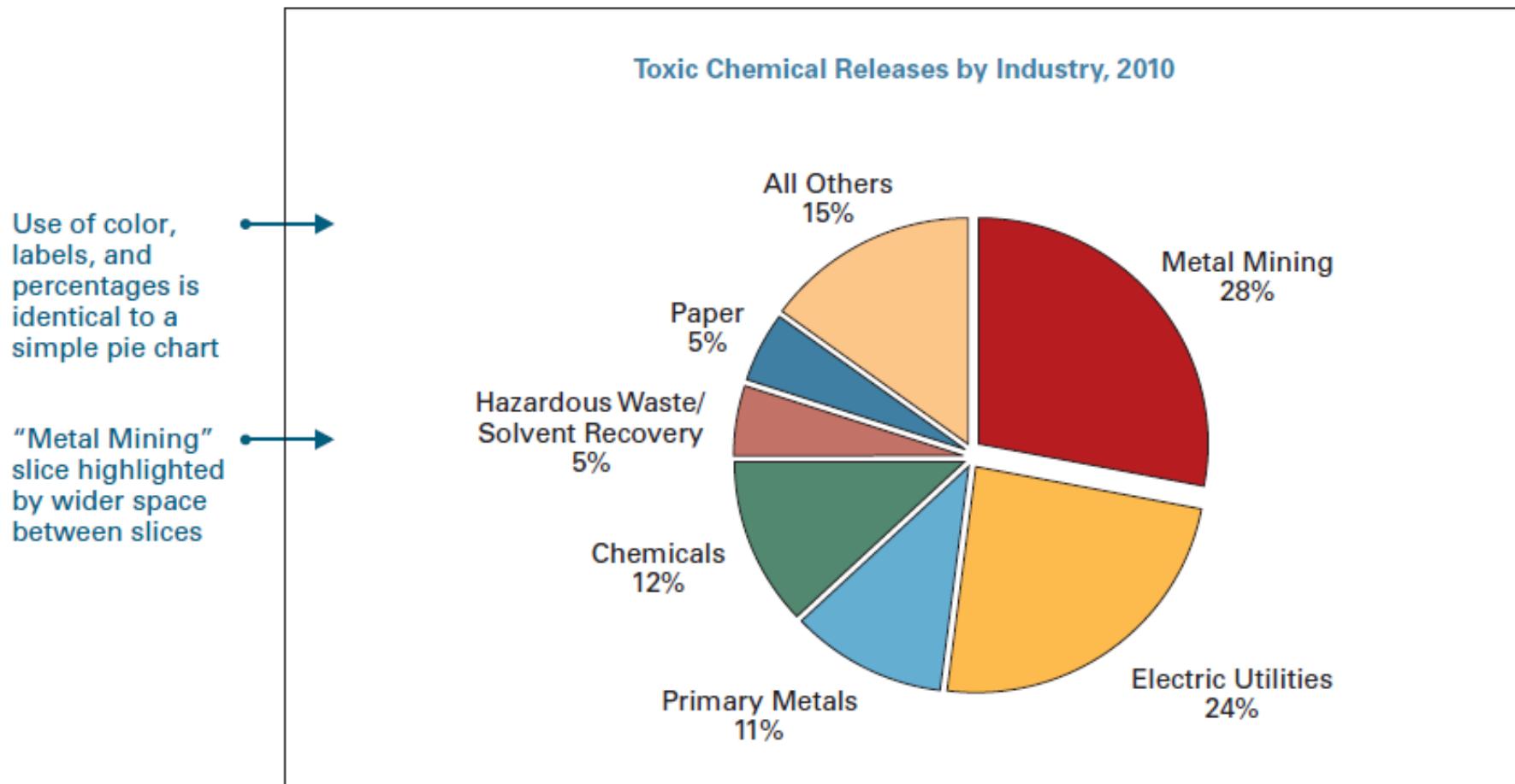


FIGURE 12.14 An Exploded Pie Chart Highlights various slices.

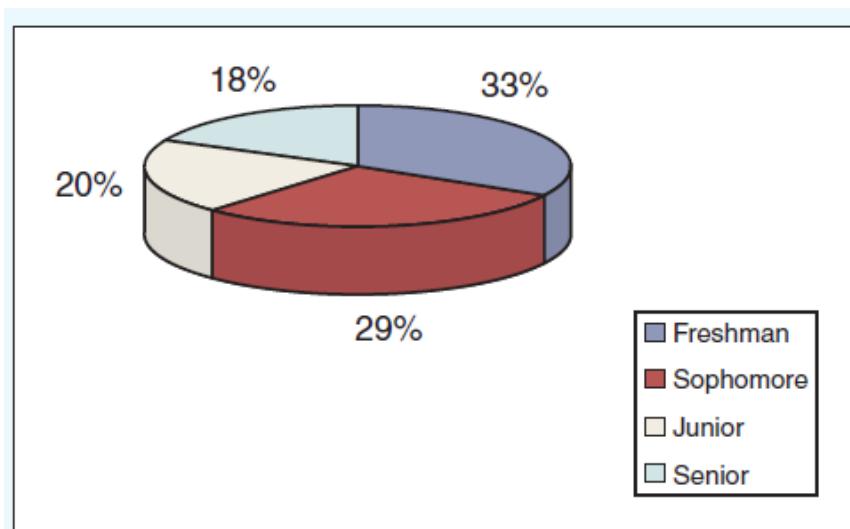
Source: U.S. Environmental Protection Agency. (See Table 12.3, page 245, for data.)

Guidelines for creating Effective Pie Charts

- **Restrict the number of slices to no more than seven.**
As the slices get smaller, judging their relative sizes becomes more difficult.
- **Begin with the largest slice at the top and work clockwise in order of decreasing size, unless you have a good reason to arrange the slices otherwise.**
- **If you have several very small quantities, put them together in one slice, to maintain clarity.**
Explain its contents in a footnote. This slice, sometimes called “other,” follows the other slices.
- **Place a label (horizontally, not radially) inside the slice, if space permits.**
Include the percentage that each slice represents and, if appropriate, the raw number.
- **To emphasize one slice, use a bright, contrasting color or separate the slice from the pie.**
Do this, for example, when you introduce a discussion of the item represented by that slice.

Guidelines for creating Effective Pie Charts

- **Check to see that your software follows the appropriate guidelines for pie charts.**
Some spreadsheet programs add fancy visual effects that can impair comprehension.
For instance, many programs portray the pie in three dimensions, as shown here.
- **Don't overdo fill patterns.**
Fill patterns are patterns, shades, or colors that distinguish one slice from another. In general, use simple, understated patterns or none at all.
- **Check that your percentages add up to 100.**
If you are doing the calculations yourself, check your math.



In this three-dimensional pie chart about the percentages of a college's student body, by year, the sophomore slice looks bigger than the freshman slice, even though it isn't, because it appears closer to the reader. To communicate clearly, make pie charts two-dimensional.

Charts

Organization Charts

- A popular form of diagram is the *organization chart*, in which simple geometric shapes, usually rectangles, suggest logical relationships.
- You can create organization charts with your word processor.
- An organization chart is often used to show the hierarchy in an organization, with the most senior person in the organization in the box at the top.
- Alternatively, an organization chart can show the functional divisions of a system, such as the human nervous system.

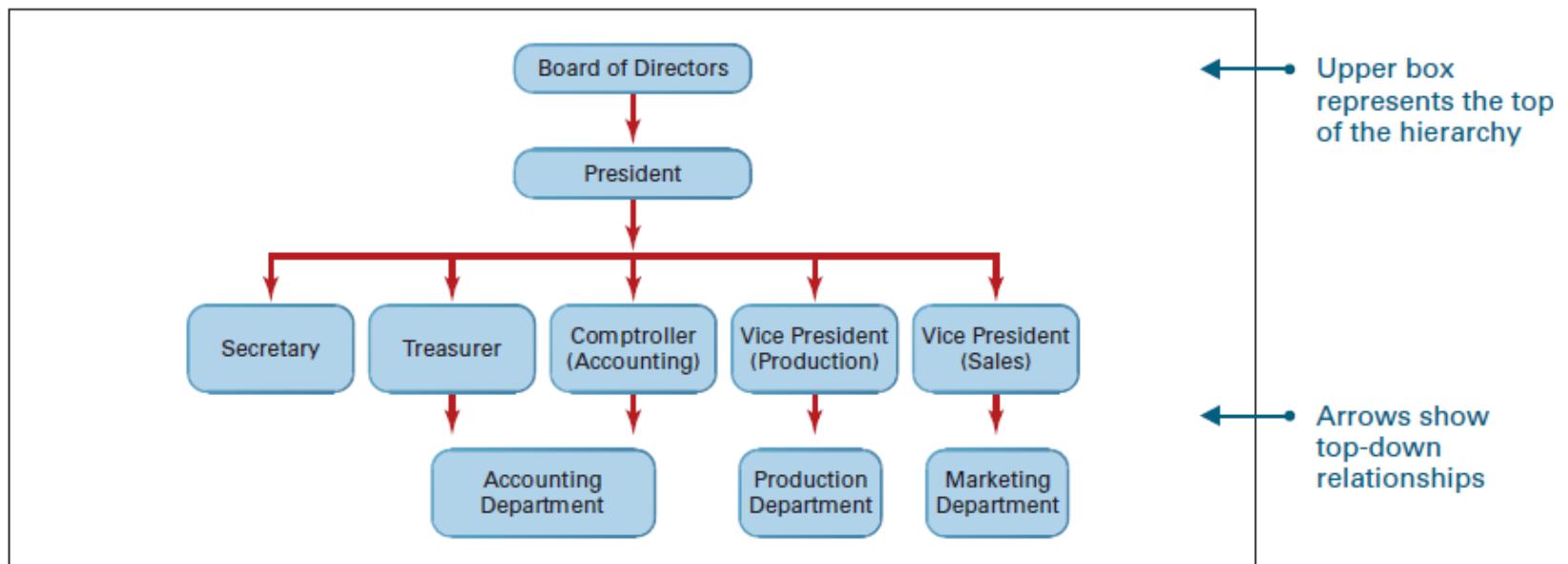


FIGURE 12.15 An Organization Chart Shows how different people or departments are ranked and related.

Charts

Flow Charts

- A flowchart traces a procedure or process from beginning to end.
- Figure 12.16 illustrates the procedure for helping an adult choking victim.

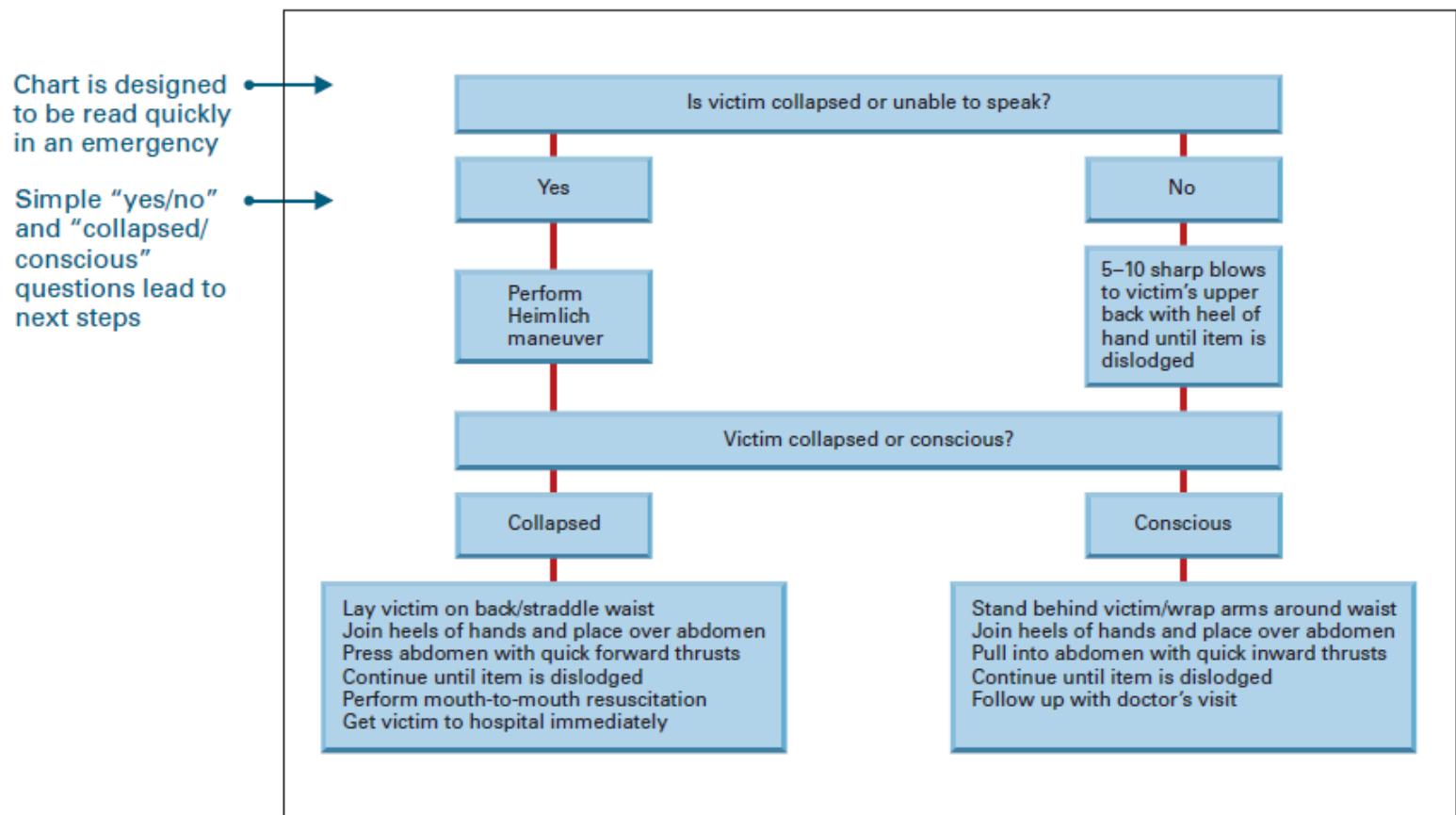


FIGURE 12.16 A Flowchart Depicts a sequence of events, activities, steps, or decisions.

Charts

Tree Charts

- Flowcharts display the steps in a process, tree charts show how the parts of an idea or concept are related.
- Figure 12.17 displays part of an outline for this chapter so that readers can better visualize relationships.
- The tree chart seems clearer and more interesting than the prose listing.

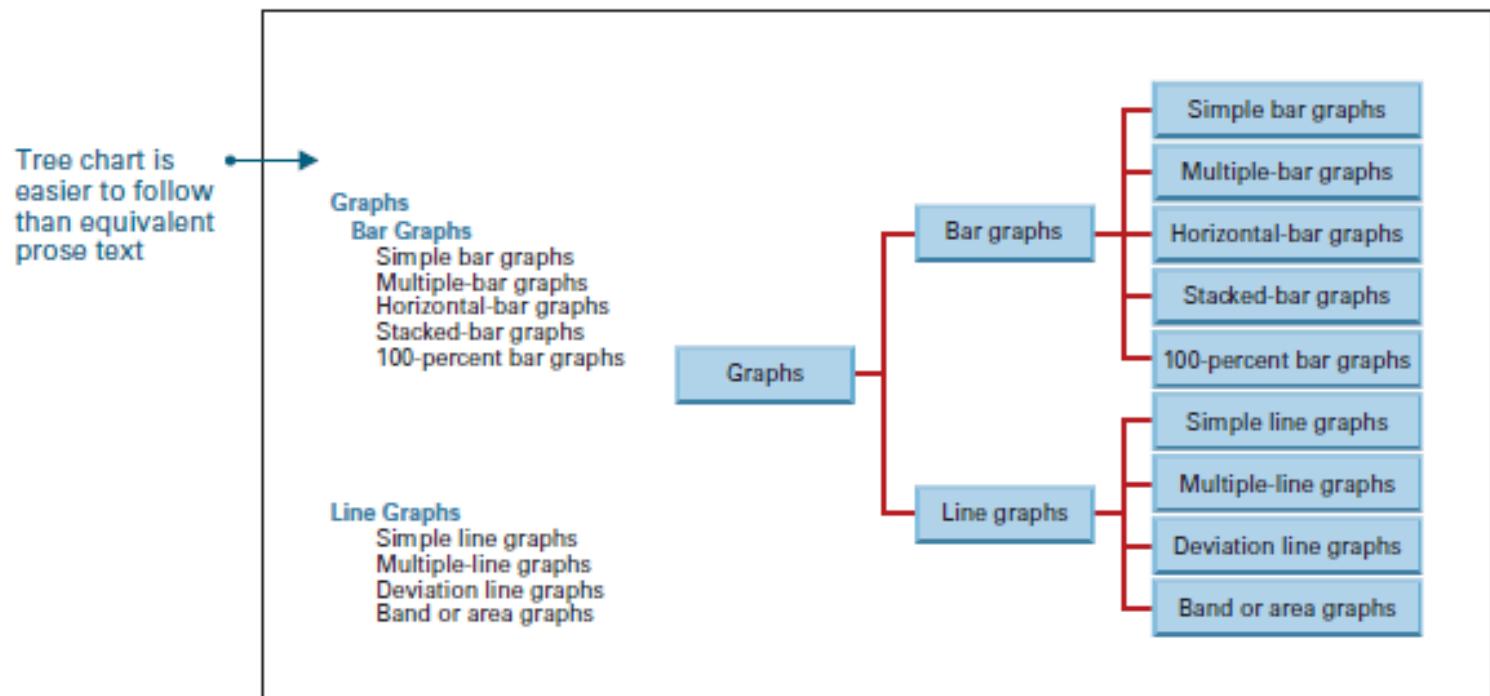


FIGURE 12.17 An Outline Converted to a Tree Chart Shows which items belong together and how they are connected.

Charts

Gantt Charts

- Named after engineer H. L. Gantt (1861–1919), Gantt charts depict how the parts of an idea or concept relate.
- A series of bars or lines (time lines) indicates start-up and completion dates for each phase or task in a project. Gantt charts are useful for planning and tracking a project.
- The Gantt chart in Figure 12.18 illustrates the schedule for a manufacturing project.

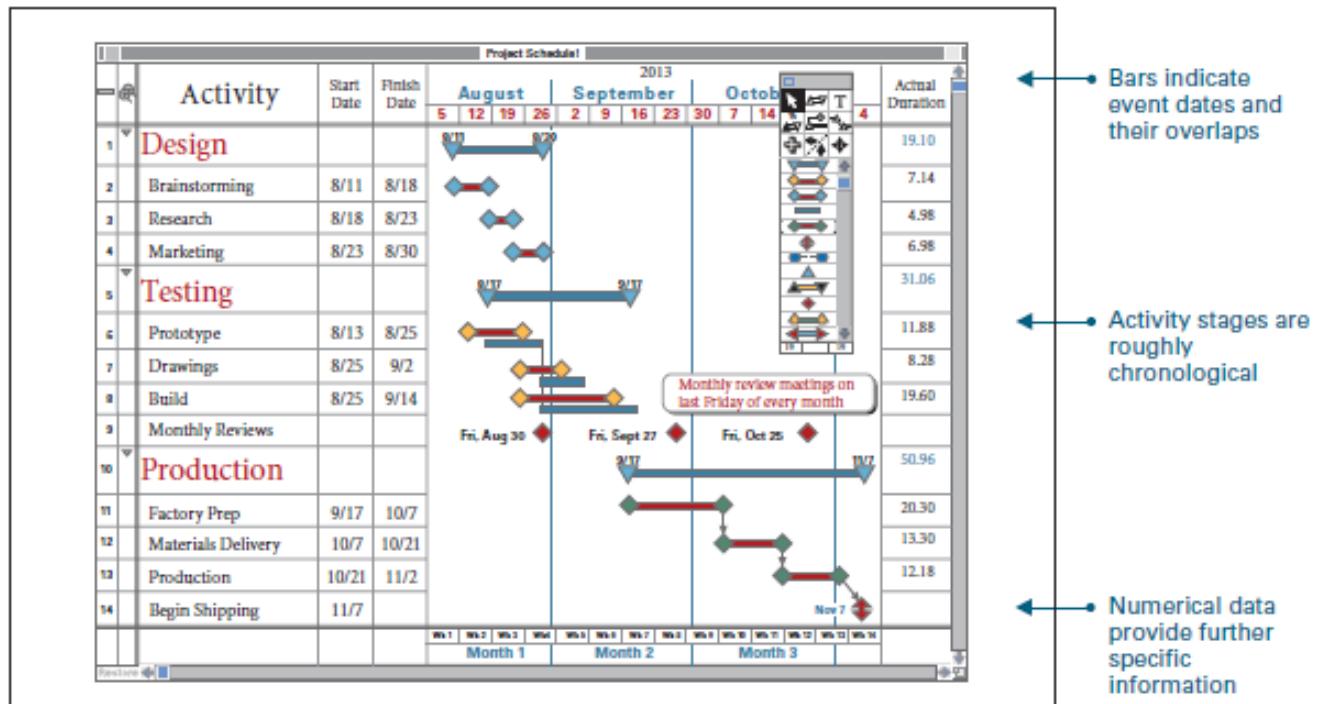


FIGURE 12.18 A Gantt Chart Depicts how the phases of a project interrelate.
Source: Chart created in *FastTrack Schedule™*. Reprinted by permission from AEC Software.

Charts

PERT Charts

- A PERT (Program Evaluation and Review Technique) chart uses shapes and arrows to outline a project's main activities and events (Figure 12.19).
- Both types of charts can be created with project management software such as *Microsoft Project*.

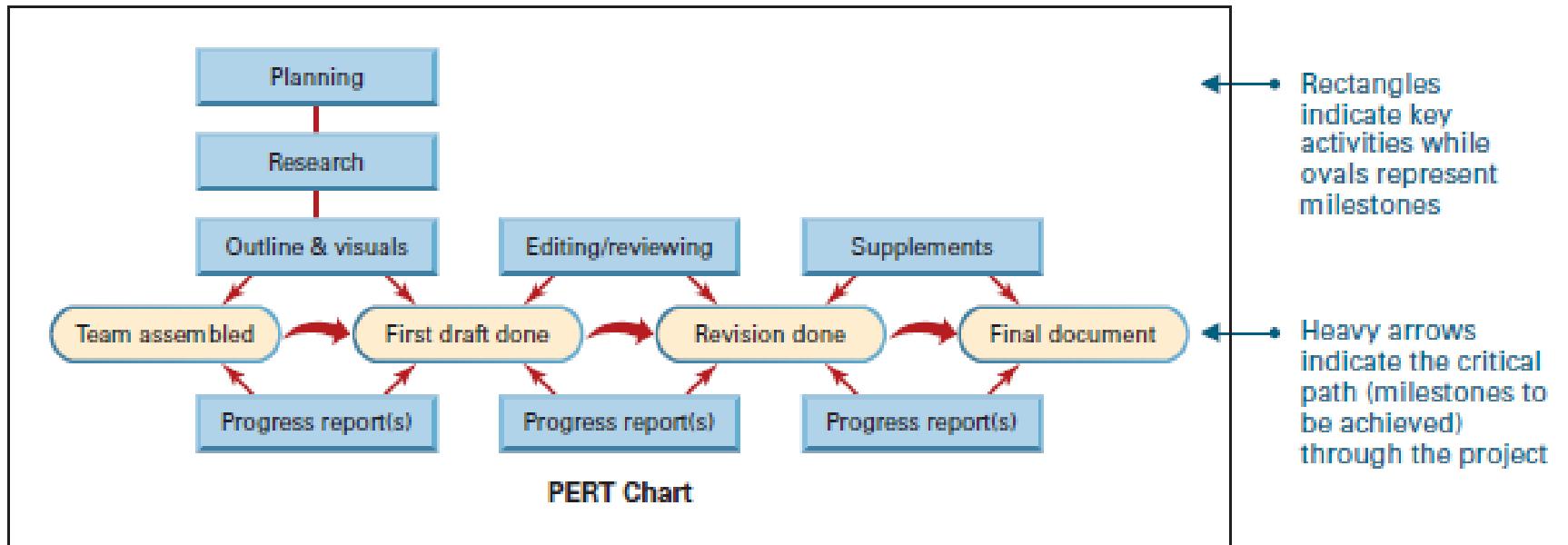


FIGURE 12.19 A PERT Chart This chart maps out the key activities and milestones ("Team assembled," "First draft done," and so on) for a major technical report to be produced by a collaborative team.

Charts

Pictograms

- Pictograms are something of a cross between a line graph and a chart.
- Like line graphs, pictograms display numerical data, often by plotting it across *x* and *y* axes.
- But like a chart, pictograms use icons, symbols, or other graphic devices rather than simple lines or bars.
- In Figure 12.20, stick figures illustrate population changes during a given period.
- Pictograms are visually appealing and can be especially useful for nontechnical or multicultural audiences.

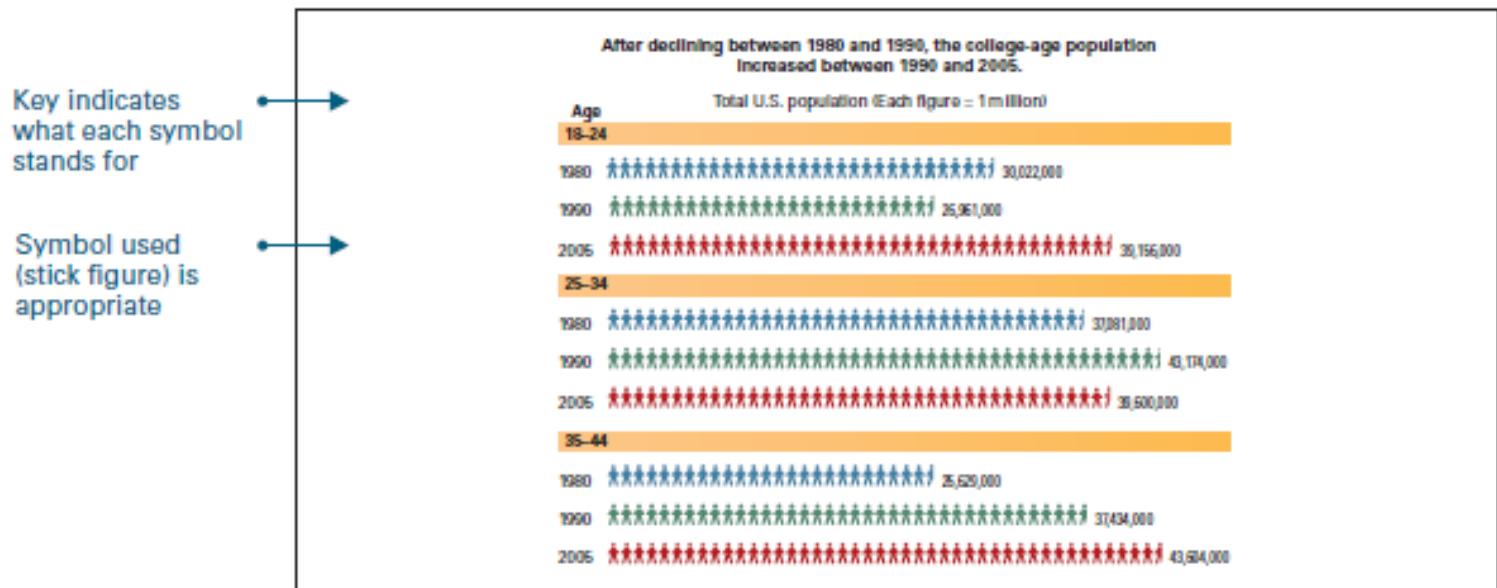


FIGURE 12.20 A Pictogram In place of lines and bars, icons and symbols lend appeal and clarity.

Source: U.S. Bureau of the Census.

Guidelines for Creating Charts

Pie Charts

- **Make sure the parts of the pie add up to 100 percent.**
- **Differentiate and label each slice clearly.**

Use different colors or shades for each slice, and label the category and percentage of each slice.

- **Keep all labels horizontal.**
Make the chart easy to read.
- **Combine very small pie slices.**
Group categories with very small percentages under “other.”

Organization Charts

- **Move from top to bottom or left to right.**
Place the highest level of hierarchy at the top (top-to-bottom chart) or at the left (left-to-right chart).
- **Use downward- or rightward-pointing arrows.**
Arrows show the flow of hierarchy from highest to lowest.

Guidelines for Creating Charts

- **Keep boxes uniform and text brief.**

Shape may vary slightly according to how much text is in each box. Maintain a uniform look. Avoid too much text in any box.

Flowcharts, Tree Charts, and Gantt Charts

- **Move from top to bottom or left to right.**

The process must start at the top (top-to-bottom chart) or left (left-to-right chart).

- **Use connector lines.**

Show relationships between the parts.

- **Keep boxes uniform and text brief.**

Pictograms

- **Use symbols that are universally recognized.**

- **Keep the pictogram clean and simple (avoid too much visual clutter).**

Graphic Illustrations

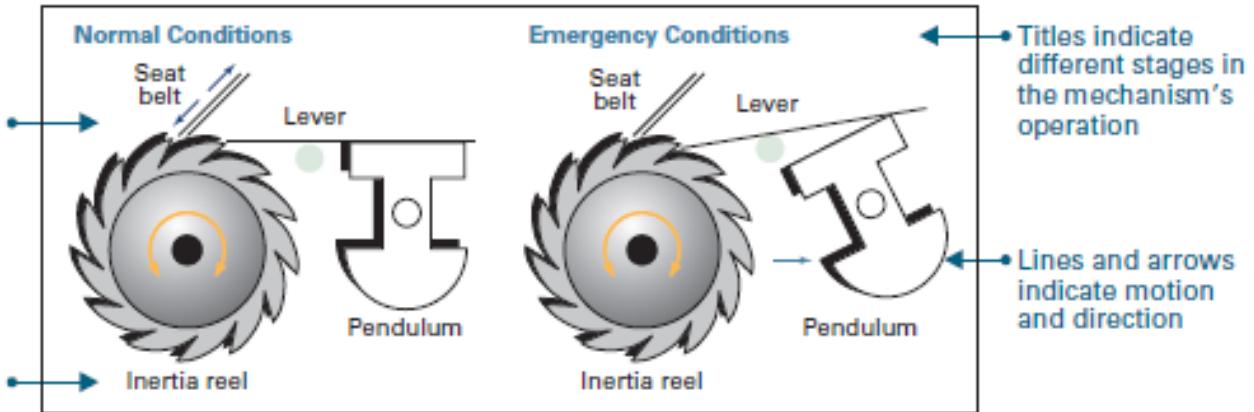
- Illustrations can be diagrams, maps, drawings, icons, photographs, or any other visual that relies mainly on pictures rather than on data or words.
- For example, the diagram of a safety-belt locking mechanism in Figure 12.21 accomplishes what the verbal text alone cannot: it portrays the mechanism in operation.

The safety-belt apparatus includes a tiny pendulum attached to a lever, or locking mechanism. Upon sudden deceleration, the pendulum swings forward, activating the locking device to keep passengers from pitching into the dashboard.

Verbal text that requires a visual supplement

Simple line drawings make the diagram easy to understand

All parts are clearly labeled



Titles indicate different stages in the mechanism's operation

Lines and arrows indicate motion and direction

FIGURE 12.21 A Diagram of a Safety-Belt Locking Mechanism Shows how the basic parts work together.

Source: U.S. Department of Transportation.

Graphic Illustrations

- Illustrations are invaluable when you need to convey spatial relationships or help your audience see what something actually looks like.
- Drawings can often illustrate more effectively than photographs because a drawing can simplify the view, omit unnecessary features, and focus on what is important.

Graphic Illustrations

- Diagrams are especially effective for presenting views that could not be captured by photographing or actually observing the item.
- **Exploded diagrams** show how parts of an item are assembled, as in Figure 12.22.
- These diagrams often appear in technical repair or maintenance manuals.
- This diagram could be annotated with numbers, or a caption, or other information to explain the relationship of parts to the whole.

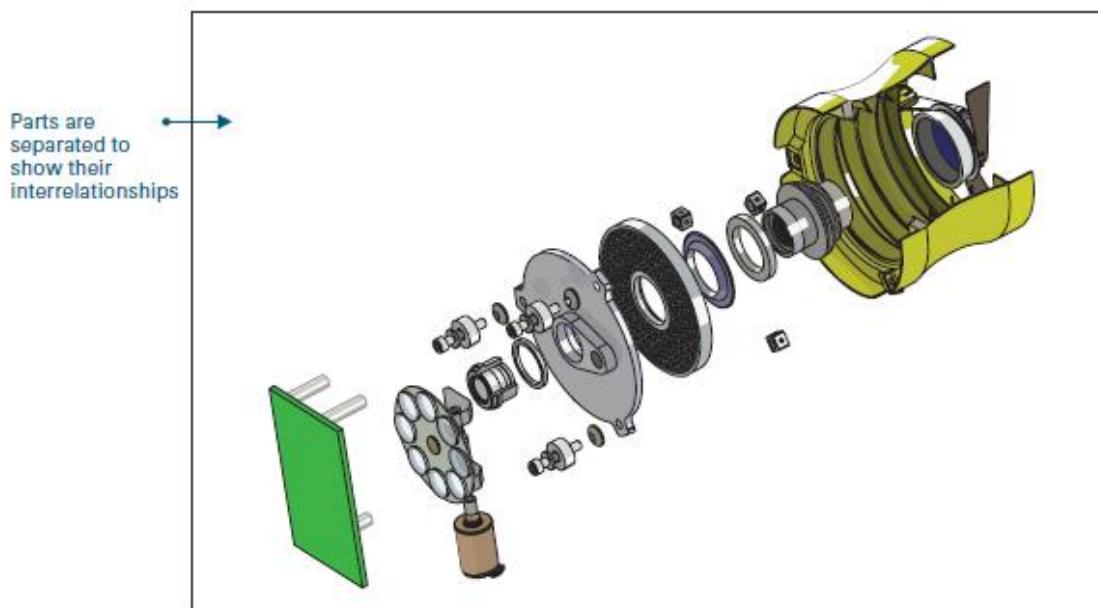


FIGURE 12.22 An Exploded Diagram of Imaging Instruments Used in Space

Source: NASA

Graphic Illustrations

- **Cutaway diagrams** show the item with its exterior layers removed to reveal interior sections, as in Figure 12.23.
- Unless the specific viewing perspective is immediately recognizable (as in Figure 12.23), name the angle of vision: “top view,” “side view,” and so on.

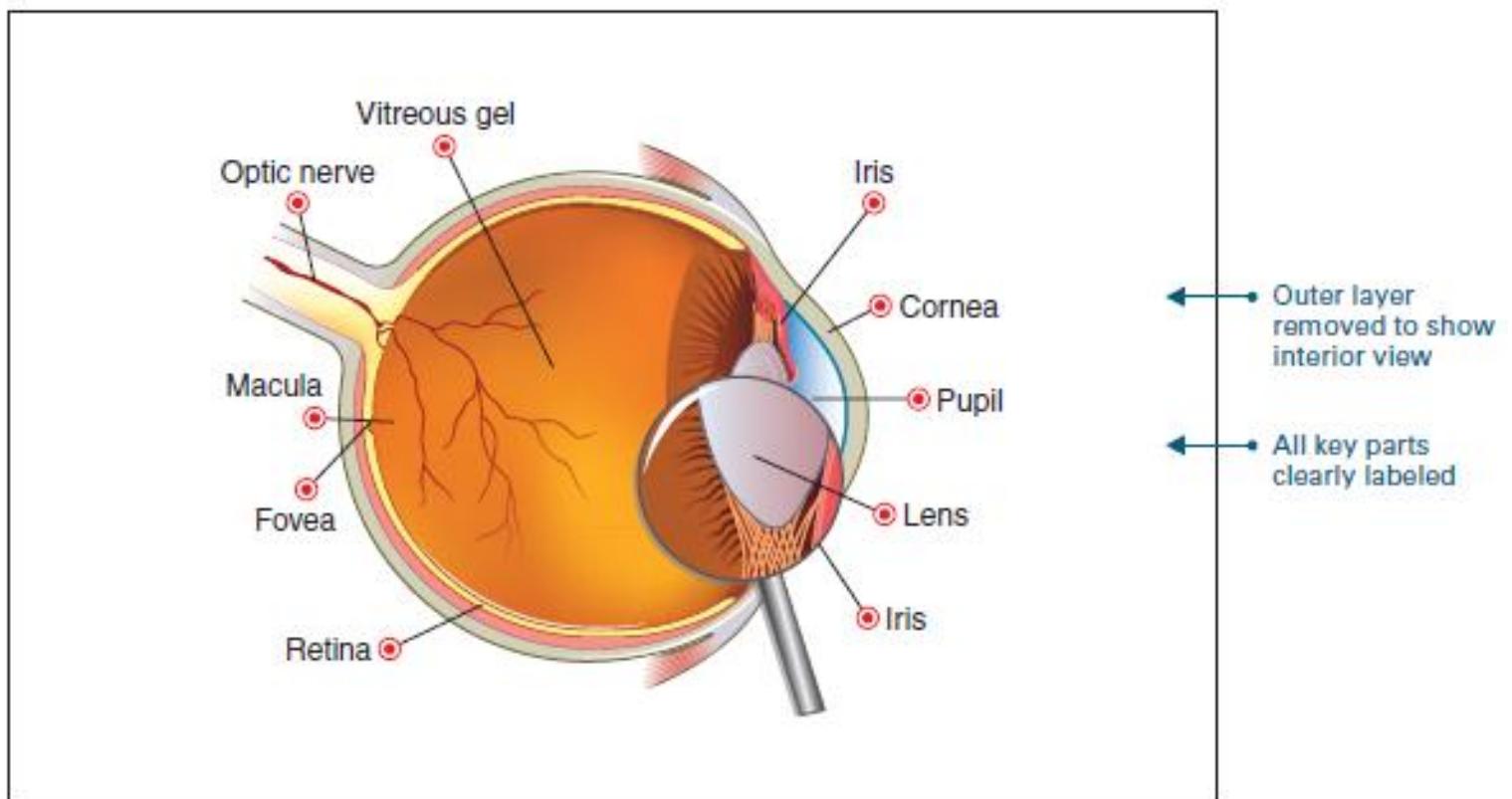


FIGURE 12.23 Cutaway Diagram of an Eye Shows what is inside.

Source: Courtesy of National Eye Institute, National Institutes of Health (NEI/NIH).

Graphic Illustrations

- **Block diagrams** are simplified sketches that represent the relationship between the parts of an item, principle, system, or process.
- Because block diagrams are designed to illustrate *concepts* (such as current flow in a circuit), the parts are represented as symbols or shapes.
- The block diagram in Figure 12.24 illustrates how any process can be controlled automatically through a feedback mechanism.
- Figure 12.25 shows the feedback concept applied as the cruise-control mechanism on a motor vehicle.

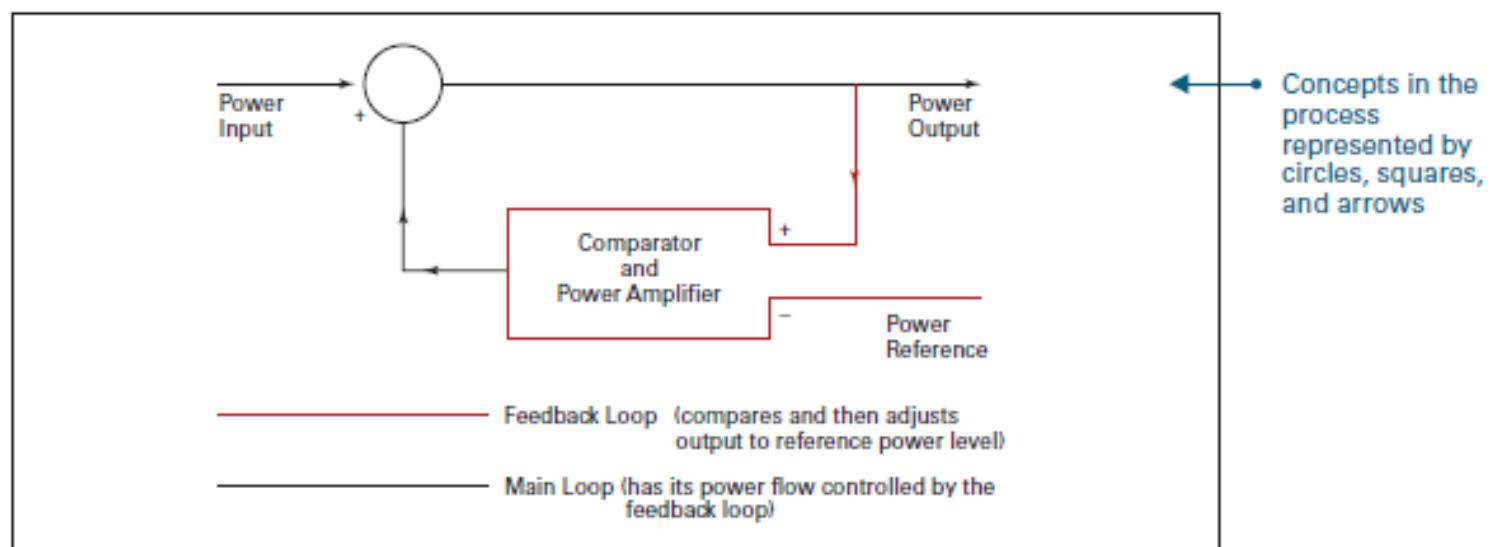


FIGURE 12.24 A Block Diagram Illustrating the Concept of Feedback

Graphic Illustrations

- Specialized diagrams generally require the services of graphic artists or technical illustrators.
- The client requesting or commissioning the visual provides the art professional with an *art brief* (often prepared by writers and editors) that spells out the visual's purpose and specifications.
- The art brief is usually reinforced by a *thumbnail sketch*, a small, simple sketch of the visual being requested.

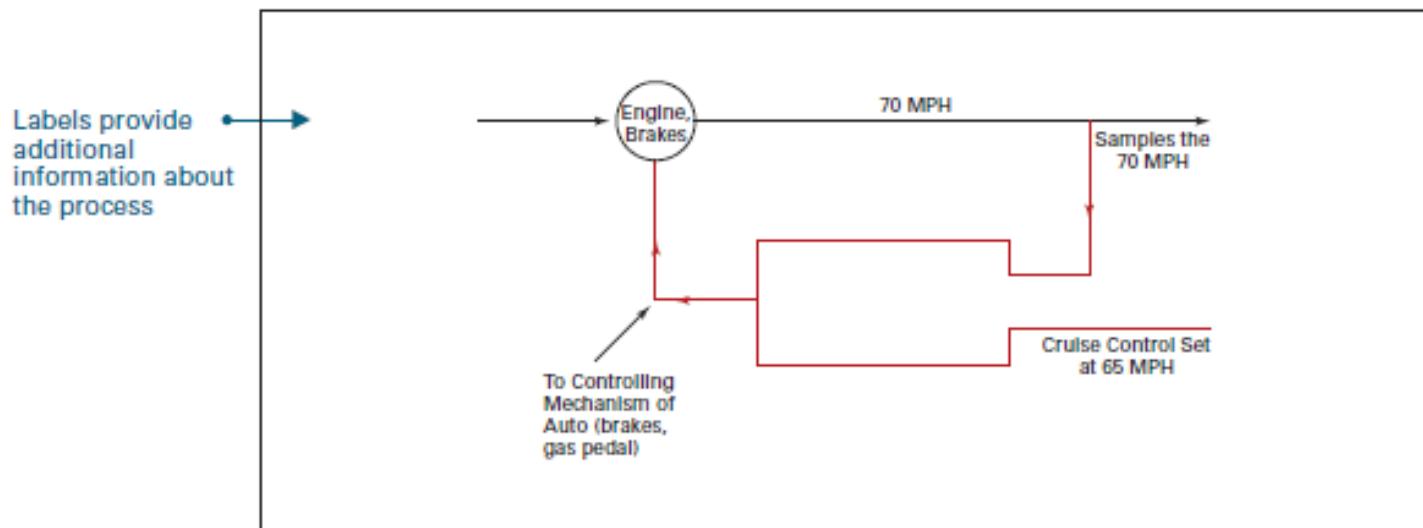


FIGURE 12.25 A Block Diagram Illustrating a Cruise-Control Mechanism Depicts a specific application of the feedback concept.

Maps

- Besides being visually engaging, maps are especially useful for showing comparisons and for helping readers *visualize* position, location, and relationships among various data.
- Figure 12.26 synthesizes statistical information in a format that is accessible and understandable.
- Color enhances the comparisons.

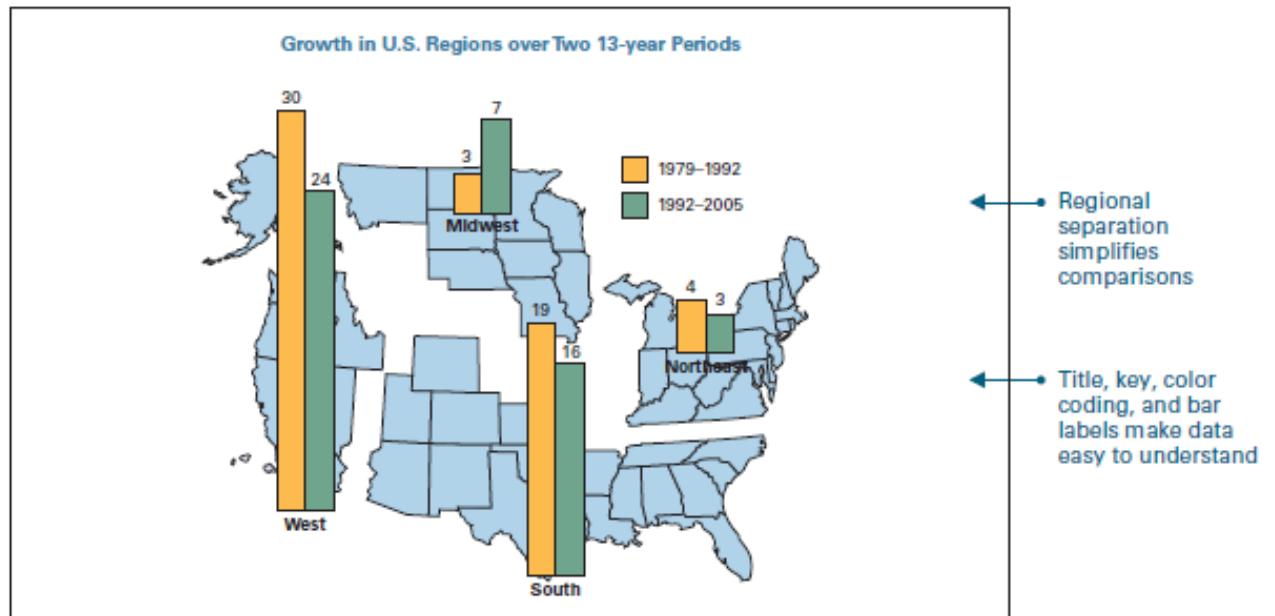


FIGURE 12.26 A Map Rich in Statistical Significance Shows the geographic distribution of data.

Source: U.S. Bureau of the Census.

Symbols and Icons

- Symbols and icons can convey information visually to a wide range of audiences.
- Because such visuals do not rely on text, they are often more easily understood by international audiences, children, or people who may have difficulty reading.
- Symbols and icons are used in airports and other public places as well as in documentation, manuals, or training material.
- Some of these images are developed and approved by the International Organization for Standardization (ISO).
- The ISO makes sure the images have universal appeal and conform to a single standard, whether used in a printed document or on an elevator wall.
- The words *symbol* and *icon* are often used interchangeably.
- Technically, icons tend to resemble the item they represent: An icon of a file folder on your computer, for example, looks like a real file folder.
- Symbols can be more abstract.
- Symbols still get the meaning across but may not resemble, precisely, what they represent. Figure 12.27 shows some familiar icons and symbols.

Symbols and Icons

- Ready-to-use icons and symbols can be found in clip-art collections, from which you can import and customize images by using a drawing program.
- Because of its generally unpolished appearance, consider using clip art only for in-house documents or for situations in which your schedule or budget preclude obtaining original artwork.



FIGURE 12.27 Internationally Recognized Icons and Symbols

Guidelines for Creating Graphic Illustrations

Drawings and Diagrams

- **Provide clear explanations.**
Explain how diagram parts fit together or operate.
- **Use lines and arrows to indicate direction and motion.**
For diagrams that show action, directional markers help viewers understand the action.
- **Keep diagram illustrations simple.**
Only show viewers what they need to see.
- **Label each important part.**

Maps

- **Use maps from credible sources, such as the U.S. Census Bureau or other government agencies.**
- **Keep colors to a minimum, so that the maps are easy to read on a computer or in print.**

Symbols and Icons

- **Use internationally recognized symbols and icons.**
Check out the International Standards Organization (ISO) Web site for more information.

Photographs

- Photographs are especially useful for showing exactly how something looks (Figure 12.28) or how something is done (Figure 12.29).
- Unlike a diagram, which highlights certain parts of an item, photographs show everything.
- So, while a photograph can be extremely useful, it also can provide too much detail or fail to emphasize the parts on which you want people to focus.
- For the most effective photographs, use a professional photographer who knows all about angles, lighting, lenses, and special film or digital editing options.

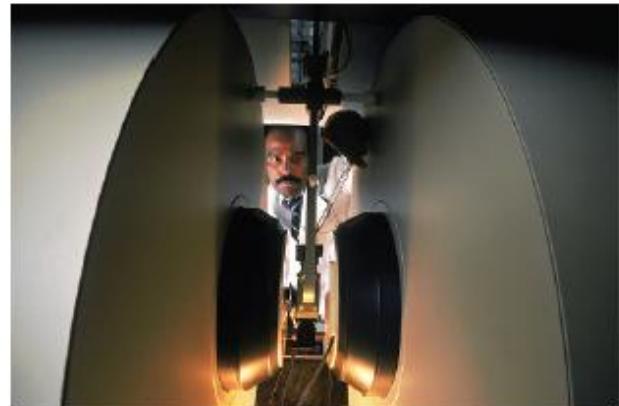


FIGURE 12.28 Shows a Realistic Angle of Vision Titration in measuring electron-spin resonance. (Shows object as well as person for sense of scale. Also shows angle that simulates operator's angle of vision. Photo has been cropped to remove needless detail.)
Source: RGB Ventures LLC dba SuperStock/Alamy.



FIGURE 12.29 Shows Essential Features Labeled Standard flight deck for a long-range jet.
Source: Design Pics Inc.—RM Content/Alamy.

Photographs

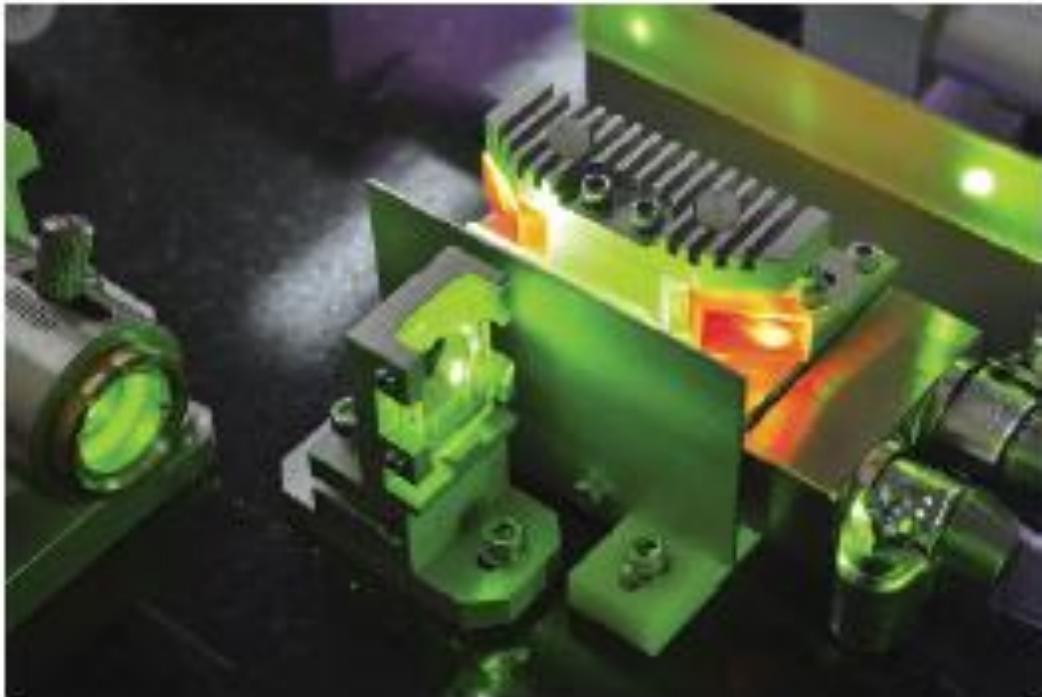


FIGURE 12.30 Shows a Complex Mechanism Free tunable laser.
Source: YuryZap/Shutterstock.

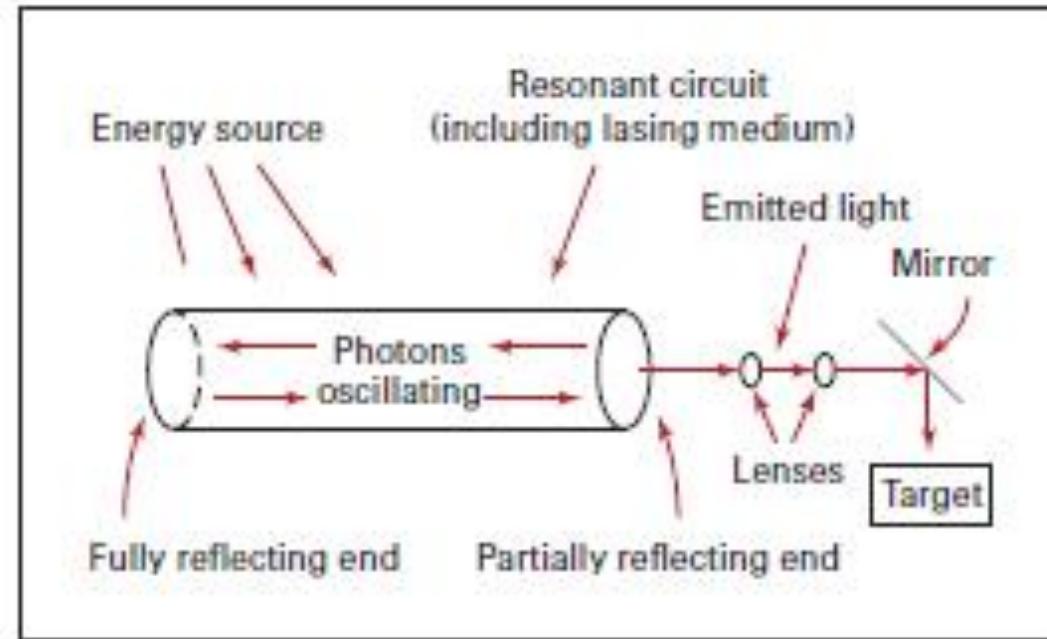


FIGURE 12.31 A Simplified Diagram of Figure 12.30 Major parts of the laser.

Guidelines for Using Photographs

- **Simulate the readers' angle of vision.**

Consider how they would view the item or perform the procedure (Figure 12.28).

- **Trim (crop) the photograph to eliminate needless detail** (Figure 12.28).
- **Provide a sense of scale for an object unfamiliar to readers.**

Include a person, a ruler, or a familiar object (such as a hand) in the photo (Figure 12.28).

- **Label all the parts readers need to identify** (Figure 12.29).
- **Supplement the photograph with diagrams.**

This way, you can emphasize selected features. (Figures 12.30 and 12.31).

- **If your document will be published, attend to the legal aspects.**

Obtain a signed release from any person in the photograph and written permission from the copyright holder.

Cite the photographer and/or the copyright holder.

Guidelines for Using Photographs

- Explain what readers should look for in the photo.
Do this in your discussion or use a caption.
- Use appropriate digital sources.
Online, you can find a wealth of photography sites.
Some sites offer copyright-free photos or photos that can be used exclusively for educational or other limited-use purposes.
Check out Creative Commons, Shutterstock, or the Flickr Commons.
- Do not alter photos.
Except for adding annotations, captions, and citation information, as a rule, you should not alter original photographs without permission from the copyright holder.
Altering photos beyond their original look and feel is not only a legal concern; it could be an ethical one as well.

Principles of Effective Visual Design

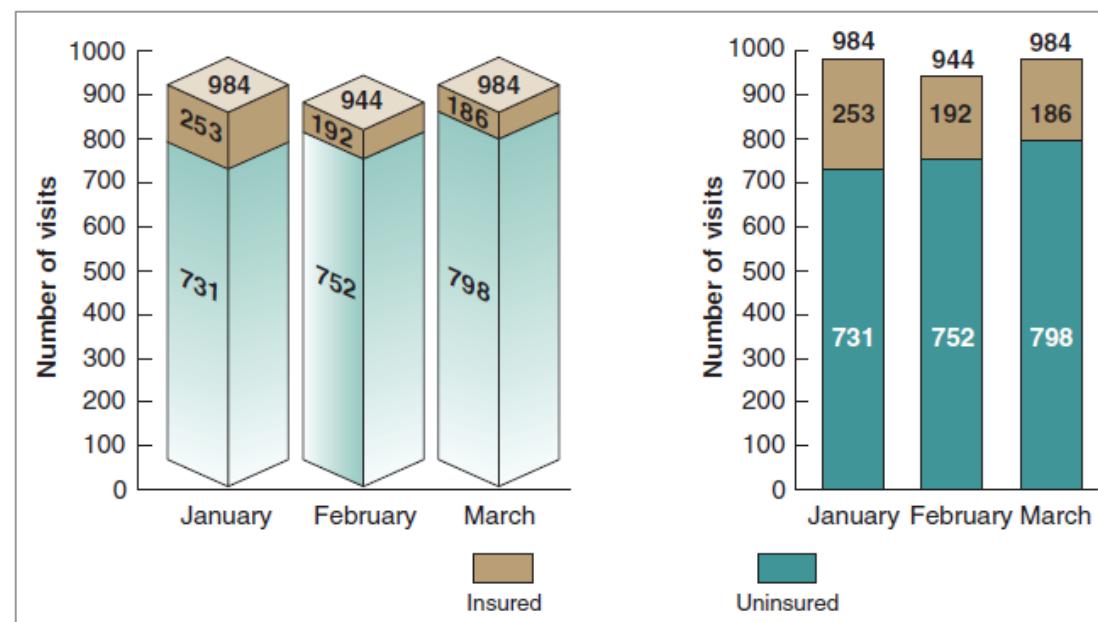
To be effective, graphics must be clear, understandable, and meaningfully related to the larger discussion. Follow these five principles:

- **A graphic should serve a purpose.**

- Don't include a graphic unless it will help readers understand or remember information.
- Avoid content-free photographs and clip art, such as drawings of businesspeople shaking hands.

- **A graphic should be simple and uncluttered.**

Three-dimensional bar graphs are easy to make, but they are harder to understand than two-dimensional ones, as shown in Figure 12.1.



Unnecessary 3D is one example of chartjunk, a term used by Tufte (1983) to describe the ornamentation that clutters up a graphic, distracting readers from the message.

The two-dimensional bar graph is clean and uncluttered; the three-dimensional graph is more difficult to understand because the additional dimension obscures the main data points. The number of uninsured emergency-room visits in February, for example, is very difficult to see in the three-dimensional graph.

FIGURE 12.1 *Chartjunk and Clear Art*

Principles of Effective Visual Design

- **A graphic should present a manageable amount of information.**

Presenting too much information can confuse readers.

Consider audience and purpose:

- what kinds of graphics are your readers familiar with, how much do they already know about the subject, and what do you want the document to do?
- Because readers learn best if you present information in small chunks, create several simple graphics rather than a single complicated one.

- **A graphic should meet readers' format expectations.**

- Through experience, readers learn how to read different kinds of graphics.
- Follow the conventions—for instance, use diamonds to represent decision points in a flowchart—unless you have a good reason not to.

- **A graphic should be clearly labeled.**

- Give every graphic (except a brief, informal one) a unique, clear, informative title.
- Fully label the columns of a table and the axes and lines of a graph.
- Don't make readers guess whether you are using meters or yards, or whether you are also including statistics from the previous year.

Integrating Graphics and Text

It is not enough to add graphics to your text; you have to integrate the two.

- **Place the graphic in an appropriate location.**
 - If readers need the graphic in order to understand the discussion, put it directly after the relevant point in the discussion or as soon after it as possible.
 - If the graphic merely supports or elaborates a point, include it as an appendix.
- **Introduce the graphic in the text.**
 - Whenever possible, refer to a graphic before it appears (ideally, on the same page).
 - Refer to the graphic by number (such as “see Figure 7”).
 - Do not refer to “the figure above” or “the figure below,” because the graphic might move during the production process.
 - If the graphic is in an appendix, cross-reference it: “For complete details of the operating characteristics, see Appendix B, page 19.”

Integrating Graphics and Text

- **Explain the graphic in the text.**
 - State what you want readers to learn from it.
 - Sometimes a simple paraphrase of the title is enough: “Figure 2 compares the costs of the three major types of coal gasification plants.”
 - At other times, however, you might need to explain why the graphic is important or how to interpret it.
 - If the graphic is intended to make a point, be explicit: As Figure 2 shows, a high-sulfur bituminous coal gasification plant is more expensive than either a low-sulfur bituminous or an anthracite plant, but more than half of its cost is for cleanup equipment.
 - If these expenses could be eliminated, high-sulfur bituminous would be the least expensive of the three types of plants.
 - In addition to text explanations, graphics are often accompanied by captions, ranging from a sentence to several paragraphs.
- **Make the graphic clearly visible.**
 - Distinguish the graphic from the surrounding text by adding white space around it, placing rules (lines) above and below it, putting a screen behind it, or enclosing it in a box.
- **Make the graphic accessible.**
 - If the document is more than a few pages long and contains more than four or five graphics, consider including a list of illustrations so that readers can find them easily.



PES
UNIVERSITY

TECHNICAL WRITING

UNIT 4

Core Technical Document Production and AI Integration

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Purpose of Technical Reports

A technical report is a formal document that **communicates factual information** about technical research, development, or investigation clearly and objectively.

- 1. Record and Reference:** They serve as a **permanent record** of work done, data collected, and conclusions reached. (e.g., *a record of lab results or a design specification*).
 - 2. Decision Making:** Reports provide the **data and analysis** necessary for managers, clients, or other engineers to make informed decisions. (e.g., *Should we approve this design? Should we switch materials?*).
 - 3. Problem Solving:** They document the **process of investigation** and propose solutions to a technical problem.
 - 4. Knowledge Transfer:** They ensure that **complex technical knowledge** is shared accurately and efficiently across teams or organizations.
- **Think of it this way:** A technical report is your opportunity to **prove your work and persuade** your audience to act based on your data.

Categories of Reports

- **Formal**
 - Meticulously structured, focus on objectivity, organization, deeper details, written in proper style.
 - A technical report is a formal and organized documentation of the process, progress, results of research created to communicate to an audience important information about the work.
- **Informal**
 - short, free-flowing messages, casual language style

Types of Research Reports

1. Technical or Scientific Report

- A document that describes the process, progress, or results of a research or the state of a technical or scientific research problem
- Includes summary of results, nature of study, research methodology, details of data, analysis, conclusions, bibliography, appendix, index

2. Popular Report

- Emphasis on simplicity and attractiveness, consists of clear writing, minimal technical and mathematical details, liberal use of charts and diagrams, large-print, cartoons
- Includes findings, recommendations, objective, methods, results, appendix

Types of Research Reports

3. Interim Report

- Short report to analyze how project is proceeding before completion
- May contain first results of analysis
- Helps sponsoring agency to take action without full report, keeps their interest alive in study and prevent misunderstanding about delays
- Important in medical trials to ensure patients are not exposed to danger, and helps researchers find appropriate style of reporting

4. Summary Report

- Includes a brief statement about problem, objective, background information, concise analysis, findings and conclusion
- Aids managers in decision making, important part of business plans
- Short, limited size, published in newspapers

Types of Research Reports

5. Algorithmic Research Report

- Problems exist in reality and solution to these problems can be expressed or obtained as an algorithm
- A report that contains the problem, algorithms used to solve the problem and the steps, implementation and findings

Standard Components

1. Title

- Few words(keywords), concise, crisp, specific but not narrow
- Captures relevant aspects of study without expectations
- Captivating, expressive, no extra words(articles, studies etc.)
- Indexed in search engines or databases and important for literature search

2. Authors

- Greatest to least contribution, head of group is listed last, use same name in all papers

3. Abstract

- Summary, widely read and important
- Helps identify content of a paper and determine relevance to one's current research work—should be consistent with main content
- Returned by search engines
- IMRaD format – Introduction, Method, Results and Discussion
- No figures, charts, tables or references
- Do not copy-paste from main content, write after main content is written

Standard Components

4. Introduction

- Background to understand paper
- Highlight relevance and importance of work, no obvious facts
- Pose research question and motivate
- Short, general to specific content structure
- Identify knowledge gap, unknowns, attempts made
- How is problem solved, need for solving
- Key primary literature, investigate hypothesis
- Terms, definitions, clarifications
- Strong verbs and active voice, write after main content

Standard Components

5. Materials and Methodology

- Helps replicate and evaluate work
- Describe study design in detail so that work is reproducible
- Identify equipment, variables, metrics, analysis, sources, approvals, statistical methods
- Reason for methodology(should be sound–affects credibility and validity of results)
- Past tense, active voice, use tables and figures

Standard Components

6. Results

- Two parts—description of results and presentation of data
- Tables and figures
- Present results, do not add too much detail
- Organized order—answer the research questions
- No methodology, no raw data(present results/insights)
- Short, summarized, past tense

Standard Components

7. Discussion

- Answer research questions with justification based on results
- Explain research gap, questions, summary of findings and how it answers the questions
- Discussion and introduction are a pair(answers to questions)
- Limitations, relationship with other research, relevance of study
- Specific to general, active voice

8. Tables

- Should be understandable without text, self-explanatory
- Uniform format across paper, follow instructions to authors
- Add table number and caption

Standard Components

9. Figures

- Avoid too much information
- Ensure font size in image is readable when printed
- Add figure number and caption
- Follow instructions to authors

10. Acknowledgement

- Thank people who helped with work but did not make contributions deserving
- Authorship (example, financial support) after taking their prior permission.

11. References/Bibliography

- Give credit to other authors and add credibility to your own work
- Aids further reading on topic
- Use correct reference format

Standard Components

Active and Passive Voice

- Use active voice for emphasis on important parts of a sentence and cutdown wordcount.
- Use passive voice if the agent is unknown, unimportant or obvious,
- Or is less important than the action or topic.

Keywords for Research Articles

- Indexed by search engines and used for quick retrieval
- Avoid terms in title(use alternate ones),ensure they are relevant
- Test keywords before submitting

Elements of a Technical Proposal

- Research (or grant) proposals request approval (and often funding) for some type of study.
- Research proposals are solicited by many agencies, including the National Science Foundation and the National Institutes of Health.
- Each agency has its own requirements and guidelines for proposal format and content.
- In these cases, proposal readers will generally be other scientists; therefore, writers can use language that is appropriate for other experts.
 1. Problem
 2. Solution
 3. Methodology
 4. Budget
 5. Timeline

Elements of a Technical Proposal

Element	Focus	Key Question Answered
1. Problem	The "Why"	What is the challenge/need, and why does it matter?
2. Solution	The "What"	What exactly will be delivered or achieved?
3. Methodology	The "How"	How will the solution be implemented, step-by-step?
4. Budget	The "Cost"	How much money and resources are required?
5. Timeline	The "When"	How long will each phase take, and when will it be finished?

Elements of a Technical Proposal

- **Element 1 - The Problem Statement**
- **Objective:** To clearly and compellingly define the gap or need. This section builds urgency and justifies the entire project.
- **Content Includes:**
 - **Context:** Background information on the situation.
 - **Specific Need/Challenge:** A clear, measurable statement of the problem (e.g., "The current system fails to meet 'X' regulatory standard").
 - **Impact:** What is the consequence of *not* solving the problem? (e.g., increased costs, safety risks, lost productivity).
- **Technical Tip:** Be precise. Avoid vague terms. Use data and statistics to substantiate the problem.

Elements of a Technical Proposal

- **Element 2 - The Proposed Solution**
- **Objective:** To present a clear, high-level overview of the proposed resolution that directly addresses the problem.
- **Content Includes:**
 - **Executive Summary-Level Answer:** State the solution simply and directly (e.g., "We propose to design and implement a new automated quality control system using Machine Vision").
 - **Benefits:** What tangible value will the solution provide? (e.g., 20% reduction in manufacturing defects, real-time data monitoring).
 - **Deliverables:** A list of the tangible items the client will receive (e.g., a prototype, a final design report, trained personnel).
- **Rule of Thumb:** Ensure a direct and visible link between the problem you identified and the solution you propose.

Elements of a Technical Proposal

- **Element 3 - Methodology (Work Plan)**
- **Objective:** To explain **how** the proposed solution will be executed, proving feasibility and competence. This is often the most critical technical section.
- **Content Includes:**
 - **Phases/Stages:** Breaking the project down logically (e.g., Research → Design → Prototype → Testing → Implementation).
 - **Specific Tasks:** Detailed steps for each phase.
 - **Tools/Techniques:** Mention the specific engineering methods, software, equipment, or standards you will use.
 - **Evaluation:** How will success be measured? (e.g., performance metrics, testing procedures).
- **Engineering Focus:** This section demonstrates your **technical expertise** and attention to detail.

Elements of a Technical Proposal

- **Element 4 - Budget**
- **Objective:** To provide a detailed, itemized cost breakdown of the project.
- **Content Includes:**
 - **Personnel:** Labor hours and rates for engineers, technicians, etc.
 - **Materials/Equipment:** Cost of components, software licenses, testing gear.
 - **Travel/Indirect Costs:** (Overhead, administrative fees, travel expenses).
 - **Total Cost:** The final requested amount.
- **Principle:** Every budget item must be logically justifiable by the tasks outlined in the **Methodology**. Transparency builds trust.

Elements of a Technical Proposal

- **Element 5 - Timeline (Schedule)**
- **Objective:** To define the start and end dates and the duration of key project activities.
- **Content Includes:**
 - **Key Milestones:** Specific, verifiable points of progress (e.g., "Final Design Review," "Prototype Completion").
 - **Duration:** Estimated time for each major phase/task.
 - **Visual Representation:** Use a **Gantt Chart** or milestone chart for clarity.
- **Realism Check:** Ensure the timeline is aggressive yet achievable. An overly optimistic timeline undermines credibility.

Research Papers & Journal Articles: The IMRAD Structure

- **IMRAD** is the globally standardized organizational structure for reporting original, primary research.
- **Acronym Breakdown:**
 - Introduction
 - Methods
 - Results
 - And
 - Discussion
- **Purpose:** To present scientific work logically and systematically, allowing readers to easily find, understand, and replicate the study. It answers four core questions:
 - **Why** did you do it? (Introduction)
 - **How** did you do it? (Methods)
 - **What** did you find? (Results)
 - **What** does it mean? (Discussion)

Research Papers & Journal Articles: The IMRAD Structure

- **Introduction (I)**
- **Function:** To provide context, define the problem, and state the paper's objective. It moves from general background to the specific focus of your work.
- **"Why did you do this research?"**
- **Key Content (The "Funnel" Approach):**
 - **Background:** Broad context and importance of the field.
 - **Literature Review:** What is already known? Highlight key existing research and identify the **research gap**.
 - **Problem Statement:** Clearly define the specific, unanswered question or engineering challenge.
 - **Objective/Hypothesis:** State the aim of your work (e.g., "This paper aims to investigate...") or the hypothesis being tested.
- **Convention:** The last paragraph of the Introduction often outlines the structure of the rest of the paper.

Research Papers & Journal Articles: The IMRAD Structure

- **Methods (M)**
- **Function:** To describe *exactly* how the research was conducted, providing sufficient detail for replication.
- **"How did you do this research?"**
- **Key Content (Specific to Engineering):**
 - **Study Design:** (e.g., experimental, simulation, theoretical modeling).
 - **Materials/Apparatus:** Specific components, equipment, software, or tools used (include make, model, and relevant tolerances).
 - **Procedure:** A chronological, step-by-step description of the experiment or simulation. Use the past tense and the passive voice (or first-person active, depending on the journal's convention).
 - **Data Analysis:** Methods used to process raw data (e.g., statistical tests, computational algorithms).
- **Convention:** Avoid presenting *results* in this section. Focus purely on the *process*.

Research Papers & Journal Articles: The IMRAD Structure

- **Results (R)**
- **Function:** To objectively present the key findings of the research without interpretation.
- **"What did you find?"**
- **Key Content:**
 - **Textual Summary:** State the key findings clearly and concisely.
 - **Visual Aids:** Use **Figures** (graphs, diagrams, photos) and **Tables** to present data efficiently. *Figures and Tables must be referenced in the text.*
 - **Statistical/Quantitative Data:** Report measured values, errors, and outcomes of analysis.
- **Convention:** Only report findings that directly address the objectives/hypotheses stated in the Introduction. Do not discuss implications or compare with prior work yet.

Research Papers & Journal Articles: The IMRAD Structure

- **Discussion (D) and Conclusion**
- **Function:** To interpret the results, discuss their implications, and tie the findings back to the original problem/gap.
- **"What does it mean?"**
- **Key Content:**
 - **Interpretation:** Explain *why* the results are important and relate them to the Introduction's objectives.
 - **Comparison:** How do your results compare with previously published work? (Agree, disagree, or extend?).
 - **Limitations:** Acknowledge any shortcomings or sources of error in the methodology.
 - **Implications/Applications:** Discuss the practical relevance of your findings for engineering practice or future research.
- **Conclusion (Often a separate sub-section):** A brief, focused summary of the main finding and its significance—*do not* introduce new data here.

Research Papers & Journal Articles: The IMRAD Structure

IMRAD forms the core, but a full paper includes vital supporting sections:

Section	Content
Title	Clear, specific, and informative (includes keywords).
Abstract	A standalone summary (150-300 words) of I-M-R-D.
Keywords	3-5 terms for searchability (essential for indexing).
Acknowledgements	Thanking individuals/organizations who contributed but didn't qualify as authors (e.g., funding bodies, technical staff).
References/Bibliography	A complete list of all sources cited. Must adhere strictly to the journal's Citation Style (e.g., IEEE, APA).

Title, Abstract and Keywords

- Words in title and abstract and keywords are indexed in search engines, databases—used to search for paper
- Mostly these sections are freely available online (people read before buying access to paper)
- First sections read by reviewers, editors
- Title should contain keywords, no filler, repetitive or junk words, crisp and concise, based on answer store search questions
- Abstract is marketing tool, helps decide if full paper is required to be read, summary of contents—why was it done, aim of study, what are the findings
 - Descriptive used in social sciences and humanities reports, no information about methods and results
 - Informative used in scientific reports, information on background, aim, methods, results and conclusions
 - Structured used in medical sciences and clinical trials, divided into headings (objective, method, results, conclusion)

Title, Abstract and Keywords

- Write abstract after full paper, include research problem and relevance, how was it solved, main findings, implications of findings. No figures, tables, extra information, abbreviations, citations.
- Abstract should be consistent with main contents, meets guidelines given to authors, no errors
- Keywords should contain repeated or important terms or phrases, and variants of the same as well as abbreviations.
- Ensure terms are present in an indexing standard in the research discipline and also test on search engines for relevancy.

Literature Review

- A broad, comprehensive, in-depth, systematic, and critical review of scholarly publications.
- It is a critical evaluation of available literature on the topic of research to be carried out.
- Provides an overview of the problem to be studied.

Technique of Reviewing of Literature

- Key words / refined / focused
- Shortlist articles – basis of Abstract
- Data base / s
- Latest first & backwards - year
- Table - authors, place, year, Journal
- Methods (Expt. Details)
- Data collection, analysis
- Findings, results, inference

- Organize (acc. to time / theme / method)
- Transition –linking
- Intro. -Body –Conclusion (justify)
- Comprehensive, Cohesive, Concise Write-up

Literature Review - Organization

- You've got a focus, and you've narrowed it down to a **thesis statement**.
- Now what is the most **effective** way of presenting the information?
- What are the most important **topics, subtopics**, etc., that your review needs to include?
- And in what **order** should you present them?

Literature Review - Organization

How to organize studies

- Chronological
 - By publication date
 - By trend
- Thematic
 - A structure which considers different themes
- Methodological
 - Focuses on the methods of the researcher,
 - e.g., qualitative versus quantitative approaches

Literature Review

What should you write?

- The accepted facts in the area
- The popular opinion
- The main variables
- The relationship between concepts and variables
- Shortcomings in the existing findings
- Limitations in the methods used in the existing findings
- The relevance of your research
- Suggestions for further research in the area

Literature Review – Critiquing Criteria

When you read your RoL:

1. Uncover gaps, inconsistencies & consistencies
2. Relevant concepts & variables included
3. Reveal components of study of design (Expt.)
4. Strengths, weaknesses & conflicts depicted (in rel. to current area)
5. Conceptual & Data based literature included
6. Summary and synthesis done (Integration)
7. Follow a logical sequence (Time, theme, method, trend..)
8. Signify what to be researched (Justification & lead to Hypothesis)

Literature Review

A Good Literature Review is:

- **Focused** - The topic should be narrow. Present ideas and report on studies that are closely related to topic.
- **Concise** - Ideas should be presented economically
- **Logical** - logical progression from one idea to the next
- **Developed** - Don't leave the story half told
- **Integrative** - What commonality among articles? How are some studies different?

Your paper should stress how all the studies reviewed contribute to your topic.

- **Current** - Your review should focus on work being done on the cutting edge of your topic

Crafting a strong Thesis Statement

What is a Thesis Statement?

- It's the single, most important sentence of your report, research paper, or technical document.
- It's your central argument, claim, or main point about your topic.

Analogy for Engineers:

- Think of it as the project's objective function or the design's core specification.
- Every component (paragraph/section) must support or relate back to it.

Why is it Critical in Technical Writing?

- Focus: It defines the scope and boundaries of your project/paper.
- Prevents "scope creep."
- Clarity: It immediately tells the reader (your professor, potential employer, or peer reviewer) what problem you solved and what conclusion you reached.
- Roadmap: It tells the reader what to expect in the following sections.

Essential characteristics of a Strong Thesis

Characteristic

Declarative

Specific

Arguable / Debatable

Defensible

Positioned Correctly

Description

It is a statement, not a question.

Focused on a **single, manageable idea** (e.g., a specific material, method, or result). Avoid vague terms.

It presents a conclusion that *could* be challenged or requires evidence to prove. (**This is key for research-based papers**).

You must be able to support it with your data, analysis, and research.

Typically appears at the **end of the Introduction** (or Abstract) section.

Engineer's Check

Is it an assertion?

Is it quantifiable or clearly defined?

Can someone reasonably ask, 'How do you know that?'

Do I have the results to back this up?

Is it the last sentence before the main body?

Crafting a strong Thesis Statement

4-Step Thesis Crafting Process:

1. Start with the Question/Problem:

What was the main technical challenge your work addressed? (e.g., How can we increase the yield strength of this concrete mixture?)

2. Determine Your Conclusion/Result:

What is your answer or finding? (e.g., Adding \$5\%\$ micro-silica increases yield strength by \$15\%\$.)

3. Identify the "How" or "Why":

What is the underlying mechanism or justification? (e.g., It improves particle packing density.)

4. Synthesize and Refine:

Combine these into a single, polished sentence.

Example Synthesis: "Adding a \$5\%\$ micro-silica admixture (Result) significantly increases the compressive yield strength of high-performance concrete by \$15\%\$ (Claim) primarily by improving the granular particle packing density of the mixture (Justification)."

Weak vs. Strong Thesis Examples

Weak Thesis

"Bridges are important civil engineering structures."

"I will discuss the factors that lead to material failure."

"Renewable energy is a great way to generate power."

Why it's Weak

Too obvious, general, and not debatable.

States an intent (*a topic*), not a conclusion or argument.

Vague and a simple statement of fact/opinion.

Strong Thesis

"The proposed steel-cable hybrid design significantly reduces long-term maintenance costs for medium-span suspension bridges by an estimated 18% compared to traditional all-steel systems."

"High-cycle fatigue, rather than excessive static load, is the predominant failure mechanism in the aluminum alloy 7075-T6 used in aerospace components operating near a \$0.4\$ stress ratio."

"A micro-inverter-based grid-tie photovoltaic system offers a 12% increase in overall energy harvest efficiency compared to a centralized inverter system in shaded urban environments due to module-level power point tracking."

AI Tools in Technical Writing: Augmenting the Engineer's Workflow

The AI Shift: From Human Writer to AI-Powered Strategist

- What is Technical Writing?

The practice of communicating complex technical information (like product manuals, research reports, or system documentation) in a clear, concise, and accessible way for a specific audience.

- The Challenge for Engineers:

As a future engineer, you have the technical knowledge, but time is your biggest enemy. Writing up your findings can take days.

- The AI Promise:

- AI is not replacing technical writers or engineers; it is augmenting them.
- Think of it like moving from manual calculation to a calculator, or from hand-drafting to AutoCAD.
- It automates the tedious parts so you can focus on the critical thinking, analysis, and data validation.

Core AI Use Cases in Technical Documentation

Function

Drafting & Ideation

Clarity & Readability

Consistency & Terminology

Summarization

Code Documentation

AI Tool Application

Generating initial drafts for the "Introduction," "Literature Review," or "Materials/Methods" sections based on bullet points or a short summary.

Simplifying complex jargon, flagging passive voice, and checking sentence length to ensure the text is accessible (e.g., Grammarly).

Enforcing a specific **style guide** or checking for consistent use of specialized engineering terms (e.g., always using "compressive strength" instead of "crushing force").

Condensing a lengthy white paper, meeting transcript, or external research article into a concise executive summary or abstract.

Generating comments, explanations, or docstrings directly from source code (e.g., GitHub Copilot) for API and software manuals.

Benefit for Engineers

Saves Time: Quickly creates a solid framework and structure, overcoming writer's block.

Improves Quality: Ensures the documentation meets professional standards of clarity and conciseness.

Maintains Integrity: Critical for documentation where precision and uniformity are non-negotiable (e.g., regulatory compliance).

Boosts Research Efficiency: Helps you quickly extract key findings from large volumes of technical data.

Accelerates Development: Bridges the gap between the code and its necessary documentation.

Essential AI Tools for the Engineering Writer

Categories of tools and their specific functions:

- Large Language Models (LLMs):
 - Examples: ChatGPT, Gemini, Claude.
 - Primary Use: Generating initial drafts, brainstorming section outlines, and rephrasing complex concepts to be simpler or more formal.
- Editing and Proofreading Tools:
 - Examples: Grammarly, DeepL Write.
 - Primary Use: Real-time checking for grammar, spelling, tone consistency, and overall clarity. DeepL is also excellent for technical translation.

Essential AI Tools for the Engineering Writer

Categories of tools and their specific functions:

- Paraphrasing & Citation Tools:
 - Examples: QuillBot, Paperpal, specialized academic tools.
 - Primary Use: Helping to repurpose content (e.g., turning lab notes into a formal report section) and generating accurate citations in required formats (like IEEE or APA).
- Visual & Diagramming Tools (Often AI-Enhanced):
 - Examples: Canva, specialized flowchart generators.
 - Primary Use: Creating professional-looking diagrams, flowcharts, and infographics to visually explain technical processes, which is essential for user manuals.

The Human Element: Where AI Fails

AI is a co-pilot, not the pilot. As an engineer, your expertise is irreplaceable in these areas:

- **Technical Accuracy & Validation (The Golden Rule):**

- AI can fabricate ("hallucinate") data, cite non-existent papers, or misunderstand a complex boundary condition.
- Your job is to fact-check every technical claim and number generated by the AI against your raw data and lab results.

- **Context and Strategy:**

- AI cannot define the goal of the document, the specific audience (e.g., fellow engineers vs. a management team), or the project's unique political/business context.

- **Ethical and IP Concerns:**

- AI models are trained on vast public data. You must not input proprietary, confidential, or sensitive project data into general-purpose public AI tools.
- You are responsible for plagiarism and intellectual property (IP) compliance, even if the AI generated the text.

Learn to Prompt Like an Engineer

The quality of your output depends on the quality of your prompt. Be **precise** and provide **context** like an engineer would.

Weak Prompt (General)

"Write an introduction about using composite materials."

Strong Prompt (Technical)

"As a 7th-semester civil engineer, write a 200-word Introduction for a lab report on the flexural strength testing of carbon fiber reinforced polymer (CFRP) composites. Audience is the professor. The Introduction must cite the ASTM D7264 standard."

The Generative Leap: AI in Technical Documentation Workflows

What are LLMs and Generative AI?

Large Language Models (LLMs):

- These are deep-learning models trained on vast amounts of text data to understand, summarize, generate, and predict human-like language.
- Examples include GPT-4, Claude, and Gemini.

Generative AI:

- This is a type of AI that can generate new and original content (text, images, code) based on patterns learned from its training data.
- LLMs are the engine of Generative AI for text.

Impact:

- They act as powerful co-pilots, automating routine tasks and dramatically accelerating documentation workflows.

Transformation of the Documentation Workflow

Traditional Workflow Stage

Drafting

Simplification

Consistency & Review

Translation

Maintenance

AI-Driven Workflow Transformation

Automated Draft Generation: Creates a first draft (outlines, sections, code comments) from simple prompts, system specifications, or code snippets.

Automatic Clarity Enhancement: Rewrites complex technical jargon into plain, accessible language for non-technical users or different audience levels.

Real-time Consistency Check: Monitors for inconsistencies in terminology, style, and facts across the entire document corpus.

Instant, Cost-Effective Localization: Generates high-quality initial translations, making global deployment of documentation faster and cheaper.

Automated Updates (e.g., Code Changes): Integrates with Continuous Development/Integration (CI/CD) pipelines to suggest documentation updates based on new code commits.

Key AI Capability

Content Generation, Code Summarization

Summarization, Rephrasing, Audience Adaptation

Pattern Recognition, Real-Time Consistency Monitoring

Advanced Machine Translation

Retrieval-Augmented Generation (RAG), Code Analysis

Practical LLM Applications for Engineers

As future engineers, you'll be both the authors and the Subject Matter Experts (SMEs) for technical documents.

- **Generating Code Documentation:** An LLM can analyze a function's code and automatically generate a descriptive comment, saving time and ensuring consistency.
- **Creating Starter Outlines:** Quickly generate a comprehensive table of contents or outline for an API reference or user manual.
- **Drafting Technical Summaries:** Input a large system design document and ask the LLM to generate a concise summary for a project manager or executive stakeholder.
- **Answering User Queries:** Using a technique like **Retrieval-Augmented Generation (RAG)**, an LLM can be connected to your internal, up-to-date document repository (source code, PDFs, internal wikis) to provide accurate, real-time answers to user questions, transforming your static documentation into an intelligent knowledge base.

Practical LLM Applications for Engineers

While powerful, these tools require **human oversight and expertise**.

- **Accuracy and Hallucination:** LLMs can confidently generate plausible-sounding, yet incorrect or fabricated information ("hallucinations"). **Human verification is NON-NEGOTIABLE.**
- **Product Knowledge:** General LLMs lack specific, real-time knowledge of your proprietary product, system, or newest features.
- **Prompt Engineering:** The quality of the output depends on the quality of the input. Learning to write effective, clear, and specific **prompts** is a critical new skill.
- **Ethical Concerns:** Issues like data privacy (don't input sensitive information), bias, and compliance require human judgment and adherence to guidelines.

Your Future Role: The future technical writer/engineer won't just *write* documentation; they will **manage, verify, curate, and strategically apply** AI tools to maximize efficiency and maintain quality. Your engineering background remains essential for verifying technical accuracy.

Core Functions of Editorial AI Tools

Tools like Grammarly, Microsoft Editor, and DeepL Write are more than just simple spell checkers; they use LLMs to analyze context and intent.

1. Grammar and Mechanics (The Foundation)

Feature

Punctuation & Syntax

Spelling & Typos

Passive Voice Detection

Benefit to the Engineer

Eliminates errors in complex technical sentences (e.g., run-on sentences, improper hyphenation).

Catches simple human errors, especially in fast drafting.

Forces a stronger, clearer, and more direct voice (e.g., "The module was tested" "We tested the module").

Core Functions of Editorial AI Tools

2. Conciseness and Flow (The Efficiency Driver)

- **Wordiness Reduction:** Automatically flags filler phrases and weak modifiers.

Example: “Due to the fact that” → “Because”

- **Sentence Simplification:** Suggests splitting overly long sentences, improving readability for busy professionals.

Mastering Style and Tone Adaptation

This is where generative AI goes beyond simple editing, helping you match your writing to the *audience*.

Adapting Tone for Different Audiences

A great technical document uses the right tone for the person reading it. AI tools help you shift your writing effortlessly:

Audience	Required Tone	Tool Capability
API Developer	Formal, Authoritative	Checks for adherence to structured, explicit conventions.
End-User / Customer	Friendly, Encouraging	Suggests simpler vocabulary and a supportive voice.
Executive Summary	Confident, Concise	Rephrases paragraphs to be brief, high-level, and impactful.

Case Example: DeepL Write

This tool specializes in rephrasing entire sentences or passages while preserving the technical meaning, offering several stylistic options (e.g., "More Professional," "More Casual," "Shorter"). This is invaluable when adapting internal specs into customer-facing documentation.

Integrating AI into the Engineering Workflow

A Co-Pilot, Not an Auto-Pilot

Best Practice: The technical content comes from the engineer; the polish and format come from the tools.

1. **Draft Technically:** Focus purely on writing correct, accurate technical details, code, or procedures (the *what*).
2. **Run the AI Scan:** Use Grammarly or DeepL Write for a *first pass* on grammar, flow, and conciseness.
3. **Human Verification & Context:** Crucially, review every suggestion. AI often lacks context and may try to "correct" technically correct terms (e.g., editing a specific function name or specialized acronym).
 - **Override AI when necessary** to preserve technical accuracy or style guide compliance.
4. **Final Style Guide Check:** Ensure the finalized document adheres to your project's specific terminology and internal style guide.

The Technical Mechanics of Grammarly

Grammarly's power comes from a multi-layered approach combining rules and statistical models.

1. Natural Language Processing (NLP) & Parsing

Tokenization & Parsing: The tool first breaks the text into tokens (words, punctuation) and constructs a parse tree to understand the grammatical relationship between words (e.g., identifying the subject, verb, and object).

2. Machine Learning (ML) Models for Advanced Checks

- **Contextual Correction:** Unlike simple software that flags words not in a dictionary, Grammarly uses ML models trained on a vast corpus of correctly edited text. This allows it to:
 - Distinguish between homophones based on context (e.g., "Their" vs. "There").
 - Suggest a more powerful word for a weak one ("very important" "critical").
- **Clarity and Conciseness:** ML models identify patterns of "fluff" or ambiguity that deviate from the most direct way to express an idea.

3. Plagiarism and Grounding

- **Source Comparison:** The tool scans billions of web pages and proprietary databases, comparing sections of your text to identify exact or near-exact matches. This is a form of **textual grounding** that is critical for academic and professional honesty.

Practical Guide: How to Use Grammarly

Mastering the tool requires understanding its configuration options *before* you start reviewing suggestions.

Step 1: Set Document Goals (Crucial for Engineers)

- **Audience:** Who is reading this? (General, Expert, etc.)
- **Formality:** What tone is needed? (Informal, Neutral, Formal - *Engineers almost always choose Formal or Neutral.*)
- **Tone:** What feeling should the text convey? (Confident, Analytical, Friendly)
- **Intent:** What is the document's purpose? (Inform, Describe, Tell a Story)
Action: Use these settings to calibrate the AI's suggestions to your specific technical document type.

Practical Guide: How to Use Grammarly

Step 2: Review and Prioritize Suggestions

- **Correctness (Red/Blue):** Focus on these first. These are hard errors (grammar, spelling, punctuation). **Accept or dismiss quickly.**
- **Clarity (Green):** These improve conciseness. *Always* review for technical accuracy before accepting.
- **Engagement/Delivery (Purple/Yellow):** These relate to word choice, tone, and flow. Use these to tailor the document to the target audience (e.g., making a document friendlier for end-users).

Step 3: Utilize the Score and Reports

- **Overall Score:** Aim for a high score (90+) but do not chase 100%. The score is a metric, not the goal.
- **Download Report:** Use the report feature to check for **Style Guide Consistency** across large documents.

Practical Guide: How to Use DeepL Write

What is DeepL Write? (And How is it Different?)

Layout: Two_Column_Tiled_Text

Content:

Title: A Power Tool for Writing

Column 1: Grammar Checker (e.g., Basic Spell-Check)

Focus: Fixes *errors*.

Finds typos and basic subject-verb agreement.

It's a *passive* tool.

Column 2: DeepL Write (AI Rephrasing Engine)

Focus: *Improves* writing.

It's an *active* editing partner. It suggests entirely new, more professional sentence structures.

It understands *context* and *nuance* to help you sound like a professional, native-speaking expert.

Practical Guide: How to Use DeepL Write

The Core Workflow: A Quick Tour

Content (Left):

Title: The Core Workflow

Text:

Paste: Add your draft text (a sentence or paragraph) into the left-hand pane.

Review: Instantly see a rephrased, improved version on the right.

Explore: Click *any word* (in your draft or the suggestion) to see a list of alternatives (synonyms, different phrasings).

Select: Choose the option that is most precise, formal, and concise.

Practical Guide: How to Use DeepL Write

Step 1: Refining STYLE

Layout: Styled_Bullet_Points

Content:

Title: Step 1: Refining Technical Style

Goal: Shift from "conversational" to "formal and precise."

Your Action:

Paste your draft sentence.

Draft: "The experiment was done to see if the new material was better."

Review the initial suggestion.

DeepL: "The experiment was *conducted* to *determine* if the new material offered superior performance."

Click key terms to find the *most* precise option.

Clicking "determine" might also show: "assess," "evaluate," "quantify."

Select the best fit for your technical context.

Practical Guide: How to Use DeepL Write

Step 2: Calibrating TONE

Layout: Styled_Bullet_Points

Content:

Title: Step 2: Calibrating TONE

Goal: Shift from "uncertain/casual" to "confident/professional."

Your Action:

Paste your "lab notes" draft.

Draft: "We ran the test again and the numbers looked a lot better, so I think the calibration was the problem."

Review the rephrased, objective options.

Option 1: "The test was re-run, *yielding significantly improved results*, which *suggests* the initial problem was one of calibration."

Option 2: "Upon *repeating* the experiment, the data *improved considerably*, indicating that calibration was the *likely source of the error*."

Select the version that is most objective and confident.

Practical Guide: How to Use DeepL Write

Step 3: Mastering CONCISENESS

Layout: Highlighted_Numbers

Content:

Title: Step 3: Mastering CONCISENESS

Goal: Engineers value efficiency. Your writing should be "information-dense."

Text (Left):

Draft: "It is important to remember that the software must be updated on a regular basis in order to ensure that it continues to function in the correct way."

(28 words)

Number (Right):

DeepL Suggestion: "Regular software updates are essential for maintaining correct functionality."

(10 words)

Number Label: A 64% Reduction in Word Count

Content Generation & Augmentation using AI

It's important to understand the two main ways engineers use AI for writing:

Feature

Role

Process

Example

Engineer's Task

Content Generation

The AI writes the initial draft.

Providing a prompt and receiving a full output.

"Generate a 500-word introduction to a report on PID control tuning."

Heavy **fact-checking** and validation.

Content Augmentation

The AI edits/enhances *your* draft.

Providing your text and asking for a specific improvement.

"Take this paragraph and rewrite it for a non-technical audience."

Refining style, tone, and conciseness.

Content Generation & Augmentation using AI

Step 1: Generating Structured Drafts (Skeletal Framework)

AI excels at creating structure and boilerplate text.

Action: Use Targeted Prompts

Ask the AI to generate a **structured outline** for a document (e.g., "Give me a standard outline for a Materials and Methods section of an experiment on stress analysis").

Generate **boilerplate code comments** or API documentation based on function signatures.

Generate the first draft of non-technical sections, like the **Abstract** or **Executive Summary**.

Key Prompt Rule: Be specific about **Role, Goal, Audience, and Format**.

Example: "Act as a senior engineer. Draft a three-paragraph, formal executive summary for a project report on implementing predictive maintenance, aimed at the CEO."

Content Generation & Augmentation using AI

Step 2: Augmentation for Clarity and Tone

This is where AI saves the most time for engineers who already have a draft.

Augmentation Task Examples:

Simplification: "Rewrite this section [paste text] for an audience with no prior knowledge of thermodynamics." (Helps you explain concepts to stakeholders).

Formality Check: "Ensure the tone of this report section [paste text] is professional, formal, and objective."

Active Voice: "Convert all instances of passive voice to active voice in this paragraph [paste text]." (Creates clearer, stronger sentences).

Content Generation & Augmentation using AI

Step 3: Augmentation for Conciseness

Engineers must be efficient with words. AI helps eliminate "fluff."

Action: Use Brevity Prompts

"Condense this paragraph [paste text] into three bullet points without losing technical detail."

"Review this paragraph [paste text] and eliminate any unnecessary introductory phrases or filler words."

"What is a more concise way to phrase this sentence: 'Due to the fact that the load was not distributed equally...'" (AI will suggest: "**Because** the load was not distributed equally...")

Content Generation & Augmentation using AI

Key Takeaways

1. AI tools are powerful **assistants** that reduce drafting time.
2. Use **Generation** for outlines, summaries, and boilerplate text.
3. Use **Augmentation** for refining **style, tone, and conciseness** in your core technical analysis.
4. **NEVER** skip the manual **Verification** and **Fact-Check** of all AI-generated content.

Content Generation & Augmentation using AI

Why Integrate AI into Your Workflow?

- **Engineers vs. Writers:** Your priority is technical accuracy and analysis. AI helps bridge the communication gap.
- **Focus Shift:** Use your time for validation and deep technical review, not struggling with first drafts.
- **AI's Strengths in Documentation:**
 1. Overcoming writer's block (Brainstorming).
 2. Ensuring logical flow (Outlining).
 3. Creating structured, formal text (Initial Drafting).
 4. Adapting content for different audiences (Summaries/FAQs).

Content Generation & Augmentation using AI

Phase 1: Brainstorming & Ideation

Breaking Writer's Block and Defining Scope

- **Goal:** Use AI to rapidly explore topic angles, key arguments, and necessary components of a document.
- **Action: Targeted Prompting for Ideation**
 - **Problem Identification:** "Given the task of [Engineering Challenge], what are 5 key, non-obvious factors I must address in my feasibility report?"
 - **Argument Generation:** "I am arguing for [Solution A] over [Solution B]. Generate 3 strong technical arguments and 3 counterarguments I should prepare for."
 - **Audience Framing:** "List the top 5 questions a **non-technical executive** would ask about my project on **IoT security protocols**." (Helps you frame the content).

Content Generation & Augmentation using AI

Phase 2: Outlining and Structure

Generating a Structured Document Framework

The quality of an outline determines the quality of the final report's flow. AI can apply standard conventions instantly.

Action: Prompting for Technical Structure

- "Generate a detailed, formal outline for a final year project thesis on [Topic]. Include the standard sections: Abstract, Introduction, Literature Review, Methodology, Results, Discussion, Conclusion, and Appendices."
- "Using the IMRaD format, generate an outline for a lab report detailing the efficiency testing of a **Pelton Turbine**."
- "Create a template for a **Software Requirements Specification (SRS)** document."

Benefit: Ensures all standard, expected sections are included, preventing crucial omissions.

Content Generation & Augmentation using AI

Phase 3: Drafting Initial Content

Accelerating Boilerplate and Objective Content

AI is excellent at generating text that requires formal, objective language but little technical nuance (the "fluff" that takes time).

Action: Prompting for Draft Content

- **Introduction/Abstracts:** "Draft a 150-word objective abstract for a paper on optimizing heat exchanger performance, based on the following key findings: [List 3-4 Key Findings]."
- **Methodology/Equipment Lists:** "Generate the initial draft for the **Materials and Methods** section of a report on [Experiment]. Include a list of standard equipment used in this type of test." (You then refine specific parameters.)
- **Transitions:** "Provide three formal transition sentences to move from the 'Literature Review' section to the 'Methodology' section."

Content Generation & Augmentation using AI

Phase 4: Summaries and Audience-Specific Content

Condensing Information and Creating Support Materials

Effective technical communication means adapting your core information for diverse audiences (peers vs. managers).

- **Action: Prompting for Condensation and FAQs**
 - **Executive Summary:** "Take this 10-page report [Paste or Summarize Key Sections] and generate a concise, one-page Executive Summary focused only on costs, timelines, and main conclusion."
 - **FAQ Generation:** "Based on the 'Results and Discussion' section of this report [Paste text], generate a list of 8 Frequently Asked Questions (FAQs) and provide simple, one-sentence answers for a client."
 - **Glossary:** "Generate a glossary of 10 key technical terms used in a report about **Finite Element Analysis (FEA)**."

Content Generation & Augmentation using AI

Guardrails: The Essential Engineering Check

- **Your Professional Responsibility: Verification**
 - **The Golden Rule:** The AI is an assistant; the Engineer is the Verifier. You are accountable for all content.

Rule

Fact-Check Everything

Maintain Context

Ethics & Originality

Description

MUST manually verify every number, equation, citation, and technical claim generated by the AI.

AI can lose track of nuances. Read the AI's output **in the context** of your full report.

Use AI to structure *your* ideas and refine *your* drafts. Do not claim AI-generated analysis as your own original work.

AI for Research & Information Synthesis

Phase 1: AI for Literature Synthesis

Rapid Review and Key Extraction

- **Goal:** Quickly understand the core contributions, methodologies, and limitations of a large set of papers.
- **Action: Using AI to Summarize**
 - **Paste an Abstract or Full Paper Section:** Prompt the AI to "Summarize the key findings and main methodology of this paper in three bullet points."
 - **Extract Variables:** Prompt: "From this 'Results' section, list all independent and dependent variables studied and the units used." (Crucial for Methods and Results sections).
 - **Identify Gaps:** Prompt: "Based on the conclusion of this paper, what are the two main limitations the authors suggest for future work?" (Helps frame your **Literature Review gaps** and **Future Work** sections).

AI for Research & Information Synthesis

AI for Comparative Analysis (The Matrix)

- **Goal:** Synthesize multiple sources into a single, organized structure for quick comparison.
- **Action: Creating a Synthesis Matrix**
 - **The Prompt Formula:** "I need to compare five papers on [Topic]. Generate a markdown table with columns for: Paper Title, Methodology Used, Key Result, and Limitation."
 - You then input the details from each paper into the corresponding rows.
- **Benefit:** This structured output directly aids the drafting of the comparative sections of your Literature Review.

AI for Research & Information Synthesis

Phase 2: AI for Data Synthesis & Analysis

Organizing and Interpreting Raw Data

AI tools can help organize data outputs, though they cannot replace statistical validation.

- **Action:** Structuring Findings for the Report
 - **Data Translation:** "Explain the meaning of these statistical results [Paste p-values, R-squared] in simple, technical language for my 'Discussion' section."
 - **Trend Identification:** "Based on the following raw data points [Paste up to the token limit], describe the observable trends in the relationship between Temperature and Yield." (Use caution, always verify against your own charts).
 - **Report Template:** Prompt: "Generate a table template for reporting the stress-strain data, including columns for Applied Load (kN), Measured Strain ($\mu \epsilon$), and Calculated Stress (MPa)."

Utilizing AI tools for quick data retrieval

The Data Retrieval Challenge

- Technical reports require grounding in facts, specifications, standards, and previous research data.
- **Challenge:** Sifting through lengthy documents (manuals, standards, research tables) to find one specific number or parameter.
- **Goal:** Use AI tools (specifically those with document parsing capabilities) to act as a **hyper-efficient search engine** over complex technical texts.
- **Core Benefit:** Saves hours in the "Materials," "Specifications," and "Background" sections of your reports.

Utilizing AI tools for quick data retrieval

Phase 1: Retrieving Specific Data Points

Querying Technical Specifications and Standards

- **Goal:** Extract single, critical data points from dense documents (e.g., PDFs of ASTM standards, component datasheets).
- **Action:** **Using Document-Aware AI Tools** (e.g., PDF summarizers/chatbots)
 - **Upload:** Upload the target document (e.g., "Datasheet for Microcontroller X" or "ASTM Standard Y").
 - **Query Example 1 (Specification):** "What is the maximum operating voltage of the component listed on page 5, table 2?"
 - **Query Example 2 (Standard):** "What is the minimum required tensile strength (in MPa) for material grade 304 under the specified standard?"
- **AI Output:** Provides the exact value and often the **source page number or table name** from the document.
- **Benefit:** Ensures accuracy by citing the specific source value, not a generalized memory.

Utilizing AI tools for quick data retrieval

Phase 2: Extracting and Formatting Data Tables

Converting Unstructured Text to Structured Data

- Often, relevant data is embedded in paragraphs or poorly formatted tables within old PDFs or scanned documents.
- Action: Prompting for Table Generation**
 - Paste or Select:** Copy and paste the messy section of text containing the data.
 - Prompt Example:** "Convert the following specifications into a markdown table with columns for **Property**, **Value**, and **Units**. [Paste text listing properties]."
 - Prompt Example 2 (Comparative):** "Extract the **Young's Modulus** and **Yield Strength** for both **Aluminum 6061** and **Steel AISI 1018** from the text below, and present the comparison in a two-row table."
- Benefit:** Instantly transforms unusable text into a clean, copy-and-paste table for your report's "Results" or "Materials" section.

Utilizing AI tools for quick data retrieval

Phase 3: Finding Context and Definitions

Quick Definitions and Contextual Clues

- When writing a technical section, you need quick confirmation of definitions or context for specific variables.
- **Action: Using General AI for Rapid Definition and Context**
 - **Definition Query:** "Provide a concise, formal definition of the Joule-Thomson effect suitable for an introductory section."
 - **Variable Context:** "In the context of CFD modeling, what does the term 'Mesh Convergence' specifically refer to?"
 - **Nomenclature Check:** "What is the standard engineering notation (symbol) for Kinematic Viscosity and what are its standard SI units?"
- **Benefit:** Ensures you use the precise, industry-accepted terminology and symbols throughout your document.

Utilizing AI tools for quick data retrieval

The AI Data Verification Protocol

Mandate: AI can retrieve data, but **cannot verify its currency, context, or accuracy** against all known standards.

Risk Area

Old/Outdated Data

Unit Errors

Context Mismatch

The Engineer's Action

Check Date: Always verify the source document's revision date (e.g., is the standard 1998 or 2023?).

Check Units: Manually ensure the retrieved value's units (e.g., psi vs. Pa; $\mu\epsilon$ vs. % strain) match your report's convention.

Check Scope: Ensure the retrieved data point applies to the **exact conditions** of your project (e.g., room temperature vs. cryogenic conditions).

Utilizing AI tools for summarizing complex research, and identifying key insights

Traditional vs. AI-Assisted Workflow

Traditional Research

- Manually read 20-30 papers.
- Spend hours highlighting and taking notes.
- Manually synthesize in a Word doc.
- This is slow, laborious, and you risk missing critical connections.

AI-Assisted Research

- Screen 50 abstracts with AI.
- Deep-dive 10 key papers using an AI co-pilot.
- Use AI to compare papers and find connections.
- You spend your valuable time on **analysis**, not just searching.

Utilizing AI tools for summarizing complex research, and identifying key insights

Skill 1: Summarization (The "What")

What is AI Summarization?

AI moves beyond simple "extractive" summaries (copying sentences) to "abstractive" summaries (rewriting concepts in simple terms).

- Condenses jargon-heavy text.
- Pulls out main arguments, methodology, and results.

Your Goal: Get the gist of a 30-page paper in 60 seconds.

Skill 2: Insight Identification (The "So What?")

What is Insight Identification?

It goes *beyond* one paper and finds patterns, contradictions, and gaps *across* multiple papers.

This is true **synthesis**.

It helps you define your unique contribution.

Your Goal: Confidently answer the question, "What is the novel gap my project is filling?"

Key Tools Comparison

Tool	Best For...	Key Feature
Elicit.org	Literature Reviews	"Find papers like this" & concept matrix
SciSpace	Deep-Diving a PDF	"Co-pilot" - ask direct questions to the paper
Consensus.app	Answering a Specific Question	Synthesizes direct answers from many papers
Perplexity AI	General Research & Citations	"Pro" search with academic source filters

Visuals & Multimedia with AI

Your AI Diagram Toolkit

- **Mermaid.js**
A simple, text-based syntax to generate complex diagrams. Great for documentation (e.g., in GitHub) and easy to edit.
- **Text-to-Diagram Tools**
Apps like Lucidchart, tldraw, or Whimsical now have AI features. You sketch or write a prompt, and the AI perfects the shapes and layout.
- **Generative LLMs**
Ask ChatGPT or Gemini: "Write me the Mermaid.js code for a flowchart about..."
This is the fastest way to get a complex first draft.

AI in Data Visualization

Smarter, Faster Charts

- **"What chart should I use?"** AI tools in Excel, Power BI, and Tableau analyze your data and *suggest* the right chart (bar, line, scatter).
- **Natural Language Query:** Type "Show me the average sensor reading by month as a line chart" instead of fighting with pivot tables.
- **Insight Generation:** Some tools can even add a text summary *describing* the key insight from the chart.

Visuals & Multimedia with AI

AI for Simple Multimedia

Animated GIFs

- Need to show a process? (e.g., an algorithm sorting, a mechanical part moving).
- Use AI tools to generate simple animated GIFs from text prompts or simple sketches.

Synthetic Voiceovers

- For your capstone demo video, AI tools (like ElevenLabs, Play.ht) can create a clean, professional, and consistent voiceover.
- No more "umms" or "ahhs".

Visuals & Multimedia with AI

Your Most Important Role: The Human-in-the-Loop

- **AI Generates; You Verify:**
AI **will** be wrong. It can misinterpret data, "hallucinate" a process, or make a chart that is technically correct but misleading.
- **You Own the Output:**
You are the engineer. You are responsible for the accuracy of every single diagram and chart.
- **Focus on Clarity, Not Flash:**
The goal is **communication**. Does the AI-generated visual **actually** make your point clearer? Or is it just a gimmick?

Prompt Engineering Basics

The "Vague" Prompt

- **Prompt:** "Explain my capstone project."
- **AI Output:** "*I do not have access to your capstone project details...*" or a generic, *useless paragraph about capstone projects*.
- **Analysis:** The AI has no context, no sense of audience, and no defined task. It fails.

The "Engineered" Prompt

- **Prompt:** "Act as a technical writer. Summarize my capstone project (details below) into a 100-word abstract for a recruiting event..."
- **AI Output:** *A targeted, professional summary fit for the exact purpose.*
- **Analysis:** By providing clear constraints, the AI has a well-defined problem to solve.

Prompt Engineering Basics

The 4 Pillars of a Good Prompt

1. Role

Tell the AI *who* to be. This sets the entire tone and knowledge base.

Ex: "Act as a senior systems engineer..."

2. Context

Provide the necessary background. This is your "given" information.

Ex: "...my project involves an Arduino..."

3. Task

The specific, actionable verb. What must it *do*?

Ex: "...write, summarize, analyze, refactor, compare..."

4. Format

Constraints. How do you want the output? Length, style, etc.

Ex: "...in a 3-column table. Keep the tone formal."

Prompt Engineering Basics

The Prompting "Debug" Loop

Don't Settle for V1.0

Iterative prompting is the process of refining your prompts based on the AI's output. You are steering the AI toward the correct answer.

- **Prompt:** Give your initial instruction.
- **Generate:** Analyze the output. What's wrong? What's missing?
- **Refine:** Modify your prompt. Add constraints, give an example, or correct a misunderstanding.
- **Repeat:** Continue until the output meets your engineering standards.

Prompt Engineering Basics

Iteration in Action: A Case Study

Version	Prompt	AI Output (Analysis)	Refinement
V1	"Write about my project."	Generic, useless output. AI has no context.	<i>Add context and a clear task.</i>
V2	"Summarize my project: [pasted abstract]"	Output is just a rephrasing of the abstract. Not simpler.	<i>Add audience and format. Tell it *how* to simplify.</i>
V3	"Summarize my abstract for a 1st-year student in 5 bullet points."	Good! But it still uses the jargon "thermodynamic efficiency."	<i>Give a specific instruction to replace jargon.</i>
V4	"Same as before, but replace 'thermodynamic efficiency' with 'how much energy is wasted as heat'."	Success. The output is now simple, accurate, and targeted.	<i>N/A</i>

Prompt Engineering Basics

Advanced Prompting Tips

- **Use Delimiters:** Use markers like , ###, or <context> to clearly separate your instructions from the content you want it to work on.
- **Chain Prompting:** Don't ask for everything at once. Ask it to do Step 1. Then, in a new prompt, ask it to do Step 2 on that output. (e.g., "First, summarize. Next, extract keywords.")
- **Few-Shot Prompting:** Give the AI an example of *exactly* what you want. Ex: "Here is an example: [Your example]. Now, do the same for: [Your new data]."

Ethical Considerations with AI

The Five Ethical Pitfalls for Engineers

1. Accuracy & Hallucinations

AI ***will*** invent facts, citations, and code. It is not searching; it is generating. Your job is to **validate**.

2. Inherent Bias

AI is trained on human data, which is full of bias. It can produce text that is skewed. Your job is to **interrogate and correct**.

3. Data Privacy & Security

Public AI tools ***use your prompts for training***. Never paste proprietary code or data. Your job is to **protect**.

Ethical Considerations with AI

Data Privacy Risk

The "Black Box" Problem

- When you hit 'submit' on a public AI, where does your data go? You've sent your intellectual property to a third-party server.
- This is a critical security risk for your capstone project.
- This is a fireable offense at most companies.

Rule: Always use internal, sandboxed, or approved AI tools for sensitive work.

4. Intellectual Property

Who Owns What?

- This is a legal minefield. Can you copyright AI-generated text? Was the AI trained on copyrighted data without permission?
- Using AI output ***verbatim*** for commercial use is extremely high-risk.

Rule: The AI is for ***ideation*** and ***drafting***. Your job is to **transform** and **rewrite**, creating original work.

Ethical Considerations with AI

Case Study:

- **The Failure: The "Copy-Paste" Intern**
 - An intern is asked to write a report.
 - They paste the prompt, get the output, and submit it.
 - The report contains a 'hallucinated' statistic that is wrong.
 - The company makes a bad decision. This is an engineering failure.
- **The Success: The "Human-in-the-Loop" Engineer**
 - An engineer uses AI to summarize 10 papers.
 - They **verify** the summaries against the originals.
 - They use AI to draft a section, but **rewrite** it, **validate** every fact, and **cite** the primary sources.
 - This is an engineering success.

Ethical Considerations with AI

5. The Solution: Critical Evaluation

Your "Critical Evaluation" Checklist

- **VERIFY:** Did I check every fact, citation, and number against a primary source? (Assume AI is wrong until proven right).
- **TRANSFORM:** Have I rewritten the content in my own words? Is it integrated, not just copied? Does it meet *our* standards?
- **INSPECT (BIAS):** Does this text make any assumptions? Is the language inclusive? Is it appropriate for all audiences?
- **SECURE:** Am I using a tool that is approved and secure for this data? (When in doubt, don't paste it).