Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Brainstorm and narrow down topics for a report.
2. Create an outline for a report.

Writing Process

The writing process takes you from the very beginning of a writing project—finding topics and analyzing audience and purpose—all the way to the end—writing and revising the rough draft. The following chapters focus on some of the key phases of that process:

- Strategies for team-writing
- Audience Analysis
- Brainstorming and invention
- Narrowing
- Outlining
- Note-taking
- Libraries, Documentation, Cross-Referencing
- Strategies for Peer-Reviewing
- Power-Revision Techniques

Find Report Topics

As a writer in a technical writing course, you may need some strategies for finding topics for writing projects, which are provided in this section.

By definition, technical-writing courses are opportunities to focus on practical uses of your writing skills. In the ideal technical-writing course, you would have a work-related writing project every two to three weeks: for example, instructions for that pesky fax machine down the hall or recommendations on home alarm systems. However, technical-writing courses are also great opportunities for exploring science and technology: latest advances in nanotechnology, latest theories about the origin of the universe, latest methods for hydroponic gardening. If your instructor encourages you to find your own topics, take a look at the following suggestions.

Cutting-Edge Technologies

*How ambitious and daring are you? The link below takes you to some amazing, crazy inventions and discoveries.*

Gizmag.com clippings

Volunteer Opportunities

*Find a service-learning opportunity that involves some writing!*

Read about Service Learning. In particular, take a look at the volunteer opportunities.

<table>
<thead>
<tr>
<th>Topic Ideas for Technical-Writing Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wormholes</td>
</tr>
</tbody>
</table>

*Peruse these topics—see if any possibilities for projects come to mind.*
<table>
<thead>
<tr>
<th>Ideas for Audiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>See if the following list of audiences brings to mind technical-writing projects.</td>
</tr>
</tbody>
</table>

City council members | Parent-teacher association | Downtown renovation commission |
Neighborhood association | City transportation board | Rural utilities cooperative |
Recycling special interest group | Student parking action group | Student housing board |

1/8/2020 Writing Process
https://softchalkcloud.com/lesson/files/wcrTVeL3Ajapo6/5_1WritingProcess_print.html 2/25
City mass transportation agency | Business secretary association | Pet owners society
Save-our-trees action group | Citizens antipornography league | City beautification commission
Alternative energy-resource investors | Friends of sidewalk artists | Housing for the homeless society
Computer animators society | Alternative-transportation action group | College solar-automobile club
High-school science teachers association | City bus riders support group | Drug-rehab center board
Citizens-against-crime league | Computer-game design society | Your local government representative
City mayor | County commissioners | Home-brewers and microbrewers club
Organic foods cooperative | Student housing cooperative | Local wine makers society
Student services director

Academic and Workplace-Oriented Majors

Consider interesting courses or projects related to your major or any of the following.

| Accounting | Air conditioning technology | Aerospace technology | Refrigeration technology |
| Astronomy | Automotive technology | Biology | Biotechnology |
| Engineering | Chemistry | Child development | Computer science |
| Culinary arts | Diagnostic medical imaging | Electronics | Building construction technology |
| Emergency medical service technology | Engineering design graphics | Information records management | Physical fitness technology |
| Geomatics (land surveying technology) | Fire protection technology | Medical lab technology | Meteorology |
| Molecular genetics | Urban studies | Engineering | Marine biology |
| Molecular biology | Biochemistry | Petroleum engineering | Geosystems engineering |
| Neurobiology | Mechanical engineering | Electrical engineering | Biomedical engineering |
| Military science | Civil engineering | Chemical engineering | Nursing |
| Occupational therapy | Office systems technology | Pharmacy technology | Photography |
| Geology | Physics | Printing technology | Quality assurance |
| Surgical technology | Technical communication | Welding technology | X-ray operations |

Interesting Magazines and Journals

Go to your local library or newsstand and flip through some of the following.

| Flying | Mother Earth News Magazine | Popular Photography |
| Issues in Medical Ethics | Wood Magazine | 4 Wheel & Off Road magazine |
| Air & Space Magazine | Audio Magazine | Smithsonian |
| Home Improver Magazine | Family Business Magazine | PC Magazine |
| Byte Magazine | Family | Handyman Magazine |
| Anthropological Linguistics | Nature | Astronomy Magazine |
| Scientific American | National Geographic | Cogeneration |
| Energy Research News | Lab Animal | Molecular Vision |
Work Place: Ideas for Technical-Writing Projects

What's going on at work? Are the projects there, just waiting for you? Browse some of these ideas:

- Does the office need a new photocopy machine?
- Are you considering a fax machine? a CD writer? a digital camera?
- Is the staff expected to use a new software application for which there is no user guide?
- Are you and other employees interested in telecommuting (using electronic and computer methods to work at home)?
- Is management considering putting all operating procedures and other administrative materials online?
- Has your agency been challenged to go "paperless"—to get all files stored and searchable electronically?
- Have you been tasked with recommending a personal digital assistant, cell phone, or notebook computer for all employees in your company?

Problems, Problems, Problems...

A good source for volunteer projects is Idealist at www.idealist.org, a site run by Action Without Borders, a non-profit foundation. It lists 10,000 Web sites for non-profit organizations, information on volunteering, jobs, and projects.
<table>
<thead>
<tr>
<th>Inadequate public transportation</th>
<th>Lack of parking</th>
<th>Overflowing land fills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smog and otherwise dirty air</td>
<td>Crowded streets and highways</td>
<td>Crime, vandalism</td>
</tr>
<tr>
<td>Homeless people</td>
<td>Lack of daycare facilities</td>
<td>Unemployment</td>
</tr>
<tr>
<td>Lack of low-cost housing</td>
<td>Dwindling water supplies</td>
<td>Expensive electricity</td>
</tr>
<tr>
<td>Natural areas threatened by urban development</td>
<td>Lack of parks and recreational facilities</td>
<td>Lack of facilities for the elderly</td>
</tr>
<tr>
<td>Rodent infestations</td>
<td>Mosquitoes</td>
<td>Lack of vegetation (trees, shrubbery, etc.)</td>
</tr>
<tr>
<td>Projects for nonprofits</td>
<td>Lack of facilities for young people</td>
<td>Expensive water</td>
</tr>
</tbody>
</table>

**Brainstorm Topics for Writing Projects**

If you have a topic for your writing project, the next step is to think about subtopics related to it. During this stage, the "invention" or "brainstorming" stage, use the following suggestions to explore your writing project topic:

Let the subject of your writing project itself suggest subtopics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Possible topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>The sun</td>
<td>its temperature</td>
</tr>
<tr>
<td></td>
<td>its composition</td>
</tr>
<tr>
<td></td>
<td>its unusual phenomenon</td>
</tr>
<tr>
<td></td>
<td>its relative size</td>
</tr>
<tr>
<td>Ultrasound in medicine</td>
<td>its physical properties</td>
</tr>
<tr>
<td></td>
<td>equipment used</td>
</tr>
<tr>
<td></td>
<td>medical uses</td>
</tr>
<tr>
<td></td>
<td>advantages</td>
</tr>
</tbody>
</table>

**A Checklist of Invention Questions**

Use an invention checklist like the following. If you ask yourself the questions listed below, you'll be less apt to overlook important subtopics; and, with use, these questions eventually become almost automatic.

<table>
<thead>
<tr>
<th>Problems or needs</th>
<th>Does your writing project concern itself with a problem or a need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solutions and answers</td>
<td>Should your writing project discuss potential solutions or answers to the problems or questions presented in the project?</td>
</tr>
<tr>
<td>Historical events and natural phenomena</td>
<td>Does your writing project concern itself with some historical event or natural (or mechanical) phenomenon?</td>
</tr>
<tr>
<td>Causes and effects</td>
<td>Should your writing project discuss the causes, effects, or both related to the phenomenon, historical event, or problem you are discussing?</td>
</tr>
<tr>
<td>Descriptions</td>
<td>Which aspects of your writing project require description?</td>
</tr>
<tr>
<td>Processes</td>
<td>Does your writing project involve processes, procedures, routines, or repetitive events that must be discussed in steps?</td>
</tr>
<tr>
<td>Classes</td>
<td>Can the main topic or any subtopic within your writing project be divided into classes or types?</td>
</tr>
<tr>
<td>Comparisons to similar or familiar things</td>
<td>Can similar things in your writing project be compared to each other? Can you compare something complex in your writing project to something familiar or common?</td>
</tr>
<tr>
<td>Illustrative examples</td>
<td>Will a discussion of examples related to your writing project be effective?</td>
</tr>
<tr>
<td>Theoretical background (definitions)</td>
<td>Are there unfamiliar terms in your writing project? Should you include them in your project and define them?</td>
</tr>
<tr>
<td>Applications</td>
<td>Can you discuss the applications related to your writing project?</td>
</tr>
<tr>
<td>Advantages and</td>
<td>Should you discuss the advantages or benefits related to your subject?</td>
</tr>
</tbody>
</table>
Here is an excerpt of a brainstorming session in which these questions were used:

How does a wind-powered electrical system (WPES) work? What are the steps in its operation? Savings: discuss the amount of money that can be saved using WPES. Relationship between average windspeeds and electrical output: what happens when there's no wind, only very light breezes? Too much wind? Basic parts: rotor, generator, tail assembly, tower. Different manufacturers of WPES: how to get a good system and avoid being ripped off. Dimensions, materials, construction of common models of WPES; sensitivity to low wind speeds. Historical background on WPES: the time when more WPES were being used, just before rural electrification in the 1930s; who were the first developers? When has interest in WPES reappeared? Why? Two general class of wind machines: lift and drag machines. Lightning protection of WPES. Aerodynamic principles as they apply to WPES. Understanding weather patterns and seasonal and geographical factors affecting wind. Principles of electricity: circuits, generators, types of current, meanings of terminology. Local, state, federal tax credits and research support in wind systems research, and WPES purchase by consumers.

**Narrow That Report Topic**
For a writing project in a technical-writing course, the ideal starting place is a workplace problem requiring some writing as part or all of the solution. With such a project, the audience and problem are there to help you narrow the topic. However, if you begin with a topic, it’s harder to narrow. You are likely to end up trying to write a ten-pound textbook on automotive plastics, residential solar energy in the home, or La Niña. Narrow the topic and do some careful research—the result will be a practical, useful document that doesn’t go on forever.

Narrowing means selecting a portion of a larger topic: for example, selecting a specific time period, event, place, people, type, component, use or application, cause or effect, and so on. Narrowing also means deciding on the amount of detail to use in discussing those topics.

**Note:** In the following example of the narrowing process, you may wonder how all those subtopics seem to come to mind so effortlessly. If that’s not the way it is for you, try some brainstorming and invention first.

### Following the Narrowing Process

Let's walk through a typical narrowing exercise to see how it works. This particular example works "backward" from a topic to a realistic audience and purpose. In a "real world" situation, you'd begin with a workplace situation.

1. Imagine that you want to write something about gardening. You have a backyard vegetable garden that you grow as a hobby, and of course for the vegetables it produces.
2. What can you do with a topic like gardening? You know you want to focus on vegetable gardening, but that's only a first timid step at narrowing. There are still dozens and dozens of topics related to vegetable gardening.
3. What are the possibilities related to vegetable gardening? Obviously, there are topics like planting techniques, pest control, fertilization and irrigation topics, perhaps even special-focus reports on individual vegetables—tomatoes, onions, butter beans, peppers. Among these, you lean more to gardening methods or techniques—such as drip irrigation, raised-bed gardening, organic pest control, and so on.
4. Now you are getting somewhere! But you can’t write on all those techniques—pick one! Recently, you were reading about how NASA’s plans for the human exploration of Mars includes growing food there on the planet—specifically by using hydroponic methods. This sparks your curiosity; it's the right topic for a technical document of some kind.
5. You’re all done with narrowing, right? Sorry, you’re barely half-way there. Hydroponics, the science and craft of growing plants without soil, is a big topic in its own right. What specifically interests you about hydroponics: Interested in setting up a hydroponics system in your garage? Curious whether the claims about hydroponically grown foods are true? Wondering what it takes to run a hydroponics system? Interested in finding a commercially available hydroponic system that meets your needs and price range? Yes—something about practical realities of hydroponics! Your real interest here is the feasibility of hydroponic gardening, recommendations, or both.
6. Now you have a choice: (a) focus on the feasibility of hydroponics or (b) focus on commercially available systems to determine which is best and which will fit in your garage. At this stage, you are not ready to pick a system; instead, you must convince yourself that the whole concept is practical. Therefore, let’s focus on the general feasibility.
7. Another chapter in this book presents several kinds of feasibility: practical feasibility, whether it works; economic feasibility, whether it's too expensive and whether it pays for itself or offers economic advantages; implementation feasibility, whether it's too much trouble, whether you have to remodel your entire garage; and feasibility in terms of the yield and quality—whether hydroponically grown vegetables are any good.
8. So what’s it going to be? You know that you want answers to these questions: does hydroponic gardening work? What's the yield? Is it any good? How much of a hassle is it? How expensive and how difficult is it to build your own system? And what do you need—in general terms—to build a system? Is this too much for a semester report in a technical-writing course?

You've come a long way from "gardening," but you may still need to keep going. Actually, you’ve done one other narrowing operation without noticing: the focus is small-time, hobbyist, or "home" hydroponic gardening—not commercial hydroponic gardening. In any case, you have four main questions: (a) how does it work, (b) how well does it work, (c) how much work is it, and (d) and what are the costs? These translate into the subtopics you see at the very bottom of this flow chart.
To this point, you've been operating in a vacuum, not considering audience and situation, focusing instead on your interests in this topic. Now it's time to get real—to define a real or realistic audience and situation. Who wants this document? Who would hire you (hydroponics expert) to write it? How would people obtain this document? Imagine that a hydroponics association, club, or special-interest group sends out a request for proposals (RFP). Its members want a technical writer to develop an overview guide on hydroponics: not a how-to, not a parts list—just an introduction answering people's questions and concerns. The organization will ship your overview to anybody who inquires about the topic—and the organization will pay you for all of this great work.

Are we there yet? Not quite. Narrowing means two things: zooming in on progressively smaller and smaller subtopics. And deciding on level and amount of detail. In this hydroponics overview, must you cover the four subtopics in excruciating detail? No, at most you'll want to cover practicality in moderate detail: readers need enough detail to see that the method actually works. Use the same amount of detail for yield, perhaps citing some comparative studies. But use only light detail for management and costs. You must keep this overview relatively brief and readable. Notice that these four main topics are not in the best sequence; we'll get to that in the outlining phase.
Home hydroponics system: topics

| Costs—how expensive to build and run a system? | light detail |
| Practicality—do they really work? | moderate detail |
| Management—how much hassle? | light detail |
| Yield—how much and how good is the produce? | moderate detail |

**Finishing the Process**

In the end, try to produce something that is integrated with a real or realistic situation like this:

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does the RFP that you are responding to request?</td>
<td>An avid association of US hydroponic gardeners wants to spur interest in this method by being able to distribute some sort guide regarding the method.</td>
</tr>
<tr>
<td>Describe the organization or individual making the request.</td>
<td>American Home Hydroponics Association is an advocacy group seeking to spur interest in this gardening method and to support current membership with techniques and troubleshooting advice.</td>
</tr>
<tr>
<td>How will the organization or individual use the requested document?</td>
<td>The AHHA will advertise this guide in gardening magazines and send hardcopy to people who are interested but without Internet connection. Also, it will post links to the PDF guide on its website.</td>
</tr>
<tr>
<td>If the requesting organization will make the document available to others, who are those people and how will they get the document?</td>
<td>The requested guide will be aimed at an audience of gardeners but assume nothing about their knowledge of hydroponics. It will seek to spur their interest.</td>
</tr>
<tr>
<td>What kind of document is requested? What is the purpose of the document?</td>
<td>It will be a guide enabling people to get interested in hydroponics and see how to get started.</td>
</tr>
<tr>
<td>What are the characteristics of the target readers of the document (knowledge, background, experience)?</td>
<td>The requested guide will be aimed at an audience of gardeners but assume nothing about their knowledge of hydroponics. It will seek to spur their interest.</td>
</tr>
</tbody>
</table>

**Outlining-Generating Items and Sequencing Them**

When you write a technical report, not only must you think of the right information to include (or exclude); you must also find a good way to arrange it. This is a two-part chapter: this part focuses on generating outline items and sequencing them; the second part focuses on turning a rough outline into a good, polished outline.

Outlines for technical reports are usually hard to handle solely in your mind; it’s a little like trying to add a list of large numbers mentally. You must get report outlines in print in order to think about the arrangement of the topics within them. A good working outline serves you in at least four important ways:

- It shows you which areas of information to investigate and gather information on.
- It shows you which areas you can safely ignore (thus saving you plenty of time).
- It enables you to schedule your work into manageable units of time.
- It gives you a "global" view of your report project, an overall sense of the contents, parts and organization of the report.

**Generating Outline Elements**

If you go through a brainstorming process, you have generated a rough list of topics that you can start working with. The topic list below concerns cocombustion, which is the incineration of municipal solid waste (MSW) with conventional fuels.
to reduce conventional fuel consumption costs and related MSW disposal problems. Imagine that you had developed a topic list on this subject and then had narrowed the list to these topics:

- Advantages of cocombustion
- Steps in cocombusting MSW
- Disadvantages of cocombustion
- Historical background on cocombustion
- Economics of cocombustion
- Special components for cocombustion
- Composition of MSW
- Cocombustion power plant construction costs
- Cocombustion power plant operating costs
- Economic advantages of cocombustion
- Environmental advantages of cocombustion
- Characteristics of municipal solid waste (MSW)
- Environmental disadvantages of cocombustion
- Methods of MSW disposal

**Grouping, Combining, and Subordinating Outline Elements**

You can tell that the list above needs serious help:

- You can see that a number of topics involve advantages and disadvantages; these might be combined in a more general outline called Advantages and Disadvantages of Cocombustion. The specific related topics would be subordinated beneath this more general topic: Advantages and Disadvantages of Cocombustion
  - Advantages of cocombustion
  - Disadvantages of cocombustion
- But wait a minute! One of the advantages has to do with economics. So we could create another group: Economics of cocombustion
  - Economic advantages of cocombustion
  - Cocombustion power plant construction costs
  - Cocombustion power plant operating costs
- So what do we do with environmental advantages of cocombustion and environmental disadvantages of cocombustion? It might be best to create a higher-level heading environmental aspects of cocombustion and subordinate those other two beneath it. And so that means we no longer need Advantages and Disadvantages of Cocombustion. It has been split into an economics group and an environment group.
- Looking further at the rough list of topics, you can probably see that Steps in cocombusting MSW, Special components for cocombustion, Composition of MSW, Characteristics of municipal solid waste (MSW) are related to each other and should exist in their own area of the outline.

So this is how the business of generating, grouping, combining and subordinating works early in the outlining process. Outlining is a messy process so you'll probably come back to this phase again.

**Sequencing Outline Elements**

The next step in outlining is to sequence the items appropriately. There are so many different patterns of sequencing that only most common ones can be reviewed here. And, frankly, these are all pretty obvious. If they are obvious to you, skip to Elaborating the rough outline.

Chronological sequencing. One of the most common patterns in outlining is the chronological one. In a historical background section of an outline, the chronological approach is just about the only one you can use. Here is an outline excerpt concerning the historical background of nuclear research:

II. Historical background of nuclear research
   A. Becquerel's theory of radition in uranium (1896)
   B. The work of the Curies
   C. The work of Rutherford
1. Demonstration of the internal structure of the atom (1911)
2. Transmutation of atoms (1919)

D. Development of technology to study atomic structure
   1. Cascade transformer (1928)
   2. Linear accelerator (1931)
   3. Cyclotron (1932)
   4. Betatron (1940)

E. Hahn-Strassmann discovery of uranium fission (1938)
F. Oppenheimer work on nuclear chain reactions (near 1940s past)
G. Explosion of the first atomic bomb (1945)

In some outlines, however, you almost don't notice the chronological pattern. For example, effects come after causes; solutions, after problems; or findings, after research method. The chronological pattern is most important in a research proposal outline:

I. Introduction
   A. Historical background on caffeine studies (past)
   B. Objectives of the study
   C. Limitations of the study
   D. Plan of development

II. Review of the literature on caffeine

III. Experimental method to be used

IV. Results of the tests

V. Discussion of the results

VI. Summary and conclusions

VII. Implications for further research (future)

Chronologically, the researcher first defines the problem, the reviews the literature on the problem, plans a research method, conducts the research and gathers data, analyzes the data and draws conclusions from it. Afterward, she may consider areas for further research on the problem. At-rest to in-motion sequence. Another common outlining pattern is to start with an object at rest, motionless as if in a photograph, and then to move to a discussion of it in operation, in action as if in a motion picture.

II. Basic Components of Wind-Powered Electrical Systems
   A. Rotor (motionless)
   B. Generator
   C. Tower

III. Basic Operation of Wind-Powered Electrical Systems
   A. Wind energy into mechanical energy
B. Mechanical energy into electrical \textit{(in motion)} energy
C. Stabilization of electrical energy
D. Conversion to household current

Specific to general sequence. Some outlines move from a specific, close-up focus to a more general, panoramic focus. They seem to start with a microscope, examining the minute details of a subject, and end with a telescope, considering the subject from a distance in relation to other things. (This pattern can also be reversed.)

I. Introduction
II. Characteristics of municipal solid waste (MSW)
III. Methods of disposal of MSW \textit{(microscope)}
IV. Processing municipal solid waste
V. Plant modifications for cocombustion
VI. Advantages of cocombusting MSW
   A. Environmental advantages
   B. Economic advantages \textit{(telescope)}
VII. Case studies of three cocombustion plants

In this next outline, the focus broadens after part III, changing to aspects related to computerized voice recognition technology:

I. Introduction
II. Human voice production
   A. The generation of sound
   B. Factors affecting the human \textit{(microscope)} voice
III. Components of the isolated word recognition system
   A. The preprocessor
   B. The feature extractor
   C. Components in the classification phase
   D. Decision algorithms
IV. Problems with computerized speech recognition
   A. Accuracy
   B. Limited vocabulary size
   C. Privacy
V. Applications of voice recognition systems
   A. Data entry
   B. Mobility
   C. Security
D. Telephone access

E. Devices for the handicapped *(telescope)*

VI. Current availability of speech recognition systems

VII. The future of the computerized speech recognition industry

Rhetorical sequence. Elements in outlines can also be arranged rhetorically, in other words, according to what is most effective for the reader. Here are some examples of rhetorical patterns:

- Simple to complex
- Least important to most important (or vice versa)
- Least controversial to most controversial
- Most convincing to least convincing (or vice versa)
- Most interesting to least interesting

This list is by no means complete, but you can see that elements in it are arranged according to impact on the reader—that is, the impact the writer would like to have. Here are some excerpts of outlines where these patterns are used.

If you have ever studied computer programming, you know that commands like PRINT are simple; variable assignment commands (like LET A = 30), less simple; and FOR-NEXT loop statements, rather complex. If you were outlining a report on fundamental BASIC commands for the beginner, you'd probably start with the simple ones and work your way to the complex:

**Simple-to-complex order**

III. USEFUL BASIC COMMANDS

A. PRINT

B. LET

C. IF-THEN

D. FOR-NEXT

E. DIM

An obvious outlining principle is to avoid creating interruptions within an outline sequence. Here's an example:

**Outline excerpt with interruption**

I. Municipal solid waste generated in the US

A. Total amounts of MSW
   1. Increases since 1950
   2. Projected increases to the year 2000

B. Processing MSW for cocombustion
   1. Primary storage
   2. Grinding
   3. Air sorting
   4. Magnetic separating
   5. Screening
6. Secondary storage

C. Characteristics of MSW
   1. Composition of MSW
      a. food waste
      b. paper and other rubbish
      c. noncombustibles
   2. Factors affecting energy content
      a. moisture content
      b. areas of MSW origination

II. Power plant modifications for cocombustion

Revised outline excerpt

I. Municipal solid waste generated in the US
   A. Total amounts of MSW
      1. Increases since 1950
      2. Projected increases to the year 2000
   B. Characteristics of MSW
      1. Composition of MSW
         a. food waste
         b. paper and other rubbish
         c. noncombustibles
      2. Factors affecting energy content
         a. moisture content
         b. areas of MSW origination
   II. Processing MSW for cocombustion
      A. Primary storage
      B. Grinding
      C. Air sorting
      D. Magnetic separating
      E. Screening
      F. Secondary storage

III. Power plant modifications for cocombustion

In the problem version, the municipal solid waste discussion is interrupted by the MSW-processing discussion. A better arrangement would be to discuss MSW fully before going on to the discussion of how it is processed. Use these common
arrangement principles to get your topic list into an initial rough order. The rearranged version of the topic list shown previously might look this way:

I. Historical background
   A. Rising energy, utility costs
   B. Search for alternatives (review)
II. Composition of MSW
III. Special components of the cocombustion plant
IV. Steps in the cocombustion of MSW
V. Economics
   A. Cost to build or convert
   B. Cost to operate
   C. Cost of produced electricity
VI. Advantages
   A. Less coal used
   B. Reduction of utility rates
   C. Less landfill used
   D. Reduction of landfill costs and needs
VII. Disadvantages
   A. Expense of converting existing facilities
   B. Handling MSW
   C. Increased emissions

Electronic Note-Taking Methods

As of 2015, the writing-teaching world—at least at the college level and in terms of textbooks—is seriously behind in terms of what it knows and what it teaches about note-taking for major writing projects. Strangely, the very best writing resource on the Internet, the Purdue OWL, has nothing on note-taking. Read the following section Traditional Note-Taking Methods for a review of just what good any note-taking system is.

Until we get our act together, consider how the traditional note-taking system is implemented in software applications.

A number of software applications are available that support note-taking and related tasks: Evernote, EasyBib, NoodleTools, and more. Their basic functions are similar so let's use NoodleTools. It has a nice set of YouTube videos that walk you through the main phases of its use:

How do I create a new project? This video takes you from the very start!

How do I to create a notecard for my citation? In this video, you see how to create a single notecard. In one panel of that view, you can paste the direct quotation; in another, your understanding, paraphrase, or summary of it; in still another, you can jot down ideas and questions; and in another, you can enter the URL or the traditional bibliographical source of the information plus search tags. The video concludes with a demonstration of moving the new notecard to the "tabletop," grouping notecards, and using them to create an outline.

NoodleTools—Creating Outlines. If you've created good notecards, creating the outline from them is easy, as this video shows.
Traditional Note-Taking Methods

When you've located the right sources of information for your report, it's time to start gathering the right information from them and developing it into a report. In other words, it's time to start reading, summarizing, paraphrasing, interviewing, measuring, calculating, and developing information any other way your report project requires. The technical report may be one of the largest writing projects that you've ever tackled: you may wonder how you are going to do all that reading and remember all that information. Concerning the reading, here are several suggestions:

- Develop as specific an outline as you can: it shows you what information you must gather and, as importantly, what information you can ignore.
- Use the indexes, tables of contents, and headings within chapters to read books selectively for just the information you need.
- Divide your work into manageable, hour-long chunks (make progress rather than relying on big blocks of weekend or vacation time).

As for remembering the information you gather for your report, the most practical suggestion is to use some form of note-taking. Note-taking refers to any system for collecting and storing information until you can use it in the report. Note-taking involves the skills of summarizing, paraphrasing, or quoting. A good system of note-taking is one that enables you to gather a large amount of information over a long period of time and to be able to use that information without having forgotten it or lost it in the meantime.

Traditional Note-Taking Process: An Overview

In the traditional system of taking notes for a long report, you:

1. Develop a rough outline.
2. Do any preliminary reading necessary to construct a rough outline.
3. Locate your information sources, and make bibliography cards for each source.
4. Take the actual notes on index cards.
5. Label each notecard according to its place in the outline.
6. Provide bibliographic information on each notecard.
7. Change or add extra detail to the outline as the note-taking process continues.
8. Check off the areas of the outline for which sufficient notes have been taken.

When you have taken sufficient notes to cover all parts of an outline, you transcribe the information from the notecards into a rough draft, filling in details, adding transitions, and providing your own acquired understanding of the subject as you write. Naturally, you may discover gaps in your notes and have to go back and take more notes.

Developing the rough outline

As the section on outlining emphasizes, you must have a working outline before you begin gathering information. The rough outline shows you which specific topics to gather information on and which ones to ignore. Think of the outline as a series of questions.

If you don't have a good, specific outline, the sky is the limit on how many notes you can take. Think of the outline as a set of boxes that you fill up with the information you collect as you do your research for the report.
Information on the bibliography cards

On the bibliography cards you should record information that enables you or your readers to locate the books, articles, reports, and other sources. Remember that you'll use this information to create the bibliography or list of references for your report. See the examples of bibliography cards for books, magazine articles, encyclopedias, and government documents; the section on documentation shows you details on the information to record on many different types of sources, but remember these general guidelines:

- For books, record the "facts of publication": the city of publication, the publisher, and the date of publication.
- For magazines, record the title of the magazine, the date of issue of the specific magazine, and the beginning and ending page numbers of the article.
- For encyclopedia articles, record the edition number and date of the encyclopedia, and look up the authors' initials.
- For government documents, disregard the authors' names, use the department, administration, or agency name as the author, and copy the cataloguing number.
- For any private sources of information you use, for example, interviews or letters, record the date of the communication, the source's full name, title, and organization with which he or she is affiliated.

Information on the notecards

In the traditional note-taking system, a notecard typically looks like this:

BWR—fuel rod (III,A,1,b) fuel rod material—Zircaloy (same as PWR fuel rod) 148 in. long X 0.493 in. diam. slightly longer > PWR fuel rod 16 D, 749

This notecard has the following features:

- A word, phrase, or number that indicates where it fits into the outline (the "locator").
- Bibliographic information: that is, an abbreviation for the source of the note (book, article, etc.) and a page number.
- The note itself, the information that will go into the report.
- A number that indicates the notecard's place in the final arrangement of all the notecards.

Locator. The "locator" phrase or number tells you where the note fits into the outline, that is, when and where you'll use this information in the report. Locaters must be updated regularly. As you read, take notes, and learn more about your subject, you can flesh out, or "elaborate," your outline more and more, subdividing it into third, fourth, and even fifth levels.

Bibliographic information. Each notecard must also contain bibliographic information, those details about the source of the note: the author, title, page number, and so on. Rather than write all such information on each notecard, use abbreviations: assign a letter to each source, and keep track of the sources on bibliography cards, as shown above.

Methods of recording information on notecards
The actual information that you record on the index card is rather small: a few statistics or a sentence or two, and not much else. You take such small bits of information to make it easier to "shuffle" your notecards into the sequence in which you'll use them in writing the rough draft. There are three ways of recording the information on notecards:

- Directly quoting it, copying the information directly from the source word-for-word
- Paraphrasing it, retaining the full detail of the information but in your own words
- Summarizing it, condensing the main points in the information in your own words

See what the Purdue OWL has to say about these methods.

**Direct quotation.** In most technical reports, direct quotation is needed only for the following situations:

- Statements by important or well-known authorities or leaders
- Controversial statements you do not want attributed to you
- Statements expressed in unusual, vivid, or memorable language

Here is an example notecard with a direct quotation:

Myers, author of *The Nuclear Power Debate* and somewhat of a supporter of nuclear, emphs heavy inspect and penalties: During the period between July 1, 1975 and September 30, 1976 the NRC listed 1,611 items of noncompliance. Only six of these were considered serious violations, 923 were classified as infractions, and 682 were noted as deficiencies. The NRC issued fines to ten utilities totaling $172,250 between July 1, 1975 and December 15, 1976. NRC officials report that the limited use of fines and the efforts to get industry to regulate itself have worked. "By and large," one NRC official told IRRC, "I think our enforcement program is working." H, 46

When you copy a direct quotation onto a notecard, remember to do a few extra things that will save time and frustration later on:

- Write a lead-in to introduce the quotation, citing the author's name and any other important information about the author.
- Write a brief explanation, interpretation, or comment on the quotation you've just copied.

There are essentially two types of direct quotation: "block" quotations and "running" quotations. Here is an example of a block quotation (any quotation over 3 lines long, which is indented):

In Myers' view, the nuclear power industry has every reason to comply with the NRC's regulations to the very letter: The NRC issues an order to shut down or imposes civil fines only after repeated violations have indicated what the NRC considers "a pattern of non-compliance." The NRC argues that, particularly with power plants, civil penalties are unnecessary for the most part. "The greatest penalty," one official said, "is to require the plant to shut down, forcing it to buy replacement power (often at a cost of $100,000 to $200,000 per day) elsewhere. A civil penalty's largest cost—the NRC is limited to a $5,000-per-violation ceiling per 30 days—is the stigma attached to it." (8:46) The "stigma" refers to the fact that, once a nuclear power plant is fined, it will likely be the target of public concern and even more stringent and frequent NRC inspection.

"Running" quotations are direct quotations that are trimmed down and worked into the regular sentences of a report. Notice how much smoother and more efficient the running quotation is in the revised version below:

Ineffective direct quotation: There are two types of light water reactors: the pressurized water reactor and the boiling water reactor. LWRs of both types convert heat to electricity with an efficiency of about 32 percent—significantly less than the best fossil-fueled plants, although about equal to the national average for all thermal electricity generation [13:438]. As for harnessing the energy potential of uranium, LWRs are estimated to average only between 0.5 and 1.0 percent.

Revision with running quotation: There are two types of light water reactors: the pressurized water reactor and the boiling water reactor. According to Paul Ehrlich, who has been a consistent critic of nuclear power, both these types of LWRs "convert heat to electricity with an efficiency of about 32 percent—significantly less than the best fossil-fueled plants, although about equal to the national average for all thermal electricity generation" (13:438). As for harnessing the energy potential of uranium, LWRs are estimated to average only between 0.5 and 1.0 percent.
Guide for using direct quotations

When you use direct quotations in your report, keep these guidelines in mind.

Using ellipsis in direct quotations. The three dots "..." show that words are omitted from the sentence. The brackets "[ ]" indicate changes made by the writer using the quotation so that it would read as good English and make sense.

- Never use "free-floating" quotations in reports. Always "attribute" direct quotations; that is, explain who made the quoted statement. Notice how this is done in Figure 6.
- Always provide adequate introduction for direct quotations and explain their meaning and importance to your readers. Notice how the block quotation above on NRC penalties (a) prepares the reader for the quotation, and, afterwards, (b) provides interpretive comment, on the meaning of the word "stigma" in particular.
- Use indented or "block" quotations whenever a direct quotation goes over three lines long. With any lengthy quotation, make sure that it is important enough to merit direct quotation.
- Whenever possible, "trim" the quotation so that it will fit into your own writing.
- Punctuate direct quotations correctly. You can see the rules for punctuating direct quotations.
- Use ellipses to shorten direct quotations. When you do, however, make sure that the resulting quotation reads as good English.
- Use direct quotations only when necessary: if the passage doesn't fit one of the reasons for direct quotation cited at the beginning of this section, paraphrase or summarize it instead.

Paraphrasing. In technical-report writing, usually the better approach to note-taking is to paraphrase. When you paraphrase, you convey the information fact-by-fact, idea-by-idea, and point-by-point in your own words. The writer of the original passage ought to be able to read your paraphrase and say that it is precisely what she or he had meant. Here are some example paraphrased notecards:

BWR—fuel assembly (III,A,1,3) fuel assembly—63 f rods spaced, supported in a sq (8 x 8) arrangement by upper + lower plate 3 kinds: (a) tie rods; (b) water rod); (c) stand f rods 3rd, 6th f rods on a bundle's outer edge act as tie rods the 8 tie rods screw into castg of lower tie plate water rod: acts as spacer support rod, as source of moderator material close to the center of f bundle K, 2001

BWR—fuel assem (III,A,1,3) fuel channel—enclosure for f bundle; f bundle + f channel make up fuel assem is a tube with a square shape, made of Zircaloy dimensions: 5.518 in. X 5.518 in. X 166.9 in. function: channel core coolt thru f bundle and guide control rods K, 2001

Paraphrases are necessary and preferable for a number of reasons:

- You paraphrase because the content of the passage is so important to your report that you need every bit of it.
- When you paraphrase, you adjust the wording of the original to meet the needs of your audience, the purpose of your report, and your own writing style. In other words, you "translate" other writers' material into your own.
- A report of mostly direct quotations would be hard to read.
- Readers tend to skip over direct quotations, particularly long ones.
- One final reason for paraphrasing: you are actually writing bits of the rough draft of your report as you paraphrase.

Here is an example of an original passage and its paraphrases, with the unique wording of the original (which must be changed in the paraphrase) underlined.

Original passage: About a third of light-water reactors operating or under construction in the United States are boiling-water reactors. The distinguishing characteristic of a BWR is that the reactor vessel itself serves as the boiler of the nuclear steam supply system. This vessel is by far the major component in the reactor building, and the steam it produces passes directly to the turbogenerator. The reactor building also contains emergency core cooling equipment, a major part of which is the pressure suppression pool which is an integral part of the containment structure. . . . earlier BWRs utilized a somewhat different containment and pressure suppression system. All the commercial BWRs sold in the United States have been designed and built by General Electric. Several types of reactors that use boiling water in pressure tubes have been considered, designed, or built. In a sense, they are similar to the CANDU, described in Chapter 7, which uses pressure tubes and separates the coolant and modulator. The CANDU itself can be designed to use boiling light water as its coolant. The British steam-generating heavy-water reactor has such a system. Finally,

Paraphrased version: Boiling water reactors, according to Anthony V. Nero in his *Guidebook to Nuclear Reactors*, either completed or constructed, make up about one third of the light-water reactors in the U.S. The most important design feature of the BWR is that the reactor vessel itself acts as the nuclear steam supply system. The steam this important component generates goes directly to the turbogenerator. Important, too, in this design is the emergency core cooling equipment, which is housed with the reactor vessel in the reactor building. One of the main components of this equipment is the pressure suppression pool. The containment and pressure suppression system currently used in BWRs has evolved since the early BWR designs. General Electric is the sole designer and builder of these BWRs in the U.S. The different kinds of reactors that use boiling water in pressure tubes are similar to the CANDU, which separates coolant and moderator and uses pressure tubes, also. CANDU can also use boiling light water as a coolant. The British have designed a reactor generated steam from heavy water that uses just such a system. Also, the Soviets have developed and are now building as their main type of reactor a boiling pressure tube design that uses carbon as the moderator. [12:232]

Guide for writing and using paraphrases

Here are some guidelines to remember when paraphrasing:

- In most cases, paraphrase rather than use direct quotation.
- Avoid the distinctive wording of the original passage.
- Do not interpret, criticize, or select from the original passage.
- Include bibliographic information on the author, source, and page numbers.
- In the rough draft, cite the author's name and other important details about her or him just as you would if were quoting directly. In Figure 9, notice how the paraphrased author's name is given early.
- Refer to the paraphrased author in such a way to make it clear where the paraphrase begins and ends. (See Figure 9.)
- Document a paraphrase just as you would a direct quotation. Mark the area of the paraphrase by citing the paraphrased author's name at the beginning of the paraphrase and by inserting a footnote or parenthetical reference at the end. (Again, see Figure 9.)
- See what the Purdue OWL has to say about paraphrasing.

Summary. Summaries are usually much shorter than their originals. A summary concentrates on only those points or ideas in a passage that are important. Unlike in a paraphrase, the information in a summary can be rearranged. Here is a passage from which summaries below will be taken:

Numerous systems are available for controlling abnormalities [in boiling water reactors]. In the event that control rods cannot be inserted, liquid neutron absorber (containing a boron compound) may be injected into the reactor to shut down the chain reaction. Heat removal systems are available for cooling the core in the event the drywell is isolated from the main cooling systems. Closely related to the heat removal systems are injection systems for coping with decreases in coolant inventory.

Both abnormalities associated with the turbine system and actual loss of coolant accidents can lead closing of the steam and feedwater lines, effectively isolating the reactor vessel within the drywell. Whenever the vessel is isolated, and indeed whenever feedwater is lost, a reactor core isolation cooling system is available to maintain coolant inventory by pumping water into the reactor via connections in the pressure vessel head. This system operates at normal pressures and initially draws water from tanks that store condensate from the turbine, from condensate from the residual heat removal system, or if necessary, from the suppression pool.

A network of systems performs specific ECC [emergency core cooling] functions to cope with LOCAs [loss-of-cool-ant accidents]. (See Figure 6.) These all depend on signals indicating low water level in the pressure vessel or high pressure in the drywell, or both.
The systems include low-pressure injection, utilization of the RHR system, and high- and low-pressure core spray systems. The high-pressure core spray is intended to lower the pressure within the pressure vessel and provide makeup water in the event of a LOCA. In the event the core is uncovered, the spray can directly cool the fuel assemblies. Water is taken from the condensate tanks and from the suppression pool. On the other hand, should it become necessary to use low-pressure systems, the vessel must be depressurized. This depressurization can be accomplished by opening relief valves to blow down the vessel contents into the drywell (and hence the suppression pool). Once this action is completed, the low-pressure core spray may be used to cool the fuel assemblies (drawing water from the suppression pool) or RHR low-pressure injection (again from the suppression pool) may be initiated, or both. The RHR system may also be used simply to cool the suppression pool. (Two other functions of the RHR are to provide decay heat removal under ordinary shutdown conditions and, when necessary, to supplement the cooling system for the spent fuel pool and the upper containment pool.)


Sentence-length summaries. Often summaries are only a sentence long. To create sentence-length summaries, use one or a combination of the following methods:

Locate a sentence or two in the original passage that summarizes the information that you want, and simply rewrite it in your own words. Find the sentence in the third paragraph of the original that is the basis for this summary:

BWR—safety sys (IV,B,2) The systems that perform emergency core cooling functions in loss-of-coolant accidents include low-pressure injection, utilization of the RHR system, and high- and low-pressure core spray systems. I, 104

If no individual sentence will work, locate several sentences that contain the right information, and combine them. (This summary sentence is built from paragraphs 1 and 2 of Figure 10.)

BWR—safety sys (IV,B,2) In case of problems with control rods or loss of coolant, BWRs use an absorber to stop the reaction or emergency systems to replenish and maintain coolant around the reactor core, respectively. I, 104-107

Sometimes, the summary sentence is like a new sentence, scarcely resembling any in the original. Here is a different summary sentence on the passage above; notice how new it seems:
BWR—safety sys (IV,B,2) If the control rods malfunction, a substance can be introduced to shut down the reaction altogether, and if water is prevented from reaching the reactor core, BWRs are equipped with backup sources of coolant that can be sprayed or injected into the pressure vessel. I, 104-107

Extended summaries. A summary can be longer than a single sentence because of the important information contained in the original passage. (Remember, however, that a paraphrase is a point-by-point recap of the original, while the summary is a selection, reordering and condensation of the original.) Here's an extended summary of the passage above on BWR emergency safety systems (Figure 10):

Boiling water reactors use numerous systems to control abnormalities in reactor operations. If a problem with control rods occurs, a liquid neutron absorber can be injected to halt the chain reaction. If coolant is cut off from the reactor core, a reactor core isolation cooling system can maintain coolant inventory by pumping water from various storage areas. This system includes low-pressure injection, the residual heat removal system, and the high- and low-pressure core spray systems. The water supply for these various emergency systems ultimately come from the suppression pool.

Guide for using summaries

Whenever you summarize, you must handle the resulting summary the same way you would a direct quotation or paraphrase.

- Cite the name of the author and other important information about that author.
- Document that summary using whichever system is appropriate for your report.
- If it is an extended summary, make it clear where that summary begins and ends, for example, by referring to the author’s name at the beginning and placing a footnote or parenthetical reference at the end.

Plagiarism. If you follow the guidelines presented in the preceding, plagiarism should not be a problem at all, but make sure you understand what it is. Plagiarism refers to two kinds of theft:

Reports with plagiarized information are often easy to spot for several reasons:

- Plagiarism is the practice—whether deliberate or not—in which a writer borrows other people's facts, ideas, or concepts and presents them as if they were her or his own.
- Plagiarism is also the practice—again whether deliberate or not—in which a writer uses other writers’ exact words without quotation marks.
- In all cases, plagiarism is the lack of proper documentation: documentation refers to any system of footnoting or reference that indicates the author and source of the borrowed information.
- A reader may recognize the ideas or facts in the report as those of someone else. An expert in a field of knowledge can spot this theft of information right away.
- A reader may realize that the report writer could not possibly have developed certain information in the report. If a writer who is at the beginning of his studies sounds like an advanced physicist, something is fishy.
- Most readers can also spot a sudden change in the style or tone of the language of a report. Most people's writing style is as readily identifiable as their voices over the telephone.

Plagiarism is bad business: the plagiarizer can fail an academic course or lose his or her reputation among business and professional associates. It only takes simple documentation to transform a report with plagiarized material in it into one with legally borrowed material. The section on documentation explains these procedures in detail.

Updating the outline

As you take notes, you must regularly update the locators on all your notecards because as you read, take notes, and learn more about your technical subject, your outline may either change or become more specific. Imagine that you started with this excerpt of a rough outline and had taken these notecards:

Rough sketch outline

IV. Safety Measures
   A. Pressurized Water Reactor Safety Measures
   B. Boiling Water Reactor Safety Systems
C. Role of the Nuclear Regulatory Commission

Corresponding notecards

BWR—safety sys. (IV,B) safety sys incl control rods, containmt bldg, resid heat removl sys there work like those in PWR unique to BWR: drywell, emergency core coolg sys 1 l, 100

BWR—safety sys (IV,B) drywell—encloses react vess + assoc equip (includes recirc sys, press relief valves on main steam lines) 2 l, 100

BWR—safety sys (IV,B) emergency core coolg sys—handles loss-of-coolt accidents; includes reactor core iso sys, hi-press core spray sys, lo-press core spray sys (figure for this, p.106) 3 l, 105-6

BWR—safety sys (IV,B) react core iso coolg sys: if loss-of-coolt accidt (causg closing of steam lines,feedwtr lines to react vessel), RCICS activated (maintains coolt inventory by pumpg water to reactor via connex in press vess head 4 l, 104

BWR—safety sys (IV,B) hi-press core spray: lowers press w/in press vessel, provides suppl water in loss-of-coolt accidt. with uncovered cores, spray directly cools fuel assemblies (wtr fr condensed wtr storge tanks + suppress pool 5 l, 104

Revised outline

IV. Safety Measures

A. Pressurized Water Reactor Safety Measures

B. Boiling Water Reactor Safety Systems

1. The Drywell

2. Emergency Core Cooling Systems

a. Reactor core isolation cooling system

b. High-pressure core spray

Notice that all five of these notecards are about "IV. B. Boiling Water Reactor Safety Systems." Notecard 1 divides this safety system into the drywell and the emergency core cooling systems. This division produces "1" and "2" under "B."

Notecards 3 through 5, about the subsystems making up the emergency systems, produce "a," "b," and "c" under "2."

If you had taken these notes and updated your outline, you would revise the locators on the individual notecards like this:


Remember that if you don't like the number-combinations as locators, you can substitute short phrases, as is shown in the alternate locators above.

Final stages in the notetaking process

As you take notes, check off sections of your outline for which you gather sufficient information, as is done in this outline excerpt. In this example, the writer has taken sufficient notes for much of IV.B. but still needs information for the rest of the outline.

III. Boiling Water Reactors
A. Description of the Basic Components

1. Core
   a. core
   b. fuel
   c. fuel rod
   d. fuel assembly
2. Control Rods
3. Core Shrouds and Reactor Vessel
4. Recirculation System
5. Steam Separators
6. Steam Dryers

B. Production of Electricity

1. Circulating Water
2. Separating Steam
3. Drying the Steam
4. Producing Electricity

IV. Safety Measures

A. Pressurized Water Reactor Safety Measures

1. Residual Heat Removal System
2. Emergency Core Cooling Systems
   a. passive system
   b. low-pressure injection systems
   c. high-pressure injection systems
3. Containment Building

B. Boiling Water Reactor Safety Systems

1. The Drywell
2. Emergency Core Cooling Systems
   a. reactor core isolation cooling system
   b. high-pressure core spray
   c. low-pressure core spray

C. Role of the Nuclear Regulatory Commission

V. Economic Aspects of Light Water Reactors

A. Busbar Cost

1. Construction Cost
2. Operation and Maintenance Costs
3. Fuel Costs

B. Operating Capacity

1. Availability Factor
2. Capacity Factor

In the final step in notetaking, you arrange the notecards in the order that you'll use them as you write the rough draft. Read through your cards several times to make sure the sequence is right and that there are no gaps in the information you've gathered. When you're sure that the order is right, write sequence numbers on each of the cards to preserve the order (see the sequence numbers on the notecards in the next section). With the notecards in the right order and numbered, you are ready to write the first draft, which is discussed in the section on rough drafting.

**Other systems of notetaking**

There are plenty of other ways to take notes. The main point of any form of note-taking of course is to make your report work easier and less time-consuming. You may prefer some other note-taking system because of your own work style or because of your report project. Or, you may end up using some other system in combination with the traditional one. Any system that enables you to get your work done efficiently is a good one.

- Mental notetaking. With short reports, it is possible to remember all the information and not writing any of it down is possible. But few of us are able to remember all of the information for long, highly technical reports.
- Book marks. If you use only a few articles or books, you can mark the important passages with slips of paper and write the rough draft with them. If you have many books and articles, this approach can get to be quite chaotic.
- Photocopying. You can also photocopy everything you think you need in your report. With the photocopied pages, you highlight the important passages, or cut out the important passages and paste them on notecards. Two problems with this approach are that (a) you may photocopy many unnecessary pages and waste money and (b) you still have the job of paraphrasing and summarizing ahead of you. Still, this is a system some report writers use occasionally to supplement their more traditional note-taking procedures.
- Exploratory drafts. If you are already familiar with your report subject, you can try writing a rough skeletal draft to show you what information you need. You may discover that all you lack is specific names, statistics, or terminology. You can take notes and plug the information into the draft. Writing the exploratory draft shows you what you know and don't know.
- Notetaking by the source. If you have only a few sources, you can also use one other fairly common system of notetaking:
  1. You take notes from individual sources onto long sheets of paper rather than onto notecards.
  2. You take all the information you need from the source onto as many sheets of paper as necessary; you don't split it up into bits of information on separate notecards.
  3. At the top of each notesheet, you give full bibliographic information on the book or article.
  4. Throughout each notesheet, you indicate the exact pages the information comes from.
  5. Also, you label these pages of notes with locators, the letter-number combinations from the outline.
  6. You mark off sections of the outline as you gather sufficient information for them.
  7. In some cases, you can cut up these full-page notes and actually handle them as if they were notecards.

Here is an example sheet of notes using this approach:

In this system, the source (book, article, report, etc.) is indicated at the top of the page; the page numbers are indicated down the right margin in parentheses; and the sheet of notes is keyed to the outline down the left margin in parentheses.
Audience Analysis
David McMurrey

Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Identify the four common categories of audience and explain the differences between them.
2. Analyze your audience and explain how to tailor your writing to that audience.

The audience of a technical report—or any piece of writing for that matter—is the intended or potential reader or readers. For most technical writers, this is the most important consideration in planning, writing, and reviewing a document. You "adapt" your writing to meet the needs, interests, and background of the readers who will be reading your writing.

The principle seems absurdly simple and obvious. It's much the same as telling someone, "Talk so the person in front of you can understand what you're saying." It's like saying, "Don't talk rocket science to your six-year-old." Do we need a course in that? Doesn't seem like it. But, in fact, lack of audience analysis and adaptation is one of the root causes of most of the problems you find in professional, technical documents—particularly instructions where it surfaces most glaringly.

Note: Once you've read this chapter on audience analysis, try using the audience planner below. You fill in blanks with answers to questions about your audience and then e-mail it to yourself. Use the audience planner for any writing project as a way of getting yourself to think about your audience in detail.

Audience Planner

Types of Audiences

One of the first things to do when you analyze an audience is to identify its type (or types—it's rarely just one type). The common division of audiences into categories is as follows:

- **Experts**: These are the people who know the theory and the product inside and out. They designed it, they tested it, they know everything about it. Often, they have advanced degrees and operate in academic settings or in research and development areas of the government and technology worlds. The nonspecialist reader is least likely to understand what these people are saying—but also has the least reason to try. More often, the communication challenge faced by the expert is communicating to the technician and the executive.
- **Technicians**: These are the people who build, operate, maintain, and repair the stuff that the experts design and theorize about. Theirs is a highly technical knowledge as well, but of a more practical nature.
- **Executives**: These are the people who make business, economic, administrative, legal, governmental, and/or political decisions on the stuff that the experts and technicians work with. If it's a new product, they decide whether to produce and market it. If it's a new power technology, they decide whether the city should implement it. Executives are likely to have as little technical knowledge about the subject as nonspecialists.
- **Nonspecialists**: These readers have the least technical knowledge of all. Their interest may be as practical as technicians', but in a different way. They want to use the new product to accomplish their tasks; they want to understand the new power technology enough to know whether to vote for or against it in the upcoming bond election. Or, they may just be curious about a specific technical matter and want to learn about it—but for no specific, practical reason.

Audience Analysis

It's important to determine which of the four categories just discussed the potential readers of your document belong to, but that's not the end of it. Audiences, regardless of category, must also be analyzed in terms of characteristics such as the following:
Audience Analysis

- **Background—knowledge, experience, training**: One of your most important concerns is just how much knowledge, experience, or training you can expect in your readers. If you expect some of your readers to lack certain background, do you automatically supply it in your document? Consider an example: imagine you're writing a guide to using a software product that runs under Microsoft Windows. How much can you expect your readers to know about Windows? If some are likely to know little about Windows, should you provide that information? If you say no, then you run the risk of customers’ getting frustrated with your product. If you say yes to adding background information on Windows, you increase your work effort and add to the page count of the document (and thus to the cost). Obviously, there's no easy answer to this question—part of the answer may involve just how small a segment of the audience needs that background information.

- **Needs and interests**: To plan your document, you need to know what your audience is going to expect from that document. Imagine how readers will want to use your document and what will they demand from it. For example, imagine you are writing a manual on how to use a new smart phone—what are your readers going to expect to find in it? Imagine you're under contract to write a background report on global warming for a national real estate association—what do they want to read about; and, equally important, what do they not want to read about?

- **Other demographic characteristics**: And of course there are many other characteristics about your readers that might have an influence on how you should design and write your document—for example, age groups, type of residence, area of residence, gender, political preferences, and so on.

Audience analysis can get complicated by at least three other factors: mixed audience types for one document, wide variability within audience, and unknown audiences.

- **More than one audience.** You're likely to find that your report is for more than one audience. For example, it may be seen by technical people (experts and technicians) and administrative people (executives). What do you do? You can either write all the sections so that all the audiences of your document can understand them (good luck!). Or you can write each section strictly for the audience that would be interested in it, then use headings and section introductions to alert your audience about where to go and what to avoid in your report.

- **Wide variability in an audience.** You may realize that, although you have an audience that fits into only one category, there is a wide variability in its background. This is a tough one—if you write to the lowest common denominator of reader, you're likely to end up with a cumbersome, tedious book-like thing that will turn off the majority of readers. But if you don't write to that lowest level, you lose that segment of your readers. What to do? Most writers go for the majority of readers and sacrifice that minority that needs more help. Others put the supplemental information in appendixes or insert cross-references to beginners' books.

**Audience Adaptation**

Okay! So you've analyzed your audience until you know them better than you know yourself. What good is it? How do you use this information? How do you keep from writing something that will still be incomprehensible or useless to your readers?

The business of writing to your audience may have a lot to do with in-born talent, intuition, and even mystery. But there are some controls you can use to have a better chance to connect with your readers. The following "controls" have mostly to do with making technical information more understandable for nonspecialist audiences:

- **Add information readers need to understand your document.** Check to see whether certain key information is missing—for example, a critical series of steps from a set of instructions, important background that helps beginners understand the main discussion, or definition of key terms.

- **Omit information your readers do not need.** Unnecessary information can also confuse and frustrate readers—if after all, it's there so they feel obligated to read it. For example, you can probably chop theoretical discussion from basic instructions.

- **Change the level of the information you currently have.** You may have the right information but it may be "pitched" at too high or too low a technical level. It may be pitched at the wrong kind of audience—for example, at an expert audience rather than a technician audience. This happens most often when product-design notes are passed off as instructions.

- **Add examples to help readers understand.** Examples are one of the most powerful ways to connect with audiences, particularly in instructions. Even in noninstructional text, for example, when you are trying to explain a technical concept, examples are a major help—analogy in particular.

- **Change the level of your examples.** You may be using examples but the technical content or level may not be appropriate to your readers. Homespun examples may not be useful to experts; highly technical ones may totally miss your nonspecialist readers.

- **Change the organization of your information.** Sometimes, you can have all the right information but arrange it in the wrong way. For example, there can be too much (or too little) background information up front such that certain readers get lost. Sometimes, background information needs to be consolidated into the main information—for example, in instructions it's sometimes better to feed in chunks of background at the points where they are immediately needed.
• **Strengthen transitions.** It may be difficult for readers, particularly nonspecialists, to see the connections between the main sections of your report, between individual paragraphs, and sometimes even between individual sentences. You can make these connections much clearer by adding transition words and by echoing key words more accurately. Words like "therefore," "for example," "however" are transition words—they indicate the logic connecting the previous thought to the upcoming thought. You can also strengthen transitions by carefully echoing the same key words. In technical prose, it's not a good idea to vary word choice—use the same words so that people don't get any more confused than they may already be.

• **Write stronger introductions—both for the whole document and for major sections.** People seem to read with more confidence and understanding when they have the "big picture"—a view of what's coming, and how it relates to what they've just read. Therefore, make sure you have a strong introduction to the entire document—one that makes clear the topic, purpose, audience, and contents of that document. And for each major section within your document, use mini-introductions that indicate at least the topic of the section and give an overview of the subtopics to be covered in that section.

• **Create topic sentences for paragraphs and paragraph groups.** It can help readers immensely to give them an idea of the topic and purpose of a section (a group of paragraphs) and in particular to give them an overview of the subtopics about to be covered. Roadmaps help when you're in a different state!

• **Change sentence style and length.** How you write—down at the individual sentence level—can make a big difference too. In instructions, for example, using imperative voice and "you" phrasing is vastly more understandable than the passive voice or third-personal phrasing. For some reason, personalizing your writing style and making it more relaxed and informal can make it more accessible and understandable. Passive, person-less writing is harder to read—put people and action in your writing. Similarly, go for active verbs as opposed to verb phrasing. All of this makes your writing more direct and immediate—readers don't have to dig for it. And obviously, sentence length matters as well. An average of somewhere between 15 and 25 words per sentence is about right; sentences over 30 words are to be mistrusted.

• **Work on sentence clarity and economy.** This is closely related to the previous "control" but deserves its own spot. Often, writing style can be so wordy that it is hard or frustrating to read. When you revise your rough drafts, put them on a diet—go through a draft line by line trying to reduce the overall word, page, or line count by 20 percent. Try it as an experiment and see how you do. You'll find a lot of fussy, unnecessary detail and inflated phrasing you can chop out.

• **Use more or different graphics.** For nonspecialist audiences, you may want to use more graphics—and simpler ones at that. Graphics for specialists are more detailed, more technical. In technical documents for nonspecialists, there also tend to be more "decorative" graphics—ones that are attractive but serve no strict informative or persuasive purpose at all.

• **Break text up or consolidate text into meaningful, usable chunks.** For nonspecialist readers, you may need to have shorter paragraphs. Maybe a 6- to 8-line paragraph is the usual maximum. Notice how much longer paragraphs are in technical documents written for specialists.

• **Add cross-references to important information.** In technical information, you can help nonspecialist readers by pointing them to background sources. If you can't fully explain a topic on the spot, point to a section or chapter where it is.

• **Use headings and lists.** Readers can be intimidated by big dense paragraphs of writing, uncut by anything other than a blank line now and then. Search your rough drafts for ways to incorporate headings—look for changes in topic or subtopic. Search your writing for listings of things—these can be made into vertical lists. Look for paired listings such as terms and their definitions—these can be made into two-column lists. Of course, be careful not to force this special formatting—don't overdo it.

• **Use special typography, and work with margins, line length, line spacing, type size, and type style.** For nonspecialist readers, you can do things like making the lines shorter (bringing in the margins), using larger type sizes, and other such tactics. Certain type styles are believed to be friendlier and more readable than others. (Try to find someone involved with publishing to get some insights on fonts.)

These are the kinds of "controls" that professional technical writers use to finetune their work and make it as readily understandable as possible. And in contrast, it's the accumulation of lots of problems in these areas—even seemingly trivial ones—that add up to a document being difficult to read and understand. Nonprofessionals often question why professional writers and editors insist on bothering with such seemingly picky, trivial, petty details in writing—but they all add up! It reminds me of the ancient Chinese execution method called "death by a thousand cuts." However, in this case, it would be "perplexity by a thousand minor problems."
Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Define documentation.
2. Identify and analyze tasks in order to create documentation.
3. Differentiate between function and task orientation and explain the pros and cons of each approach.
4. Explain how to begin writing documentation.

Task Analysis and Task-Oriented Documentation

When you write instructions, procedures, and "guide" or user-guide information (generally called documentation), you normally must use a task approach. That means providing steps and explanations for all the major tasks that users may need to perform.

Of course, some instructions involve only one task—for example, changing the oil in a car. But we are concerned here with more complex procedures. While this chapter uses computer software as an example, these techniques can apply to any multi-task procedure—for example, operating a microwave oven.

Identifying Tasks

To write in a task-oriented manner, you first have to do some task analysis. That means studying how users use the product or do the task, interviewing them, and watching them. It can also mean interviewing marketing and product development people. If you can get your hands on the kinds of questions that help-desk people receive, that helps too.

But sometimes, you may not be in a position to do a thorough task analysis. Typically, product developers don't think about documentation until rather late. In these circumstances, it's often difficult to get marketing, development, engineering, and programming people to spend enough time with you to explain the product thoroughly. And so you end up doing a certain amount of educated guesswork. The developer is more likely to review your draft and let you know if your guesswork is right.

To develop your own task analysis, you can study the user interface (buttons, menus, options, etc.) of the product. This process goes for both hardware and software. Consider the interface for an icon editing tool shown below:
From just this snippet of the interface, you can identify several obvious tasks:

- Start a new icon project
- Open an existing icon project for editing
- Rename an icon project (Save As)
- Exit AZ Icon Edit

Now, look at the menu options for the next parts of the menu. You can see that when people are using this icon editor, they'll also most likely be doing these tasks:
• Undo a mistake
• Capture an image or some part of it
• Cut something out of an icon project
• Copy something out of an icon project
• Paste something into an icon project
• Flip the entire image horizontally or vertically
• Rotate the image left
• Clear the project, which probably means start over
• Restore, which you'll have to ask around, experiment with, or dig into the programming spec to find out about
• Draw with a thick, medium, or thin line.

But now look at the interface without the menu options hanging down. What additional tasks can you see? As with a lot of graphical user interfaces, some of the icons duplicate the menu options. For example, the bulleted-list icon enables you to select a thin, medium, or thick line the same way clicking on Options does. However, there are some new tools here, not available elsewhere in the interface:

• Draw straight lines (you'll have to experiment to see the difference between the two pencil icons)
• Draw freehand lines (the wavy-line icon)
• Draw unfilled rectangles (sharp edges) and unfilled rectangles (rounded edges)
• Draw unfilled ovals and filled ovals
• Fill with color (the hypodermic needle)
• Select portions of the image to move, cut, or rotate (the dotted-line icon)
• Capture images—or parts of images—(the net, but how does it work?)
• Draw filled rectangles (sharp edges) and filled rectangles (rounded edges)
• Select background color (the Screen button)
• Select line or fill color (the double-box icon)

There's a lot you still don't know about this software, but you've already done a lot of guesswork toward defining the major tasks. You'd want to group and consolidate things much more tightly than above, perhaps like the following:

• Creating, editing, renaming, and saving icons
• Selecting foreground and background color
• Drawing lines, rectangles, and ovals
• Cutting, pasting, and copying objects
• Moving, flipping, and rotating objects

You can see that in this rough task list, there is no trace of tasks such as filling an object with color, capturing images, clearing the workspace, undoing a mistake, or restoring. But as you work, these details will begin to find their place in your scheme. Now, stand back from the details of the interface and put yourself in the place of an icon software user. What questions is that individual likely to ask? How do I change the color of the background? We've got that covered. How do I change the thickness of the lines I draw? Got that one covered too. How do I make the background transparent? Hmmmm . . . that will be an issue for the color section, but it will take some research.

Different Approaches to Documentation

When you write for users, you have a choice of two approaches, function orientation and task orientation, the latter of which is by far the better choice. A function orientation lists buttons or icons and then lets readers know what the function of each item is. For example, "The save button allows you to save your project for later use." This information is helpful for a user (although probably most users know what the save button does). While it is helpful to quickly list major buttons and what they do, it's not sufficient to help readers truly use the software or appliance. Task-oriented documentation, created for specific goals that you anticipate users will want to achieve (such as, "Capturing Images") allows users to begin using the product quickly and achieving their goals satisfactorily (which hopefully leads to a high level of satisfaction with the product and your documentation).

Writing with a function orientation.

It ought to be obvious how to proceed after a task analysis, but apparently not. Computer publications—if not technical publications in general—often seem to stray into a non-task-oriented style of writing. But, no! That just doesn't work!

Another reason why some user guide instructions are not task oriented can be blamed on product specifications. Product specifications, which are written by and for programmers, engineers, developers, are written in terms of required function:

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>File menu button</td>
<td>Enables user to create a new file, open an existing file, rename a file, etc.</td>
</tr>
<tr>
<td>Crop icon</td>
<td>Enables user to cut selected segment of image.</td>
</tr>
</tbody>
</table>

You might call this approach function-oriented writing because it systematically explains each function, feature, or interface element of a product. Unfortunately, this approach shows up in user guides meant for nontechnical readers—perhaps because the writers are inexperienced, untrained, or untechnical; or else the writers have been called in too late to do much else but polish the developers' spec.

The function-oriented approach almost works sometimes. But "almost" and "sometimes" are not good enough. It almost works because the names of interface elements and functions sometimes match the tasks they support. For example, the Open menu option is pretty intuitive: open an existing file. Others are not. For example, what do you suppose is restored by the Restore button in the AZ Icon Edit interface? Also, some interface elements don't accomplish tasks all by themselves. In Photoshop, for example, you can't crop text by pressing the Crop menu option. You have to first click the text-selection button, then draw a selection box around the part of the image you want to keep, then press the Crop button.

Writing with a task orientation.

Instead of the function-oriented approach, use the task-oriented approach. Identify the tasks users will need to perform with the product, and then structure your document accordingly. Make your headings and subheadings task oriented in their phrasing. Task-oriented phrasing means phrasing like "How to adjust the volume," "Adjusting the volume," or "Adjust the volume." It does not mean phrasing like "Volume" or "Volume Adjustment." Here are some additional examples:

<table>
<thead>
<tr>
<th>Problem phrasing</th>
<th>Task-oriented phrasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture</td>
<td>Capturing images</td>
</tr>
</tbody>
</table>
Task Analysis

<table>
<thead>
<tr>
<th>Screen button</th>
<th>Selecting foreground or background objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangles</td>
<td>Drawing rectangles</td>
</tr>
<tr>
<td>Oval icon</td>
<td>Drawing ovals and circles</td>
</tr>
</tbody>
</table>

When you have defined user tasks, organized them into logical groups, and have defined task-oriented headings, you’re ready to write! Here’s an excerpt:

**Drawing Rectangles and Ovals** You can use the icon editor to draw squares, rectangles, ovals, and circles. **Draw a rectangle.** To draw a rectangle:

1. Ensure that you have selected the foreground color you want. (See “Selecting foreground color.”)
2. Click the rectangle icon.
3. Position the mouse pointer in the drawing area where you want the rectangle to appear, hold down the left mouse button, and drag to create the rectangle.

**Draw an oval.** To draw an oval:

1. Ensure that...

In this excerpt, you can see that an overall task-oriented approach is taken and that task-oriented phrasing is used for the headings (Drawing). Notice too that numbered lists are used to guide readers step by step through the actions involved in the task.

View sample documentation on creating checklists with Desire2Learn (D2L). D2L is a learning management system that university faculty might use to share class materials with students. The checklist function helps university faculty to let students know what tasks need to be completed within a course module or unit of time.
Articulating Technical Discussions
David McMurrey, Jonathan Arnett, & Tamara Powell

Chapter Objectives

Upon completion of this chapter, readers will be able to do the following:

1. Explain and apply strategies for articulating technical discussions to nonspecialist readers.
2. Use audience analysis to decide what information to include or exclude from a document and how to discuss that information.

Articulating Technical Discussions

The ability to explain complex, technical matters with ease, grace, and simplicity so that nonspecialist readers understand almost effortlessly is one of the most important skills you can develop as a technical writer. This ability to "translate" or articulate difficult-to-read technical discussions is important because so much of technical writing is aimed at nonspecialist audiences. These audiences include important people such as supervisors, executives, investors, financial officers, government officials, and, of course, customers.

This chapter provides you with some strategies for articulating technical discussions, that is, specific strategies you can use to make difficult technical discussions easier for nonspecialist readers to understand.

You use your understanding of your audience to decide

- What information to include in the document
- What information to exclude from the document
- How to discuss the information you do include in the document

Articulating is particularly important because it means supplying the right kinds of information to make up for the reader's lack of knowledge or capability. Articulating thus enables readers to understand and use your document.

Some combination of the techniques discussed in this chapter should help you create a readable, understandable translation:

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defining unfamiliar terms</td>
<td>The &quot;in-other-words&quot; technique</td>
</tr>
<tr>
<td>Comparing to familiar things</td>
<td>Posing rhetorical questions</td>
</tr>
<tr>
<td>Elaborating the process</td>
<td>Explaining the importance or significance</td>
</tr>
<tr>
<td>Providing description</td>
<td>Providing illustration</td>
</tr>
<tr>
<td>Reviewing theoretical background</td>
<td>Providing historical background</td>
</tr>
<tr>
<td>Providing examples and applications</td>
<td>Providing the human perspective</td>
</tr>
<tr>
<td>Shorter sentences and paragraphs</td>
<td>Stronger transitions</td>
</tr>
</tbody>
</table>

This list by no means exhausts the possibilities. Other techniques include

- **Headings.** See the section on using headings that break up text and emphasize points and on how to construct headings that guide readers from section to section.
- **Lists.** See the section on constructing lists that break up text and emphasize points and on how to construct headings that guide readers from section to section.

**Note to readers:** Move your mouse pointer over the highlighted words in the following examples to see discussion.

Definitions of unfamiliar terms

Defining potentially unfamiliar terms in a report is one of the most important ways to make up for readers' lack of knowledge in the report subject.

Facial Characteristics of FAS

Taken as a whole, the face of patients of fetal alcohol syndrom (FAS) is very distinctive. Structural deficiencies are thought to be the result of reduced cellular proliferation in the developing stages of the embryo because of the direct action of the alcohol. The face has a drawn-out appearance with characteristics that include short palpebral fissures, epicanthic folds, low nasal bridge, a short upturned nose, indistinct philtrum, small midface, and a thinned upper vermillion.
Comparisons to familiar things

Comparing technical concepts to ordinary and familiar things in our daily lives makes them easier to understand. For example, things in the world of electronics and computer—a downright intimidating area for many people—can be compared to channels of water, the five senses of the human body, gates and pathways, or other common things. Notice how comparison (highlighted) is used in these passages:

The helical configuration of the DNA strands is not haphazard. The nitrogen bases on each strand align themselves to form nitrogen base pairs. The pairs are T-A and C-G. Each pair is held together by hydrogen bonds. The pairing of the bases serves to fasten the two helical nucleotide strands together much the same way as the teeth of a zipper hold the zipper together. The existence of the complementary base pairs explain the constant ratios of T/A and C/G. For every T there must be a complementary A and for every G there must be a complementary C.


All the death and all the misery from a virus so small that 2-1/2 million of them in a line would take up one inch. Flu viruses fall into three types: A, B, and C. Type A, the most variables, causes pandemics as well as regular seasonal outbreaks; type B causes smaller outbreaks and is just now receiving greater attention; type C rarely causes serious health problems. In appearance, a flu virus somewhat resembles the medieval mace—a ball of iron studded with spikes. Hemagglutinin is the substance that in effect bashes into a cell during infection and allows the virus access to the cell interior where it can replicate.


Elaborating the process

Explaining in detail the processes involved in the report subject can also help readers. Consider a paragraph like this one, containing only a sketchy reference to the process:

The Video Alert and Control dashboard system, a newly developed system to help drivers avoid accidents, graphically projects an image of hazards in the road.

This brief reference can be converted into a more complete explanation as is illustrated here:

The Video Alert and Control dashboard systems uses a number of components to help drivers avoid accidents. The infrared detector is the key detecting device in that it searches for warm objects in or near the path ahead of the car. The infrared detector senses the
upcoming trouble well before the driver by sensing warm-bloodedness and then alerts the driver. The infrared detector also senses the heat of oncoming traffic. All of these objects are shown graphically on the video screen. To differentiate wildlife from other cars, the x-ray unit is used to check for metal in the object ahead. Thus, if a warm object is detected with metal in it, the computer reads it as a car and shows it on the screen as a yellow dot. On the other hand, if no metal is detected in the warm object, it is read as an animal and plotted as a red dot...

Providing descriptive detail

Descriptions also help nonspecialist readers by making the report discussion more concrete and down-to-earth:

Jarvik and his colleagues have been working on other designs, such as a portable artificial heart, which they think will be ready for a patient within the next two years. Electrohydraulic Heart Jarvik has been developing electric-energy converters and blood pumps during the past year. The electrohydraulic energy converter has only one moving part. The impeller of an axial-flow pump is attached to the rotor of a brushless direct-current motor, with the impeller and the rotor supported by a single hydrodynamic bearing. Reversing the rotation of the pump reverses the direction of the hydraulic flow. The hydraulic fluid (silicone oil of low viscosity) actuates the diaphragm of a blood pump just as compressed air does in the Jarvik-7 heart design. This hydraulic fluid is pumped back and forth between the right and left ventricles. The energy converter is small and simple and therefore can be implanted without damaging vital structures. It weighs nearly 85 grams and occupies nearly 30 cubic centimeters. The converter requires an external battery and an electronics package, which is connected to the heart by a small cable through the patient’s chest. The batteries weigh 2 to 5 pounds and can be worn on a vest or belt. The battery unit requires new or recharged batteries once or twice a day. The cable through which the power is transmitted from the battery to the heart also carries control signals from the microcomputer controller.

Providing illustrations

Illustrations—typically, simple diagrams—can help readers understand technical descriptions and explanations of processes. You can see the use of illustration in the FAS example above: epicanthic folds and the philtrum are defined under the diagram.

Providing examples and applications

Equally useful in articulating complex or abstract technical discussions are examples or explanations of how a thing can be used. For example, if you are trying to explain a LINUX command, showing how it is used in an example program helps readers greatly. If you are explaining a new design for a solar heating and cooling system, showing its application in a specific home can help also.

Continuous Speech Continuous speech causes many problems in computerized speech recognition. For example: "plea" and "please," while some words have similar acoustics, such as "what" and "watt."

Heidi E. Cootes, Report on Computers that Recognize Speech, University of Texas at Austin, May 6, 1983.
Now here is a passage with a longer, extended example:

...The user "scrolls" the worksheet right and left or up and down to bring different parts of it into view. Each position (that is, each intersection of a column and a row) on a screen corresponds to a record in memory. The user sets up his own matrix by assigning to each record either a label, an item of data or a formula; the corresponding position on the screen displays the assigned the label, the entered datum or the result of applying the formula.


### Shorter sentences and paragraphs

As simple a technique as it may seem, reducing the length of sentences can make a technical discussion easier to understand. Consider the following pairs of example passages, the second versions of which contain shorter sentences. (The passage still needs other translating techniques, particularly definitions, but the shorter sentences do make it more readable.) Notice, too, that shorter paragraphs can help in the articulating process, not only in the example below but throughout this chapter.

**Original Version: Longer Sentences**

UV-flourescence was determined on aliquots of the hexane extracts of subsurface water using the Perkin-Elmer MPF-44A dual-scanning fluourescence spectrophotometer upon mousse sample NOAA-16, considered the best representative of cargo oil. Every day that samples were processed, a new calibration curve was developed from serial dilutions of the reference mousse (NOAA-16) at an emission wavelength of ca. 360 nm, and other samples were compared to it as the standard. Emission was scanned from 275-500 nm, offset 25 nm from the excitation wavelength, with the major peak occurring at 360 nm for the reference mousse solutions. In each sample, the concentration of fluourescent material, a total oil estimate, was calculated from its respective fluourescence, using the linear relationship of fluourescence vs. concentration of the reference mousse "standard," with a correction factor applied to account for the reference mousse containing only about 30 percent.

**Revised Version: Shorter Sentences**

UV-flourescence was determined on aliquots of the hexane extracts of the subsurface water. These measurements were performed using a Perkin-Elmer MPF-44A dual-scanning fluourescence spectrophotometer. Mousse sample NOAA-16 was used as the best representative of cargo sample. Other samples were compared to it as the standard. Every day that samples were processed, a new calibration curve was developed from serial dilutions of the reference mousse (NOAA-16). Tests were run at an emission wavelength of ca. 360 nm. Emission was scanned from 275-500 nm, offset 25 nm from the excitation wavelength. The major peak occurred at 360 nm for the reference mousse solutions. In each sample, the concentration of fluorescent material, a total oil estimate, was calculated from its respective fluorescence, using the linear relationship of fluorescence vs. concentration of the reference mousse "standard." A correction factor was applied to account for the reference mousse containing only about 30 percent oil.

### Stronger Transitions and Overviews

Transitions and overviews guide readers through text. In difficult technical material, transitions and overviews are important. (For in-depth discussion, see transitions.)

- **Repetition of key words.** As unlikely as it may seem, using the same words for same ideas is a critical technique for comprehension in technical discussions. In other words, don't refer to the hard drive as a "fixed-disk drive" one place and as "DASD" (an old IBM term meaning direct access stationary drive) in another. Same goes for verbs: stick with either "boot up" or "system reset," and don't vary.

- **Arrangement of key words.** Equally important is how you introduce keywords in sentences. If your focus stays on the topic in each sentence of a paragraph, place the keyword at or near the beginning of the second and following sentences. However, if the topic focus shifts from one sentence to the next, use the old-to-new pattern: start the following sentence with the old topic and end the sentence with the new topic.

- **Transition words and phrases.** Examples of transition words and phrases are "for example," "however," and so on. When the discussion is particularly difficult and when repetition and arrangement of keywords is not enough, use transition words and phrases.

- **Reviews of topics covered and topics to be covered.** At certain critical moments within and between paragraph (or groups of paragraphs) occurs a transitional device that either captures what has been discussed in a short phrase, previews what is to be discussed in the following paragraphs, or both. The latter device is also called a topic sentence.

### The "in-other-words" Technique

In technical writing, you occasionally see questions posed to the readers. Such questions are not there for readers to answer; they are meant to stimulate readers' curiosity, renew their interest, introduce a new section of the discussion, or allow for a pause:

When an animal runs, its legs swing back and forth through large angles to provide balance and forward drive. We have found that such swinging motions of the leg do not have to be explicitly programmed for a machine but are a natural outcome of the interactions between the controllers for balance and attitude. Suppose the vehicle is traveling at a constant horizontal rate and is landing with its body upright. What must the attitude controller do during the stance to maintain the upright attitude? It must make sure that no torques are generated at the hip. Since the foot is fixed on the ground during stance, the leg must sweep back through an angle in order to guarantee that the torque on the hip will be zero while the body moves forward.

On the other hand, what must the balance servo do during flight to maintain balance? Since the foot must spend about as much time in front of the vehicle's center of gravity as behind it, the rate of travel and the duration of stance dictate a forward foot position for landing that will place the foot in a suitable spot for the next stance period. Thus during each flight the leg must swing forward under the direction of the balance servo, and during each stance it must sweep backward under the control of the attitude servo; the forward and back sweeping motions required for running are obtained automatically from the interplay of the servo-control loops for balance and attitude.

Two-Dimensional Hopping Machine

Asking rhetorical questions as an articulating technique

Sexy Technical Communication Home

Explaining the Importance

Some translating articulating work because they motivate readers. Sometimes readers need to be talked into concentrating on difficult technical discussion: one way is to explain to them or to remind them of the importance of what is being discussed. In this example, the last paragraph emphasizes the importance:

It was Linus Pauling and his coworkers who discovered that sickle cell anemia was a molecular disease. This disease affects a very high percentage of black Africans, as high as 40 percent in some regions. About 9 percent of black Americans are heterozygous for the gene that causes the disease. People who are heterozygous for sickle cell anemia contain one normal
gene and one sickle cell gene. Since neither gene in this case is dominant, half the hemoglobin molecules will be normal and half sickle. The characteristic feature of this disease is a sickling of the normally round, or platelike, red blood cells under conditions of slight oxygen deprivation. The sickled red blood cells clog small blood vessels and capillaries. The body's response is to send out white blood cells to destroy the sickled red blood cells, thus causing a shortage of red blood cells, or anemia. The sickle cell gene originated from a mistake in information. A DNA molecule somehow misplaced a base, which in turn caused an RNA molecule to direct the cell to make hemoglobin with just one different amino acid unit among the nearly 600 normally constituting a hemoglobin molecule. So finely tuned is the human organism that this tiny difference is enough to cause death. Since the disease is nearly always fatal before puberty, how can a gene for a fatal childhood disease get so widespread in a population? The answer to this question gives some fascinating insight into the mechanism and purposes of evolution, or natural selection. The distribution of sickle cell anemia very closely parallels the distribution of a particularly deadly malaria-causing protozoan by the name of Plasmodium falciparum, and it turns out that there is a close connection between sickle cell anemia and malaria. Those people who are heterozygous for the sickle cell gene are relatively immune to malaria and, except under reasonably severe oxygen deprivation such as that found at high altitudes, they experience no noticeable effects due to the sickle cell gene they carry. Half the hemoglobin molecules in the red cells of heterozygous people are normal and half are sickled. Thus, under ordinary circumstances the normal hemoglobin carries on the usual respiratory functions of blood cells and there is little discomfort. On the other hand, the sickled hemoglobin molecules precipitate, in effect, when the malaria-causing protozoan enters the blood. The precipitated hemoglobin seems to crush the malaria protozoan, thus keeping the malaria from being fatal. The significance of all this should be pondered.


**Providing Historical Background**

Discussion of the historical background of a technical subject helps readers because it gives them less technical, more general, and sometimes more familiar information. It gives them a base of understanding from which to launch into the more difficult sections of the discussion:

Now that alcohol is being used in more and more social settings, it extremely important to recognize its teratogenic effects. Teratogenic, or malformeding, agents produce an abnormal presence or absence of a substance that is required in physical development. Although Sullivan first reported on the effects of maternal drinking during pregnancy in 1899, the serious implications of his findings were virtually ignored for the next 50 years. It was not until the dramatic identification of a pattern of malformations, termed the fetal alcohol syndrome (FAS) by Jones et al in 1973, that the scientific community acknowledged the potential dangers of heavy maternal alcohol use. Since then, there has been increasing recognition that alcohol may be the most common drug in causing problems of malformations in humans.

Each morning in the soft, coral flush of daybreak, a laser dawns on Mars. Forty miles above frigid deserts of red stone and dust, it flares in an atmosphere of carbon dioxide. Infrared sunlight kindles in this gas a self-intensifying radiance that continuously generates as much energy as a thousand nuclear reactors. Our eyes are blind to it, but from sunrise to sunset Mars bathes in dazzling lasershine. The red planet may have lased in the sun for eons before astronomers identified its sky-high natural laser in 1980. The wonder is that its existence was unknown for so long. In 1898, in *The War of the Worlds*, H.G. Wells scourged earth with Martian invaders and a laserlike death ray. Pitiless, this "ghost of a beam of light" blasted brick, fired trees, and pierced iron as if it were paper.

In 1917 Albert Einstein speculated that under certain conditions atoms or molecules could absorb light or other radiation and then be stimulated to shed their borrowed energy. In the 1950s Soviet and American physicists independently theorized how this borrowed energy could be multiplied and repaid with prodigious interest. In 1960 Theodore H. Maiman invested the glare of a flash lamp in a rod of synthetic ruby; from that first laser on earth he extorted a burst of crimson light so brilliant it outshone the sun.


**Reviewing Theoretical Background**

To understand some phenomena, technologies, or their applications, readers must first understand the principle or theory behind them. Theoretical discussions need not be over the heads of nonspecialist readers. Discussion of theory is often little more than explanation of the root causes and effects at work in a phenomenon or mechanism. In this example, the writer establishes the theory and then can go on to discuss the findings that have come about through the use of NMR on living tissue.

To the extent that objections persist about the validity of modern biochemistry, they continue to be about reducing the processes of life to sequences of chemical reactions. "The reactions may take place in the test tube," one hears, "but do they really happen that way inside
the living cell? And what happens in multicellular organisms?” One technique is beginning to answer these questions by detecting chemical reactions as they occur inside cells, tissues and organisms including those of human beings. The technique is nuclear-magnetic-resonance (NMR) spectroscopy. It relies on the fact that atomic nuclei with an odd number of nucleons (protons and neutrons) have an intrinsic magnetism that makes each such nucleus a magnetic dipole: in essence a bar magnet. Such nuclei include the proton (H-1), which is the nucleus of 99.98 percent of all hydrogen atoms occurring in nature, the carbon-13 nucleus (C-13), which is the nucleus of 1.1 percent of all carbon atoms, and the phosphorus-31 nucleus (P-31), which is the nucleus of all phosphorus atoms.

Theoretical background as an articulation technique

Sexy Technical Communication Home

Combining the Articulating Techniques

This last section concludes the techniques for articulating difficult technical prose to be presented here. However, take a look at writing in fields you know about, and look for other kinds of articulating techniques used there. Now, here are several extended passages of technical writing that combine several of these strategies.

Fine-tuning the spectrum To know lasers, one must first know the electromagnetic spectrum, which ranges from long radio waves to short, powerful gamma rays. The narrow band of the spectrum we know as visible, or white, light is made up of red, orange, yellow, green, blue, and violet light. These frequencies, as well as all radiation waves, are jumbled or diffused, much as noise is a collection of overlapping, interfering sounds. Laser light is organized and concentrated, like a single, clear musical note. In lasers, nature's disorder is given coherence, and photons—the basic units of all radiation—are sent out in regular ranks of one frequency. Because the waves coincide, the photons enhance one another, increasing their power to pass on energy and information. The first devices to emit concentrated radiation operated in the low-energy microwave frequencies. Today, laser technology is extending beyond ultraviolet toward the high-energy realms of X-rays. Each wavelength boasts its own capacities as a tool for man. A laser's beam can be modulated into an infinite number of wavelengths using fluorescent dyes like those produced at Exciton Chemical Company in Ohio. At Hughes Research Laboratories in California, a blue-green laser reflected at an acute angle aneals silicon microchips, while a low-energy red laser monitors the process. Harnessing light As a bow stores energy and releases it to drive an arrow so lasers store energy in atoms and molecules, concentrate it, and release it in powerful waves. When an atom expands the orbits of its electrons, they instantly snap back, shedding energy in the form of a photon. When a molecule vibrates or changes its geometry, it also snaps back to emit a photon. In most lasers a medium of crystal, gas, or liquid is energized by high-intensity light, an electric discharge, or even nuclear radiation. When a photon reaches an atom, the energy exchange stimulates the emission of another photon in the same wavelength and direction, and so on, until a cascade of growing energy sweeps through the medium. The photons travel the length of the laser and bounce off mirrors—one a full mirror, one partially silvered—at either end. Photons, reflected back and forth, finally gain so much energy that they exit the partially silvered end, emerging as powerful beam. Out of the darkness: laser eye surgery Sight-saving shafts of light able to enter the eye without injuring it, lasers are revolutionizing eye surgery. Using techniques of New York ophthalmologist Frances L'Esperance, eye surgeons employ four levels of laser energy. Exposure time ranges from 30 minutes for low-energy photoradiation to several billionths of a second for photodisruption. With microscopic focus, beams weld breaks in the retina or seal leaking blood vessels by photocoagulation. A painless 20-minute operation call an irridectomy relieves this excess fluid buildup of glaucoma. When an artificial lens is placed behind the iris, the supportive membrane often grows milky. A laser beam is pinpointed on the taut tissue in a series of minute explosions. This photodisruption causes the tissue to unzip and part like a curtain. Bloodless scalpels, lasers can make extremely delicate incisions, cauterize blood vessels, and leave tissue unaffected only a few cell widths away. Beams that heal Surgical trauma, the jarring aftermath of the surgeon's knife, may one day be consigned to the annals of primitive medicine—thanks to a procedure called "least invasive surgery" by its growing number of practitioners. Using an endoscope, surgeons can view the interior of the body and operate with the least amount of damage. An end view of the flexible tube ... shows a large optical fiber to light the way. Smaller openings facilitate fluid suction and gas suction. A forceps, controlled by a cable near the microscope viewing lens, extracts tissue for analysis. A laser, controlled by dials to the left of the eyepiece, streams from another tube, ready to perform wherever the doctor directs it. Twisting and probing wit the end of the scope, he can identify and coagulate a bleeding ulcer in the stomach or blast tumors in the esophagus. The beam is fed through the scope by an optical fiber from a laser machine ... that might cost the hospital from $20,000 to $150,000.


Articulating techniques used in combination
Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Revise common structure-level problems in technical writing.
2. Revise common sentence-level problems in technical writing.

Power-Revision Techniques

The linked chapters here cover some of the most important aspects of writing—what's more important than the information you put in a document, how you organize it, how you link it all up together?

When you look at all these powerful ways you can review (look for potential problems) and then revise (fix those problems), you might think they're tedious and time-consuming. They do take some time, but don't worry...this stuff becomes second nature rather quickly. If you spend some time analyzing writing in the ways outlined in this chapter, the way you write and the way you review what you write will change. You'll start operating—even if you don't consciously realize it—with these ideas in mind.

This chapter covers two major categories of problems you can revise: **structure-level problems** and **sentence-level problems**.

The section on **structure-level problems** includes tips for checking your documents.

- informational value
- internal organization
- topic sentences and overviews
- transitions
- paragraph lengths

The section on **sentence-level problems** includes tips for how to revise

- nominalizations
- noun stacks
- redundant phrasing
- expletives
- weak use of passive voice verbs
- subject-verb mismatches
- readability, sentence lengths, and sentence structures

Power-Revision Techniques: Structure-Level Problems

Informational Value

One of the most important ways you can review a rough draft is to check its contents for informational value. All the good transitions, good organization, and clear sentence structure in the world can't help a technical document that doesn't have the right information for its audience.

- **Information is missing.** For example, imagine that somebody wrote a technical report on "virtual communities" but never bothered to define what "virtual community" means. The reader would be utterly lost.
- **Information is there, but not enough.** Take the same example, and imagine that the writer only made a few vague statements about virtual communities. The reader (unless she is an expert on virtual communities) needed at least a paragraph on the subject, if not a full-blown three- or four-page section.
Information is there, but at the wrong level for the audience. Imagine that the report's writer included a two-page explanation of virtual communities but included highly technical information and phrased it in language that only a sociologist (an "expert" academic audience) would understand, when the document was really intended for high-school students. The writer failed to match the readers' knowledge, background, and needs.

If you can get a sense of how information does or doesn't match your audience, you should be well on your way to knowing what specifically to do to revise. One useful brainstorming tool is to think in terms of types of content.

Internal Organization

If you have the necessary and audience-appropriate information in a technical document, you're on the right track. However, that information may still not be sufficiently organized—like when you've just moved and everything is a mess or still in boxes—and you need to consider the rough draft's internal organization. Always consider these two aspects of internal organization, on both an individual-paragraph and whole-document level:

- the levels of information
- the sequence of information

Levels of Information

Some paragraphs and sentences contain general information or broader statements about the topic being discussed. Others contain more specific information, or go into greater depth. The first elements form a "framework" that supports the second, "subordinate" elements.

When you revise, check if the document's framework is easy to follow. The most common and effective way to arrange general and specific information is to introduce the framework first, then follow it with specifics. This overarching pattern holds for sentences inside paragraphs and paragraphs inside longer documents, even if the paragraph or document uses a different sequence of information.

Sequence of Information

Match a technical document's internal sequence of information to the document's audience, context, and purpose. Here are some examples of common informational sequences:

- **General > specific.** Arrange chunks of information from general to specific. For example, defining all solar collectors is a more general discussion than discussing the different types of solar collectors. And describing the operation of a specific type of solar collector is even less general. This pattern is illustrated here:

  Problem version
  There are various types of solar collectors; however the flat-plate solar collector is currently the most common and will be the focus of discussion here. *The most important part of a solar heating system is the solar collector whose function is to heat circulating water necessary for space heating.* A typical solar collector has layers of glass with intervening air spaces to produce a heat-trapping effect. Most solar collectors consist of a black absorber plate covered by one or more of these transparent cover plates made either of glass or plastic with the sides and the bottom of the collector insulated.

  Revised version
  The most important part of a solar heating system is the solar collector whose function is to heat circulating water necessary for space heating. There are various types of solar collectors; however, the flat-plate solar collector is currently the most common and will be the focus of discussion here. A typical flat-plate solar collector has layers of glass with intervening air spaces to produce a heat-trapping effect. Most solar collectors consist of a black absorber plate covered by one or more of these transparent cover plates made either of glass or plastic with the sides and the bottom of the collector insulated.

- **Simple > complex.** Begin with the simple, basic, fundamental concepts and then move on to the more complex and technical.

- **thing-at-rest > thing-in-motion.** Describe the thing (as if in a photograph), then discuss its operation or process (as if in a video).

- **Spatial movement.** Describe a pattern of physical movement; for example, top to bottom, left to right, or outside to inside.
• **temporal movement.** Describe events in relation to what happens first, second, and so on.

• **concept > application of the concept / examples.** Discuss a concept in general terms, then discuss the concept's application and/or examples of the concept.

• **data > conclusions.** Present data (observations, experimental data, survey results) then move on to the conclusions that can be drawn from that data. (This pattern is sometimes reversed: present the conclusion first, then the data that supports it.)

• **problem / question > solution / answer.** Introduce a problem or raise a question, then move on to the solution or answer.

• **simplified version > detailed version.** Discuss a simplified version of the thing, establish a solid understanding of it, then explain it all again, but this time laying on the technical detail. (This approach is especially useful for explaining technical matters to nonspecialists.)

• **most important > least important.** Begin with the most important, eye-catching, dramatic information, and move on to information that is progressively less so. (This pattern can be reversed: you can build up to a climax, rather than start with it.)

• **strongest > weakest.** Start with the most strongest argument for your position—to get everybody's attention—then move on to less and less strong ones. (This pattern can also be reversed: you can build up to your strongest arguments, but the weakest → strongest pattern is often less persuasive.)

These are just a few possibilities. Whichever sequence you choose, be consistent with it, and avoid mixing these approaches randomly. For example, presenting some data, stating a few conclusions, and then switching back and forth between data and conclusions haphazardly will only confuse your reader.

### Topic Sentences

One of the best structural revision techniques you can use is to backtrack through a rough draft and insert topic sentences at key points.

A topic sentence is a sentence occurring toward the beginning of a paragraph that in some way tips the reader off as to the focus, purpose, and contents of that paragraph (and perhaps one or more paragraphs following). At its best, it focuses the reader's attention; it says, "Hey, here's what we're talking about!"

Often, when authors create technical documents, they don't consciously think about each paragraph's contents and logic; instead, authors focus on getting words onto the page, and they figure out what they mean while they're writing. Sometimes the results can seem disjointed. Accordingly, authors should go back and insert topic sentences that can help readers understand where they are going, what's coming up next, (often) where they've just been, and how what they are reading connects to the document as a whole.

### Types of Topic Sentences

Your best guide for deciding when to use topic sentences and which type to use is probably your own instincts and intuition. But here are some ideas and examples:

• **keyword topic sentence.** This type of topic sentence contains a keyword that hints about the content and organization of the upcoming material. Use one if your section (one or more paragraphs) discusses multiple similar things (for example, problems, solutions, causes, consequences, reasons, aspects, factors).

  During Samhain there are a number of activities the Celts took part in that resemble some customs we observe on Halloween today.

• **overview topic sentence.** This type of topic sentence names all the subtopics in the upcoming material. Use one if you want to specify all the subtopics you will address.

  Most brains exhibit a visible distinction between gray matter and white matter.

• **thesis-statement topic sentence.** This type of topic sentence makes an assertion—an argument—that the rest of paragraph must support. Use one if your section proves a point and includes multiple supporting statements.

  Although Babbage's machines were mechanical monsters, their basic architecture was astonishingly similar to a modern computer.
• **topic definition.** This type of topic sentence names the term being defined, identifies the class it belongs to, and describes its distinguishing characteristics. It must contain highly specific information. Use one if your section introduces an unfamiliar term.

**Stress is a measure of the internal reaction between elementary particles of a material in resisting separation, compacting, or sliding that tend to be induced by external forces.**

• **topic reference.** This type of topic sentence simply mentions the general subject at hand. It does not forecast what will be said about the subject. Use one to remind your reader about the general subject.

**The surface of Mars is thought to be primarily composed of basalt, based upon the Martian meteorite collection and orbital observations.**

• **no topic sentence.** Sometimes, you may not need or want a topic sentence. If your materials contain a story that leads to a point, or are part of a popular-science or -technology writing project, a topic sentence up front may be heavy, stodgy, and inappropriate.

**Transitions**

You may have audience-appropriate information in your technical document, and you may have organized that information well, but you also need to integrate those various pieces of information into a unified whole. If you don't make the document's "flow" of ideas clear, the document will read like a random assortment of ideas, and the reader will not understand how the chunks of information relate or connect to each other.

Use "transitions"—various devices that help readers connect the different sections of a document—to guide your reader from one idea to the next. You need to make clear the logic that connects every sentence in a document.

Here are some common types of transitional words and phrases:

• **additive.** Use these words to demonstrate that one idea is added to another. Examples include moreover, as well as, too, in addition to, furthermore, also, additionally.

• **narrative / chronological / temporal.** Use these words to demonstrate that one idea can follow, precede, or occur simultaneously with another. Examples include then, next, after, before, since, subsequently, following, later, as soon as, as, when, while, during, until, once.

• **contrastive / comparative.** Use these words to demonstrate differences or similarities. Examples include but, on the other hand, unlike, as opposed to, than, although, though, instead, similarly.

• **alternative.** Use these words to demonstrate that two ideas can act as alternatives or substitutes for each other. Examples include either, or, nor, on the other hand, however, neither, otherwise.

• **causal.** Use these words to demonstrate that one idea can be the cause or the result (effect, consequence, etc.) of another. Examples include thus, then, unless, subsequently, therefore, because, consequently, as a result, if, in order to/that, for, so.

• **illustrative.** Use these words to demonstrate that one idea can be an example or an illustration of another. Examples include for example, for instance, to illustrate, as an example.

• **repetitive / reiterative.** Use these words to rephrase an idea using other, perhaps more familiar, terms. Examples include in other words, in short, that is, stated simply, to put it another way.

• **spatial / physical.** Use these words to emphasize spatial relationships between things. Examples include prepositions such as under, beside, on top of, next to, behind, and many others.

Here are some more advanced types of transitions:

• **summary transitions.** Use a brief phrase (sometimes even a single word) to summarize the concepts in the preceding material. Then, in the same sentence, make a statement about that summary phrase, introduce the upcoming materials, and demonstrate their conceptual link. This technique is especially useful for establishing logical links between short sections. In the following sample paragraph, the words in green summarize the concepts, and dark red words perform the other functions.

The simplest semiconductor is called a diode. A diode serves as a rectifier to conduct alternating current (ac) to direct current (dc). While the usual current in the U.S. is ac with a frequency of 60 Hz, many electronic devices require dc for
at least part of their function. *The diode solves this mismatch of current types by its basic design in which a p- and an n-type semiconductor are joined together.*

- **review-preview transitions.** Use a relatively short phrase or sentence to summarize the topic of the preceding material, use another relatively short phrase or sentence to summarize the upcoming material, and tie them together using transitional words. In the following sample paragraph, the words in green summarize the previous ideas. The words in dark red summarize the following materials. The word in purple is the transitional word.

Coring and core analysis techniques are adequate only to a certain extent, as the previous section shows. However, a much faster and less expensive method of detecting fractures is increasingly being used in exploratory wells: wire-line logging analysis.

**Paragraph length**

One last way to revise your rough draft at the structural level is to check for paragraph breaks.

Paragraphs are odd creatures—some scholars of writing believe they don't exist and are just arbitrary break points that writers toss in whenever and wherever they please. This idea may be true for creative or expressive writing, but in technical writing, the paragraph is a key player in the battle for clarity and comprehension. Insert paragraph breaks where there is some shift in topic or subtopic, or some shift in the way a topic is being discussed.

Here are some suggestions for paragraph length:

- If your technical document needs a great deal of expository writing and will be printed in hard copy, you can probably use relatively long paragraphs. A single spaced page full of text will probably contain one to four paragraph breaks. (There's nothing magical about that average, so don't treat it as if it were law.)
- If your technical document does not require long blocks of text, consider breaking it up into short paragraphs. Three sentences per paragraph is a widely accepted average.
- If your technical document will be posted online, use short paragraphs. People generally find it easier to read short paragraphs online than to read long paragraphs online.

In any case, look at long blocks of text and think about breaking them up into bite-sized chunks.

**Power-Revision Techniques: Sentence-Level Revision**

You've probably heard plenty of times that writing should be lean, mean, clear, direct, succinct, active, and so on. This statement is one of those self-evident truths—why would anyone set out to write any other way? But what does this advice really mean? What do sentences that are not "lean, mean" and so on look like? What sorts of things are wrong with them? How do you fix them?

Sentences do have ways of becoming flabby, redundant, wordy, unclear, indirect, passive, and just plain old hard to understand. Even so, they remain grammatically "correct"—all their subjects and verbs agree, the commas are in the right places, the words are spelled correctly. Still, these sentences are far more difficult to read than a sentence with just a comma problem.

The following sections can't pretend to cover all of the ways sentences can go bad at this higher level, but they do cover seven of the most common problems and show you ways of fixing them. And knowing these seven will probably enable you to spot others we have not trapped and labeled yet.

**Nominalizations**

Check your writing for sentences that use "to be" as the main verb and use a nominalization as the sentence's subject. (A nominalization is a verb that has been converted into a noun; look for -tion, -ment, -ance, and other suffixes. For example, "nominalization" is itself a nominalization; the root verb is "to nominate." The "to be" verbs are am, is, are, was, were.)

These sentences are probably weak and indirect. Revise them by changing the nominalization into a verb and replacing the "to be" verb. Your sentences will sound more active, and they will be easier for the reader to understand.
Sometimes, you can't convert a nominalization into a main verb, or a nominalization needs to remain a sentence's subject. (For example, "information" is a nominalization, but try converting "information" into a main verb. The sentence will be awkward, at best.) More often, though, you can convert that nominalization into a main verb.

The following examples demonstrate this problem and how to fix it. In each revised version, notice how a noun has been converted into the sentence's main verb and replaced the original "to be" main verb.

**Examples**

<table>
<thead>
<tr>
<th>Problem Sentence</th>
<th>Revised Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>The contribution of Quality Circles is mostly to areas of training and motivating people to produce higher quality work.</td>
<td>Quality Circles contribute to the training and the motivating of people to produce high quality work.</td>
</tr>
<tr>
<td>Measurement of temperature is done in degrees of Fahrenheit or Celsius, and its indications are by colored marks on the outside of the thermometer.</td>
<td>Temperature is measured in degrees of Fahrenheit or Celsius and is indicated by colored marks on the outside of the thermometer.</td>
</tr>
<tr>
<td>The beginning of the clonic phase is when the sustained tonic spasm of the muscles gives way to sharp, short, interrupted jerks.</td>
<td>The clonic phase begins when the sustained tonic spasm of the muscle gives way to sharp, short, interrupted jerks.</td>
</tr>
<tr>
<td>During speech, the generation of sound is by vocal chords and the rushing of air from the lungs.</td>
<td>During speech, sound is generated by the vocal cords and rushing air from the lungs.</td>
</tr>
<tr>
<td>The response of the normal ear to sounds is in the audio-frequency between about 20-20,000 Hz.</td>
<td>The normal ear responds to sounds within the audio-frequency range of about 20-20,000 Hz.</td>
</tr>
</tbody>
</table>

**Noun Stacks**

Search your writing for sentences that contain long, piled-up strings of nouns. Their effect on a reader is similar being hit in the head with a large, blunt object.

Revise these sentences and "unpack" or "unstack" their long noun strings into multiple verbs, clauses, and phrases.

The following examples demonstrate this problem and how to fix it. In each revised version, notice how a long string of nouns has been broken apart:

**Examples**

<table>
<thead>
<tr>
<th>Problem Sentence</th>
<th>Revised Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a growing awareness of organizational employee creative capacity.</td>
<td>Awareness of the creative capacity of employees in all organizations is growing.</td>
</tr>
<tr>
<td>Position acquisition requirements are any combination of high school graduation and years of increasingly responsible secretarial experience.</td>
<td>To qualify for the position, you'll need to be a high school graduate and have had increasingly responsible secretarial experience.</td>
</tr>
<tr>
<td>The Quality Circle participation roles and tasks and time/cost requirements of Quality Circle organizational implementation will be described.</td>
<td>The tasks of the participants in Quality Circles and the time and cost requirements involved in the implementation of Quality Circles will be discussed.</td>
</tr>
</tbody>
</table>
Proper integrated circuit packaging type identification and applications are crucial to electrical system design and repair. Identifying the proper type of packaging for integrated circuits is crucial to the design and repair of electrical systems.

Cerebral-anoxia-associated neonatal period birth injuries can lead to epileptic convulsions. Birth injuries associated with cerebral anoxia in the neonatal period can lead to epileptic convulsions.

Redundant Phrasing

Eliminate redundant phrases in your writing. They can come from these three sources (but there are probably plenty more):

- **wordy set phrases**: Look for four- to five-word phrases; you can usually chop them to a one- to two-word phrase without losing meaning. For example, "in view of the fact that" can be reduced to "since" or "because."
- **obvious qualifiers**: Look for a word that is implicit in the word it modifies. For example, phrases like "anticipate in advance," "completely finish," or "important essentials" are examples of obvious qualifiers.
- **scattershot phrasing**: Look for two or more compounded synonyms. For example, "thoughts and ideas" (what's the difference?) or "actions and behavior" (if there is a difference between these two, does the writer mean to use it?) are common.

Here are some classic examples of wordy set phrases and their revised versions:

<table>
<thead>
<tr>
<th>Wordy Phrase</th>
<th>Revised Phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>in view of the fact that</td>
<td>since, because</td>
</tr>
<tr>
<td>at this point in time</td>
<td>now, then</td>
</tr>
<tr>
<td>it is recommended that</td>
<td>we recommend</td>
</tr>
<tr>
<td>as per your request</td>
<td>as you requested</td>
</tr>
<tr>
<td>in light of the fact that</td>
<td>since, because</td>
</tr>
<tr>
<td>being of the opinion that</td>
<td>I believe</td>
</tr>
<tr>
<td>in the near future</td>
<td>soon</td>
</tr>
<tr>
<td>during the time that</td>
<td>when</td>
</tr>
<tr>
<td>it would be advisable to</td>
<td>should, ought</td>
</tr>
<tr>
<td>due to the fact that</td>
<td>since, because</td>
</tr>
<tr>
<td>in this day and age</td>
<td>now, currently</td>
</tr>
</tbody>
</table>

https://softchalkcloud.com/lesson/files/3LYbcUFdV8Snq4/5_5Power-Revision_print.html
<table>
<thead>
<tr>
<th>for the reason that</th>
<th>since, because</th>
</tr>
</thead>
<tbody>
<tr>
<td>in my own personal opinion</td>
<td>I believe, in my opinion, I think</td>
</tr>
<tr>
<td>to the fullest extent possible</td>
<td>fully</td>
</tr>
<tr>
<td>in accordance with your request</td>
<td>as you requested</td>
</tr>
<tr>
<td>four in number</td>
<td>four</td>
</tr>
<tr>
<td>predicated upon the fact that</td>
<td>based on</td>
</tr>
<tr>
<td>inasmuch as</td>
<td>since, because</td>
</tr>
<tr>
<td>pursuant to your request</td>
<td>as you requested</td>
</tr>
<tr>
<td>in connection with</td>
<td>related to</td>
</tr>
<tr>
<td>take cognizance of the fact that</td>
<td>realize</td>
</tr>
<tr>
<td>it has come to my attention that</td>
<td>I have learned that</td>
</tr>
<tr>
<td>with reference to the fact that</td>
<td>concerning, about</td>
</tr>
<tr>
<td>with regard to</td>
<td>concerning, about</td>
</tr>
<tr>
<td>in close proximity to</td>
<td>near, close, about</td>
</tr>
<tr>
<td>to the extent that</td>
<td>as much as</td>
</tr>
<tr>
<td>in the neighborhood of</td>
<td>near, close, about</td>
</tr>
<tr>
<td>until such time as</td>
<td>until</td>
</tr>
<tr>
<td>has the ability to</td>
<td>can</td>
</tr>
<tr>
<td>that being the case</td>
<td>therefore</td>
</tr>
</tbody>
</table>

**Expletives**
In grammar, an "expletive" is a word that serves a function but has no meaning. The most common expletive phrases in English are "it is/are" and "there is/are." They are sometimes useful, but they are more often redundant and weaken a sentence's impact. If you can, delete them from technical documents.

Here are some examples of sentences with expletives and their revised versions without expletives.

<table>
<thead>
<tr>
<th>Problem Sentence</th>
<th>Revised Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>When there is a very strong build-up at the front of the plane, it is what is known as a shock wave.</td>
<td>When a very strong build-up occurs at the front end of the plane, a shock wave forms.</td>
</tr>
<tr>
<td>When there is decay of a radioactive substance, there is the emission of some form of a high-energy particle—an alpha particle, a beta particle, or a gamma ray.</td>
<td>When a radioactive substance decays, some form of a high-energy particle—an alpha particle, a beta particle, or a gamma ray—is emitted.</td>
</tr>
<tr>
<td>It is the results of studies of the central region of the M87 galaxy that have shown that there are stars near the center that move around as though there were some huge mass at the center that was attracting them.</td>
<td>Recent studies of the central region of the M87 galaxy have shown stars near the center moving around as though some huge mass at the center were attracting them.</td>
</tr>
</tbody>
</table>

**Weak Use of Passive-voice Verbs**

One of the all-time worst offenders for creating unclear, wordy, indirect writing is the passive-voice construction.

Look for a "to be" verb coupled with a past participle (a past-tense verb, often ending in -ed). Change it to an active verb, and rearrange the sentence to make grammatical sense.

It's easy enough to convert a sentence from active voice to passive voice, and back again.

<table>
<thead>
<tr>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive voice</td>
</tr>
<tr>
<td>Active voice</td>
</tr>
</tbody>
</table>

However, the passive voice can be a shifty operator—it can cover up its source, that is, who's doing the acting, as this example shows.

<table>
<thead>
<tr>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive voice</td>
</tr>
<tr>
<td>Active voice</td>
</tr>
</tbody>
</table>

It's this ability to conceal the actor or agent of the sentence that makes the passive voice a favorite of people in authority—policemen, city officials, and, yes, teachers. At any rate, you can see how the passive voice can cause wordiness, indirectness, and comprehension problems.
### Passive Voice

<table>
<thead>
<tr>
<th>Problem Sentence</th>
<th>Revised Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your figures have been reanalyzed in order to determine the coefficient of error. The results will be announced when the situation is judged appropriate. <em>(Who analyzes, and who will announce?)</em></td>
<td>We have reanalyzed your figures in order to determine the range of error. We will announce the results when the time is right.</td>
</tr>
<tr>
<td>Almost all home mortgage loans nowadays are made for twenty-five years. With the price of housing at such inflated levels, those loans cannot be paid off in any shorter period of time. <em>(Who makes the loans, and who can't pay them off?)</em></td>
<td>Almost all home mortgage loans nowadays are for twenty-five years. With the price of housing at such inflated levels, homeowners cannot pay off those loans in any shorter period of time.</td>
</tr>
<tr>
<td>However, market share is being lost by ride-share operators, as is shown in the graph in Figure 2. <em>(Who or what is losing market share, who or what shows it?)</em></td>
<td>However, ride-share operators are losing market share, as the graph in Figure 2 shows.</td>
</tr>
<tr>
<td>For many years, federal regulations concerning the use of wire-tapping have been ignored. Only recently have tighter restrictions been imposed on the circumstances that warrant it. <em>(Who has ignored the regulations, and who is now imposing them?)</em></td>
<td>For many years, government officials have ignored federal regulations concerning the use of wire-tapping. Only recently has the federal government imposed tighter restrictions on the circumstances that warrant it.</td>
</tr>
<tr>
<td>After the arm of the hand-held stapler is pushed down, the blade from the magazine is raised by the top-leaf spring, and the magazine and base. <em>(Who pushes it down, and who or what raises it?)</em></td>
<td>After you push down on the arm of the hand-held stapler, the top-leaf spring raises the blade from the magazine, and the magazine and base move apart.</td>
</tr>
<tr>
<td>The solution was heated to 28.4 degrees Celsius and was stirred for 9 minutes and 1 second. <em>(Who heated the solution, and who or what stirred it?)</em></td>
<td>My lab partner and I heated the solution to 28.4 degrees Celsius and took turns stirring it for 9 minutes and 1 second.</td>
</tr>
</tbody>
</table>

### Don't get the idea that the passive voice is always wrong. It is a good writing technique if

- the subject is obvious or too-often-repeated
- the actor is unknown
- the actor isn't important
- we want to stress the action more than who did it
- we need to rearrange words in a sentence for emphasis.

Notice that the passive voice is really all right in the last two examples above.

### Subject-Verb Mismatches

In dense, highly technical writing, it's easy to lose track of the real subject and pick a verb that just does not make sense. The result is a noun physically not able to do what the verb says it is doing, or some abstract thing performing something nitty-gritty real-world action.

Check to make sure every sentence's noun matches the main verb.

Here are some examples and their revisions.

### Examples

<table>
<thead>
<tr>
<th>Problem Sentence</th>
<th>Revised Sentence</th>
</tr>
</thead>
</table>
Readability, Sentence Lengths, and Sentence Structures

When you are writing about highly technical subject matter, it is easy to construct long sentences that become hard to read, or to bore your reader with highly repetitive sentence lengths and grammatical structures.

Readability

The reader of a technical document needs to be able to extract information from it as easily as possible, so most technical documents are written at the 8th-grade level. The average sentence length should be about fifteen words.

When you revise, look for long sentences that contain lots of information. Break them into shorter, bite-sized chunks that contain single ideas, and run the resulting sentences through a readability checker. For example, MS Word has a built-in readability tool that will tell you the number of words per sentence and the Flesch-Kincaid model’s estimate of the text's grade level. (Open your document in MS Word, click File > Options > Proofing, check the "Show readability statistics" box, and run the spellchecker.)

Sentence Length

The average sentence in a technical document should contain about fifteen words, but you can use significantly longer or shorter sentences if necessary. Any sentence over thirty-five or forty words almost definitely needs to be broken up. An occasional short sentence (say, five to ten words) can be very effective, but lots of them can cause writing to be choppy and hard to follow.

Similarly, if the document contains a string of sentences that are close to the same length (for example, six sentences of exactly fifteen words each), the reader will fall into a rhythm and find it hard to pay attention. Break apart or combine sentences to create variety in their length.

Sentence Structures

In English, there are four basic sentence structures:

- **simple.** This type of sentence contains a single independent clause.
- **compound.** This type of sentence contains two independent clauses.
- **complex.** This type of sentence contains an independent clause and a dependent clause.
- **compound complex.** This type of sentence contains a compound sentence and at least one dependent clause.

Technical writing usually uses simple and compound sentences, and sometimes complex sentences. It very rarely uses compound complex sentences. Look for these sentence structures and revise your technical document accordingly.

Also, as with sentence lengths, if all your sentences use the same grammatical structure, your reader will fall into a rhythm and find it hard to pay attention. Break apart or combine sentences to create variety in their grammatical structure.

Here are some examples of overly long, complex sentences and their revised versions:
In order to understand how a solid, liquid or gas can be made to give off radiation in the form of a laser beam, one must understand some of the basic theory behind laser light.

**Length:** 35 words  
**Grade Level:** 15.2

<table>
<thead>
<tr>
<th>A solid, liquid or gas can be made to give off radiation in the form of a laser beam. Understanding this process requires some knowledge about the basic theory behind laser light.</th>
</tr>
</thead>
</table>
| **Average Length:** 16 words  
**Grade Level:** 9.0 |

Laser beams, which have many properties that distinguish them from ordinary light, result from the emission of energy from atoms in the form of electromagnetic waves whose range in most laser beams is $10^{-3}$ to $10^{-7}$ meters.

**Length:** 37 words  
**Grade Level:** 19.5

<table>
<thead>
<tr>
<th>Laser beams are just beams of light, but they have special properties that distinguish them from ordinary light. Laser beams come from atoms that emit energy as electromagnetic waves. The average wavelength ranges from $10^{-3}$ to $10^{-7}$ meters.</th>
</tr>
</thead>
</table>
| **Average Length:** 12.6 words  
**Grade Level:** 10.7 |
Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Explain and apply how to find information in libraries.
2. Explain and apply how to indicate sources of borrowed information.
3. Explain and apply how to cross-reference.

Information Search

This section focuses on finding information for your technical documentation projects online and in physical libraries. Your job is to get good, specific, up-to-date information for your formal report project. You may not be able to read it all—you're not writing a dissertation, nor is your knowledge about your topic expected to be anywhere close to that level. But at least you know what's out there.

Check out the library system at Kennesaw State University. Here KSU students will find research help 24/7.

How do I get started with research?

Find a Topic, Narrow It, Brainstorm It

Before you head for the library or its Internet equivalent, you need a topic, some idea of the specific aspect of the topic you want to focus on, and some ideas about what to say about that narrowed topic. Problems finding a topic and thinking of what to say about it are often called the dreaded writer's block.

Narrowing a topic is that process in which you go from an impossibly huge topic such as nanotechnology to something more manageable such as applications of nanotechnology in brain surgery.

Brainstorming a topic is that process in which you think of everything you can that you might write about in relation to your topic.

Know Your Booleans for Searching Online or in Databases

An important tool to have when you go searching for information—either in libraries or on the Internet—has to do with Boolean operators: AND, OR, NOT and a few esoteric others. The following table will help you become an expert in narrowing search parameters, especially in a huge database such as that provided by the university.

<table>
<thead>
<tr>
<th>Technique</th>
<th>What it does</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truncation — adding a symbol to the root of the word to retrieve related terms and variant endings for the root term. Some databases have left- and right-hand truncation.</td>
<td>Expands your search</td>
<td>structur* finds structure, structuring, structures, etc. *elasticity will find elasticity, aeroelasticity, viscoelasticity</td>
</tr>
<tr>
<td>Boolean AND — retrieves only those records containing all your search terms</td>
<td>Narrows your search</td>
<td>finite AND element AND methods</td>
</tr>
<tr>
<td>Boolean OR — retrieves records containing any of your search terms; especially useful for synonyms, alternate spellings, or related concepts</td>
<td>Broadens your search</td>
<td>energy OR fuel pollut* OR contaminat* sulfur OR sulphur</td>
</tr>
<tr>
<td>Boolean NOT, AND NOT — attempts to exclude a term that is not useful or relevant</td>
<td>Narrows your search</td>
<td>&quot;Advanced Materials&quot; AND composite NOT wood</td>
</tr>
</tbody>
</table>
| Proximity — retrieves terms within a specified distance of one another; variations of proximity searches are phrase searches, where the terms | Narrows your search | "Styrenic Block Copolymers" (quotation marks ensure that the multiple-word term
Types of Resources for Information Research

Encyclopedias and Other Reference Works

If you are beginning at ground zero with your technical report topic, a good strategy would be to read some articles in general encyclopedias. As a researcher, you need to know something about the topic so you will know what kinds of questions to ask and how to organize your data. If you are knowledgeable, the entire research process will be more efficient and even enjoyable.

• World Book Online (yes, even this one!)
  Britannica
  Access Science for online access to the McGraw-Hill Encyclopedia of Science and Technology

Can you build a legitimate technical report based on encyclopedia articles that you summarize and paraphrase? NO! Most college level instructors will not accept encyclopedias as legitimate sources because their information is broad, not specific. You may not be able to gather enough information to create a report of any reasonable length. We could go on about this for a long time, but do not consider using an encyclopedia, not even wikipedia.com, as part of your cited research data...only as a place for you to begin building a background of knowledge.

You can find reference books like encyclopedias by typing in a couple of words of the title in an online library catalog (for example, mechanical engineer* handbook, "encyclopedia engineering", or "encyclopediaandengineering"), truncating any words that could have variant endings, and eliminating any prepositions or articles (of, for, the, a, an).

Here are some examples of what you might find:

• Prentice-Hall Encyclopedia of Information Technology
• McGraw-Hill Dictionary of the Life Sciences
• Robotics Sourcebook and Dictionary
• Energy: A Guide to Organizations and Information Resources in the United States
• McGraw-Hill Yearbook of Science and Technology

Books

Books can provide excellent background, a historical treatment of your subject and depth. Check a book's table of contents and index to see if it has what you are looking for. For some current research topics, however, books tend to be too general. To obtain more specific information on technological advancements, go to journal articles, technical reports, or other sources discussed later in this chapter.

Try these resources. Search "drone aircraft" on each to see which has the most up to date resources:

• Online Books
• Library of Congress Catalog
• World Cat

Here are some sites that consolidate access to thousands of libraries worldwide:

• LibDex
• The WWW Library Directory
• LibWeb

Periodicals

*Periodicals* is a librarian's word for stuff that comes out periodically—like magazines, journals, newspapers. Magazines, which are by definition for general audiences, are not likely to have much that is useful to your report. At the college level, you will be expected to use scholarly, or peer reviewed, journals for research. You can find these in the university database, or you can borrow from other systems through an system of inter-library loans. When in doubt, pay a visit to your campus library and make friends with the librarians there.
Directory of Open Access Journals. DOAJ offers free access to over 3,500 full-text, quality-controlled scientific and scholarly journals, over 1,200 of which are searchable at the article level.

Most of the following are services you pay for; some offer a free 30-day trial. Your local library may subscribe to some of these, giving you free access:

- Applied Science and Technology
- Academic Search Complete
- INSPEC
- ScienceDirect

Technical Reports

- National Technical Information Service (NTIS)
- IEEE Xplore
- NASA Technical Reports Server

Associations and Interest Groups

Organizations like associations, special-interest groups, and advocacy groups are good potential sources for information on your topic—or a terrible ideological swamp. Keep in mind that associations and interest groups generally have agendas or biases about their topics. *Encyclopedia of Associations* may be a good resource. Ask your librarian for help with this kind of resource.

Library and Subject Guides

Research assistance, subject guides, useful resources and web sites compiled by the friendly librarians at Austin Community College, for example, occupational therapy, business and technical communications, and other department and field names. These are presented here.

Austin Community College Research Guides

Your own library at Kennesaw State University also has awesome resources for you to use.

KSU LibGuides

Other Information Resources

There are certainly other kinds of information sources such as patents, standards, product literature, conference proceedings. Again, ask your librarian for help with these kinds of resources.

Evaluate Your Research Findings

The following is a system of evaluating the reliability of Internet information developed by the Cornell University Library. This information is especially important if you are using Internet sources and need to defend their validity and reliability.

| Evaluating Research Findings |
|-----------------------------|-----------------------------------------------|
| **Point of view** | Does this article or book seem objective, or does the author have a bias or make assumptions? What was the author's method of obtaining data or conducting research? Does the website aim to sell you something or just provide information? What is the author's purpose for researching and writing this article or book? |
| **Authority** | Who wrote the material? Is the author a recognized authority on the subject? What qualifications does this author have to write on this topic? Is it clear who the intended audience is? What is the reputation of the publisher or producer of the book or journal? Is it an alternative press, a private or political organization, a commercial press, or university press? What institution or Internet provider supports this information? (Look for a link to the homepage.) What is the author's affiliation to this institution? |
| **Reliability** | What body created this information? Consider the domain letters at the end of a web address (URL) to judge the site's quality or usefulness. What kind of support is included for the information? Are there facts, interviews, and statistics that can be verified? Is the evidence convincing to you? Is there any evidence provided to support the author's conclusions, such as charts, maps, bibliographies, and documents? Compare the information provided to other factual sources. |
| **Timeliness** | Has the site been recently updated? Look for this information at the bottom of a web page. How does the copyright of a book or publication date of an article impact the information contained in it? Do you need historical or recent information? Does the resource provide the currency you need? |
Scope

Consider the breadth and depth of an article, book, website, or other material. Does it cover what you expected? Who is the intended audience? Is the content aimed at a general or a scholarly audience? Based on your information need, is the material too basic, too technical, or too clinical?

In addition to the above, if you are looking at Internet sites, pay careful attention to any advertising on page. Online gambling or magic weight loss solutions might not be the kind of company your research needs to keep.

As a rule of thumb, steer clear of any resource that has "wiki" or "about" in the title or url. Your safest bets are sites sponsored by the U.S. government (.gov) or educational institutions (.edu).

Citing Sources of Borrowed Information

When you write a technical report, you can and should borrow information like crazy—to make it legal, all you have to do is "document" it. If your report makes you sound like a rocket scientist but there's not a single source citation in it and you haven't even taken college physics yet, people are going to start wondering. *(In Night Court, you'd be guilty of plagiarism. Fine—an F on the paper in question.)* However, if you take that same report and load it up properly with source citations (those little indicators that show that you are borrowing information and from whom), everybody is all the more impressed—plus they're not secretly thinking you're a shady character. A documented report (one that has source indicators in it) says to readers that you've done your homework, that you're up on this field, that you approach these things professionally—that you are no slouch. Most importantly, you've shown that you respect the rights of the original authors, the owners of the intellectual property you are using.

The following resources will provide all the guidance you need to correctly document, or give credit to, your sources.

- Research and Citation Resources. Overview from the Purdue OWL with links to specific systems.
- APA Documentation. From Austin Community College.
- MLA Documentation. From Austin Community College.
- Turabian Documentation. From Austin Community College.
- CSE Documentation: Name-Year Method. From Austin Community College.
- CSE Documentation: Citation-Sequence System. From Austin Community College.
- IEEE Citation Style Guide. From Georgia Tech. *(The IEEE system is very similar to the system described in the following.)*

Number System of Documentation

If you've taken other college writing courses recently, you have probably been exposed to other documentation systems—specifically the MLA, or works cited system. The problem with that system is that it is rather limited to the literature and humanities field. Unfortunately, it is not widely used outside that field—especially not in technical and scientific fields. One of the more common systems used in technical fields is the number system, a formatting procedure that is easy to learn and use. The citation-sequence version of the CSE *(Scientific) Documentation* (see the link above) is one of the specific incarnations of the number system. *(Notice here that we use brackets, not parentheses, for the source indicators.)*

In this number system, you list your information sources alphabetically, number them, and put the list at the back of your report. Then in the body of your report, whenever you borrow information from one of those sources, you put the source number and, optionally, the page number in brackets at that point in the text where the borrowed information occurs. The illustration below shows how this system works. However, in a hypothetical example:

- [4] would refer to source 4 in the list.
- [4;7] would indicate that the information was borrowed from source 4 and source 7.

What to Document

This question always comes up: how do I decide when to document information—when, for example, I forgot where I learned it from, or when it really seems like common knowledge? There is no neat, clean answer. You may have heard it said that anything in an encyclopedia or in an introductory textbook is common knowledge and need not be documented. Don't believe it. If it really isn't common knowledge for you, at least not yet, document it! If you just flat can't remember how you came by the information, then it has safely become common knowledge for you. *(All that's really going on here is that we're trying to protect the efforts of those poor devils who worked themselves into the ground originating the information we want to borrow—give 'em a break, give 'em their due!)* If you know you read it during your research process, you need to document it.

One other question that is often asked: do I document information I find in product brochures or that I get in conversations with knowledgeable people? Yes, most certainly. You document any information you did not create, regardless whether it is in print,
Searching Libraries, Documenting Information, Cross-Referencing

in electronic bits, magnetic spots, or in thin air. While you probably studied this in high school, it becomes a very serious issue in a university that expects research to not only be useful, but also to be honest.

How to Place the Source Indicators

It's a bit tricky deciding exactly where to place the source indicators—at the beginning of the passage containing the borrowed information, at the end? If it makes sense to "attribute" the source (cite the name of the author or the title of the information), you can put the attribution at the beginning and the bracketed source indicator at the end (as is shown in in the following).

In the number documentation system, the code numbers in the text of the report are keyed to the references page. For example, [6:5] in the middle of the page from the body of the report indicates that the information came from source 6 (in References), page 5. Notice that the attribution of the quotation indicates the beginning of the borrowed information and the bracketed source indicator marks the end.

How to Set up the Sources List

A bit more challenging is setting up the list of information sources—that numbered, alphabetized list you put at the end of the document. The best way to learn is to use examples. The following examples show you how to handle books, government reports, articles from magazines and journals, encyclopedia articles, and personal interviews.

Internet and web information sources. For format information regarding citing Internet and web sources, see any of the resources listed above. As you will see, there are quite a few variations. However, a simple functional practice would use this order:

1. Author name, last name first. If that's not available, use the organization's name, followed by a period.
2. Next, the title of the page.


REFERENCES

13
3. After that the publication date of the web page, if available; otherwise, use the "N.d." indicator.
4. Next, the full URL of the page.
5. And finally an indication of the date you accessed the page, for example, Accessed June 6, 1988.

Books. For books, first put the name of the author (last name first), followed by a period, followed by the title of the book in italics, followed by a period, followed by the city of the publisher, followed by a colon, followed by the publisher's name (but delete all those tacky "Inc., " "Co.," and "Ltd." things), followed by the year of publication, ending with a period. In this style, you don't indicate pages.


Magazine and journal articles. Start with the author's name first (last name first), followed by a period, then the title of the article in quotation marks and ending with a period, followed by the name of the magazine or journal in italics, followed by a period, followed by the date of issue of the magazine the article occurs in, followed by the beginning and ending page. If the article spread out across the magazine, you can write "33+" or "33(5)." The (5) in the preceding is an estimate of how many pages the article would be if it were continuous.

If there is no author, start with the article or book title. If there are two authors, add "and" and the second author's name, first name first. If there are too many authors, use the first one (last name first), followed by "et al.," which means "and others."


Note: You may have seen complex entries indicating volume and issue numbers. While those may be required in some contexts, normally you can simplify things and just include the issue date. But ask!

Encyclopedia articles. Encyclopedia articles are easy! Start with the title of the article in quotation marks ending with a period, followed by the name of the encyclopedia (in italics if you have it; otherwise, underline), followed by the period, then the year of the edition of the encyclopedia.


Reports. With reports, you're likely to dealing with government reports or local informally produced reports. With most reports, you may not have an individual author name; in such cases, you use the group name as the author. For government reports, the publisher is often the Government Printing Office; and the city of publication, Washington, D.C. Also, for government documents, you should include the document number, as is shown in the following example.


Personal interviews, correspondence, and other nonprint sources. With these sources, you treat the interviewee or the e-mail or letter writer as the author, follow that name with the person's title, followed by a period, then the company name, followed by a period, then the city and state, followed by a period, then what the information was ("Personal interview" or "Personal correspondence") followed by a period, ending with the date.


Product brochures. For these kinds of information sources, treat the company name as the author, followed by a period, use something identifying like the product name (including the specific model number), followed by anything that seems like the title of the brochure, followed by a period, ending with a date if you can find one (otherwise, put "N.d.").

Society to Stop Nuclear Power Plants. *Stop the Nukes*. Political brochure. N.d.

Documenting borrowed graphics. It's certainly legal to copy graphics from other sources and use them in your own work—as long as you document them. You indicate the source of a borrowed graphic in the figure title (caption), which is located just below the graphic. In the figure title, you can show the source of the graphic in two ways—the long traditional way or the shorter way that uses the format of the number system:
Cross-Referencing

Technical reports and instructions often require cross-references—those pointers to other places in the same document or to other information sources where related information can be found.

A cross-reference can help readers in a number of different ways:

- It can point them toward more basic information if, for example, they have entered into a document more complex than their level of understanding.
- It can point them to more advanced information if, for example, they already know the stuff you're trying to tell them.
- Also, it can point them to related information.

Related information is the hardest area to explain because ultimately everything is related to everything else—there could be no end to the cross-references. But here's an example from DOS—that troll that lurks inside PC-type computers and supposedly helps you. There are several ways you can copy files: the COPY command, the DISKCOPY command, and XCOPY command. Each method offers different advantages. If you were writing about the COPY command, you'd want cross-references to these other two so that readers could do a bit of shopping around.

Of course, the preceding discussion assumed cross-references within the same document. If there is just too much background to cover in your document, you can cross-reference some external website, book, or article that does provide that background. That way, you are off the hook for having to explain it all!

Now, a decent cross-reference consists of several elements:

- Name of the source being referenced—This can either be the title or a general subject reference. If it is a chapter title or a heading, put it in quotation marks; if it is the name of a book, magazine, report, or reference work, put it in italics or underline. (Individual article titles also go in quotation marks.) Choose italics over underlining when possible.
- Page number—Required if it is in the same document; optional if it is to another document.
- Subject matter of the cross-reference—Often, you need to state what's in the cross-referenced material and indicate why the reader should go to the trouble of checking it out. This information may necessitate indicating the subject matter of the cross-referenced material or stating explicitly how it is related to the current discussion.

These guidelines are shown in the following illustration. Notice in that illustration how different the rules are when the cross-reference is "internal" (that is, to some other part of the same document) compared to when it is "external" (to information outside of the document).
For details on creating graphics and then incorporating them into a document, see the section on graphics in this guide on page 16.

For details on creating graphics and then incorporating them into a document, see “Graphics” in theOnline Technical Writing Guide.

For details on creating graphics and then incorporating them into a document, see the chapter on graphics in theOnline Technical Writing Guide.

For details on creating graphics and then incorporating them into a report, see “Brighten Up That Monthly Report!” in theOffice Information Newsletter.

Activities and Exercises

1. Locate several journals in your major field and find the information for writers section. What formatting protocols are expected if you want to be published?
2. In small groups, visit the Purdue OWL Research and Citation Section and explore it. What can you learn about the different formatting styles? When would you use APA? MLA? IEEE? Chicago?
3. In small groups or a discussion forum, share some of your own research techniques...what has been effective for you in the past? What advice would you offer others in the class for becoming a good researcher?
4. Locate your school’s policy on plagiarism and academic honesty. How important do you think this is? Find some sources that reveal cases of academic dishonesty...how does lack of integrity in research affect the individuals and the university?
Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Explain and apply basic patterns of the sentence as they relate to technical writing.
2. Explain and apply basic elements of the sentence as they relate to technical writing.

This section is a quick review of the fundamentals of the sentence. If you encounter unfamiliar terminology in this textbook or in your class, refer to this section for help. For more on grammar, see the Purdue Online Writing Lab.

Basic Sentence Patterns

Subject + Verb

The simplest of sentence patterns is composed of a subject and verb without a direct object or subject complement. It uses an intransitive verb, that is, a verb requiring no direct object.

Control rods remain inside the fuel assembly of the reactor.

The development of wind power practically ceased until the early 1970s.

All amplitude-modulation (AM) receivers work in the same way.

The cross-member exposed to abnormal stress eventually broke.

Only two types of charge exist in nature.

Subject + Linking Verb + Subject Complement

Another simple pattern uses the linking verb, any form of the to be verb without an action verb.

The chain reaction is the basis of nuclear power.

The debate over nuclear power has often been bitter.

Folding and faulting of the earth's surface are important geologic processes.

Windspeed seems to be highest during the middle of the day.

The silicon solar cell can be difficult and expensive to manufacture.

Subject + Verb + Direct Object

Another common sentence pattern uses the direct object.

Silicon conducts electricity in an unusual way.

The anti-reflective coating on the the silicon cell reduces reflection from 32 to 22 percent.
Prestressing of the concrete increases the load-carrying capacity of the members.

**Subject + Verb + Indirect Object + Direct Object**

The sentence pattern with the indirect object and direct object is similar to the preceding pattern.

The walls are usually painted **black**.

The plant shutdown left the entire **area** an economic **disaster**.

The committee declared the new **design** a **breakthrough** in energy efficiency.

The low cost of the new computer made **competition** much too **difficult** for some of the other companies.

**Passive Voice Pattern**

The passive voice is not ordinarily considered a "pattern," but it is an important and often controversial construction. It reverses the subject and object and, in some cases, deletes the subject. Compare these example active and passive voice sentences.

<table>
<thead>
<tr>
<th>Passive voice</th>
<th>Active voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharin is now permitted as an additive in food.</td>
<td>The FDA now permits saccharin as an additive in food.</td>
</tr>
<tr>
<td>This report is divided into three main sections.</td>
<td>I have divided this report into three main sections.</td>
</tr>
<tr>
<td>Windmills are classified as either lift or drag types.</td>
<td>Engineers classify windmills as either lift or drag types.</td>
</tr>
<tr>
<td>The valves used in engine start are controlled by a computer.</td>
<td>A computer usually controls the valves used in an engine start.</td>
</tr>
<tr>
<td>The remains of Troy were destroyed by later builders on the site.</td>
<td>Later builders on the site of Troy destroyed the remains of citadel.</td>
</tr>
<tr>
<td>Some restaurant locations can be leased.</td>
<td>You can lease some restaurant locations.</td>
</tr>
</tbody>
</table>

**Simple Sentences**

A simple sentence is one that contains subject and a verb and no other independent or dependent clause.

**One** of the tubes **is attached** to the manometer part of the instrument indicating the pressure of the air within the cuff.

To measure blood pressure, a **device** known as a sphygmomanometer and a **stethoscope** are needed. *(compound subject)*

**There are** basically two **types** of stethoscopes. *(inverted subject and verb)*

The **sphygmomanometer** is usually **covered** with cloth and **has** two rubber tubes attached to it. *(compound verb)*
Compound Sentences

A compound sentence is made up of two or more independent clauses joined by a coordinating conjunction (and, or, nor, but, yet, for) and a comma; an adverbial conjunction and a semicolon; or a semicolon.

In sphygmomanometers, too narrow a cuff can result in erroneously high readings, and too wide a cuff can result in erroneously low readings.

Some cuffs hook together; others wrap or snap into place.

Compound Predicates

A predicate is everything in the verb part of the sentence after the subject (unless the sentence uses inverted word order). A compound predicate is two or more predicates joined by a coordinating conjunction. Traditionally, the conjunction in a sentence consisting of just two compound predicates is not punctuated.

Another library media specialist has been using Accelerated Reader for ten years and has seen great results.

This cell phone app lets users share pictures instantly with followers and categorize photos with hashtags.

Basic Parts of the Sentence

Subject

The subject of a sentence is that noun, pronoun, or phrase or clause about which the sentence makes a statement.

Einstein's general theory of relativity has been subjected to many tests of validity over the years.

Although a majority of caffeine drinkers think of it as a stimulant, heavy users of caffeine say the substance relaxes them.

Surrounding the secure landfill on all sides are impermeable barrier walls. (inverted sentence pattern)

In a secure landfill, the soil on top and the cover block storm water intrusion into the landfill. (compound subject)

Verb Phrase

The main verb, or verb phrase, of a sentence is a word or words that express an action, event, or a state of existence. It sets up a relationship between the subject and the rest of the sentence.

The first high-level language to be widely accepted, FORTRAN, was implemented on an IBM 704 computer.

Instruction in the source program must be translated into machine language. (passive construction)

The operating system controls the translation of the source program and carries out supervisory functions. (compound verb)

Predicate

The predicate is the rest of the sentence coming after the subject. It can include the main verb, subject complement, direct object, indirect object, and object complement.
The pressure in a pressurized water reactor varies from system to system. The pressure is maintained at about 2250 pounds per square inch to prevent steam from forming. The pressure is then lowered to form steam at about 600 pounds per square inch. In contrast, a boiling water reactor operates at constant pressure.

Subject Complement

The subject complement is that noun, pronoun, adjective, phrase, or clause that comes after a linking verb (some form of the be verb):

The maximum allowable concentration is ten parts \(\text{H}_2\text{S}\) per million parts breathable air. The deadening of the sense of smell caused by \(\text{H}_2\text{S}\) is the result of the effects of \(\text{H}_2\text{S}\) on the olfactory nerves of the brain. Continuous exposure to toxic concentrations of \(\text{H}_2\text{S}\) can be fatal.

Direct Object

A direct object—a noun, pronoun, phrase, or clause acting as a noun—takes the action of the main verb. A direct object can be identified by putting what?, which?, or whom? in its place.

The housing assembly of a mechanical pencil contains the mechanical workings of the pencil. Lavoisier used curved glass discs fastened together at their rims, with wine filling the space between, to focus the sun’s rays to attain temperatures of 3000° F. The dust and smoke lofted into the air by nuclear explosions might cool the earth’s atmosphere some number of degrees. A 20 percent fluctuation in average global temperature could reduce biological activity, shift weather patterns, and ruin agriculture. (compound direct object) The cooler temperatures brought about by nuclear war might end all life on earth. On Mariners 6 and 7, the two-axis scan platforms provided much more capability and flexibility for the scientific payload than those of Mariner 4. (compound direct object)

Indirect Object

An indirect object—a noun, pronoun, phrase, or clause acting as a noun—receives the action expressed in the sentence. It can be identified by inserting to or for.

In the application letter, tell [to] the potential employer that a resume accompanies the letter. The company is designing [for] senior citizens a new walkway to the park area. Do not send [to] the personnel office a resume unless someone there specifically requests it.

Object Complement

An object complement—a noun or adjective coming after a direct object—adds detail to the direct object. To identify object complements, insert [to be] between the direct object and object complement.
The supervisor found the program [to be] faulty.
The company considers the new computer [to be] a major breakthrough.
Most people think the space shuttle [to be] a major step in space exploration.

Parts of Speech and Other Sentence Elements

Nouns

A noun is the name of a person (Dr. Sanders); place (Lawrence, Kansas, factory, home); thing (scissors, saw, book); action (operation, irrigation); or idea (love, truth, beauty, intelligence). Remember that, while a word may look like a noun, it must function in the sentence as a noun:

The one experiment that has been given the most attention in the debate on saccharin is the 1977 Canadian study done on rats.
The Calorie Control Council, a group of Japanese and American manufacturers of saccharin, spent $890,000 in the first three months of the 1977 ban on saccharin on lobbying, advertisements, and public relations.
A flat-plate collector located on a sloping roof heats water which circulates through a coil and is pumped back to the collector.
The blades start turning when the windspeed reaches 10 mph, and an anemometer is attached to the shaft to measure windspeed.
The multifuel capacity of the Stirling engine gives it a versatility not possible in the internal combustion engine.
The regenerative cooling cycle in the engines of the space shuttle is made up of high pressure hydrogen that flows in tubes connecting the nozzle and the combustion chamber.

Pronouns

A pronoun stands in the place of a noun. There are several types: personal pronouns, demonstrative and indefinite pronouns, and relative and interrogative pronouns. Pronouns have antecedents, a reference to a word they take the place of.

*Personal pronouns* include nominative case, objective case, and possessive case pronouns.

**Nominative Case**

Nominative case pronouns are used in the positions of subjects or subjective complements; they include

<table>
<thead>
<tr>
<th>Nominative Case Pronouns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>we</td>
</tr>
<tr>
<td>you</td>
<td>you</td>
</tr>
<tr>
<td>he, she, it</td>
<td>they</td>
</tr>
</tbody>
</table>
Objective case pronouns are used as direct objects, indirect objects, and objects of prepositions; they include:

### Objective Case Pronouns

<table>
<thead>
<tr>
<th>me</th>
<th>us</th>
</tr>
</thead>
<tbody>
<tr>
<td>you</td>
<td>you</td>
</tr>
<tr>
<td>him, her, it</td>
<td>them</td>
</tr>
</tbody>
</table>
Relative and Interrogative Pronouns

<table>
<thead>
<tr>
<th>who</th>
<th>when</th>
<th>which</th>
</tr>
</thead>
<tbody>
<tr>
<td>whom</td>
<td>where</td>
<td>whether</td>
</tr>
<tr>
<td>whose</td>
<td>why</td>
<td>that</td>
</tr>
</tbody>
</table>

Here are some examples of relative pronouns in use:

Until the early 1960s, desk calculators, which performed only the basic arithmetic operations, were essentially mechanical in operation.

The invention of the transistor in 1948 and the integrated circuit in 1964 were two events that formed the basis of the electronic calculator revolution.

The form in which memory is presented to the software is sometimes called local address space.

George Boole, who was a self-taught man, is famous for his pioneering efforts to express logical concepts in mathematical form.

In 1855, Boole married Mary Everest, a niece of Sir George Everest after whom Mount Everest was named.

Lemaître proposed that all the matter in the Universe was concentrated into what he termed the primeval atom, whose explosion scattered material into space to form galaxies, which have been flying outward ever since.

Interrogative pronouns, similar to relative pronouns, are used in question sentences:

- What is the fundamental unit of storage in a computer?
- When did the first exhibit of computer graphics occur?
- Who were the mathematicians that arranged that first exhibit?
- Where was the first computer graphics exhibit held?
- Why is computer-aided art not considered art by some?

*Verbs*

Traditionally, verbs are divided into four groups: active verbs, linking verbs, auxiliary verbs, and modals.

*Active Verbs*

Active verbs express some sort of action and can be subdivided into intransitive and transitive verbs. Intransitive verbs do not take direct objects while transitive verbs do, as these two sets of examples show:

**Active Verbs**

<table>
<thead>
<tr>
<th>Intransitive verbs</th>
<th>Transitive verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>The rearrangement or division of a heavy nucleus may occur naturally (spontaneous fission) or under bombardment with neutrons.</td>
<td>The probability of an accident leading to the melting of the fuel core was estimated to be one chance in 20,000 reactor-years of operations.</td>
</tr>
<tr>
<td>The fuels used in ramjet engines burn in only a narrow range of fuel-air ratios.</td>
<td></td>
</tr>
</tbody>
</table>
Transitive verbs

The generation of electric energy by a nuclear power plant requires the use of heat to produce steam or to heat gases in order to drive turbogenerators.

In an auxiliary relay, when the applied current or voltage exceeds a threshold value, the coil activates the armature, which either closes the open contacts or opens the closed contacts.

The solar power satellite absorbs the energy in geosynchronous orbit.

In the photovoltaic solar power system, solar cells convert the light energy into electricity.

Linking Verbs

A linking verb is any form of the verb *to be* without an action verb; it sets up something like an equal sign between the items it links. Linking verbs of a sentence can be longer than one word:

<table>
<thead>
<tr>
<th>Linking Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>had been</td>
</tr>
<tr>
<td>would have been</td>
</tr>
<tr>
<td>was being</td>
</tr>
<tr>
<td>might have been</td>
</tr>
<tr>
<td>had to have been</td>
</tr>
<tr>
<td>will have been</td>
</tr>
</tbody>
</table>

A few linking verbs do not use *to be* but function like it:

- That word processing program seems adequate for our needs.
- This calculus problem looks difficult.
- Since the oil spill, the beach has smelled bad.
- He quickly grew weary of computer games.

Auxiliary Verbs

Auxiliary verbs *"help*" the main part of the verb. Here are some auxiliary verbs:

- By 1967, about 500 U.S. citizens had received heart transplants.
- Better immunosuppression management in transplant operations has yielded better results.
- Researchers have found propranolol to be effective in the treatment of heartbeat irregularities.

Modals

Modal verbs change the meaning of the verb in a variety of ways as illustrated in the examples below:

- Cracks in the welding can only be detected by x-rays.
- Liquid oxygen could have leaked into the turbine and cause the fire.
- The light metal fast-breeder reactor must be operated under extreme safety precautions.
Verbs are used together in a complex variety of tenses. In the chart below, keep in mind that "continuous" tenses are those that use -ing and "perfect" tenses are those that use some form of the auxiliary verb have.

<table>
<thead>
<tr>
<th>Variety of Tenses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple present</td>
<td>works</td>
</tr>
<tr>
<td>Present continuous</td>
<td>is working</td>
</tr>
<tr>
<td>Present perfect</td>
<td>has worked</td>
</tr>
<tr>
<td>Simple past</td>
<td>worked</td>
</tr>
<tr>
<td>Past continuous</td>
<td>was working</td>
</tr>
<tr>
<td>Past perfect</td>
<td>had worked</td>
</tr>
<tr>
<td>Simple future</td>
<td>will work</td>
</tr>
<tr>
<td>Future continuous</td>
<td>will be working</td>
</tr>
<tr>
<td>Future perfect</td>
<td>will have worked</td>
</tr>
<tr>
<td>Present perfect continuous</td>
<td>has been working</td>
</tr>
<tr>
<td>Past perfect continuous</td>
<td>had been working</td>
</tr>
<tr>
<td>Future perfect continuous</td>
<td>will have been working</td>
</tr>
</tbody>
</table>

**Adjectives**

An adjective provides more detail about a noun; that is, it modifies a noun. Adjectives occur just before the nouns they modify, or after a linking verb:

The armature is a rectangular ring about which another coil of wire is wound.

The generator is used to convert mechanical energy into electrical energy.

The steel pipes contain a protective sacrificial anode and are surrounded by packing material.

**Adverbs**

An adverb provides more information about a verb, adjective, or another adverb; that is, it "qualifies" the verb, adjective, or adverb:

The desk is made of an especially corrosion-resistant industrial steel.
The drilling bit actually tears rock apart to get at the oil.

The power company uses huge generators which are generally turned by steam turbines.

The debate over nuclear power has often been bitter.

## Conjunctions

Conjunctions link words, phrases, and whole clauses to each other and are divided into coordinating, adverbial, and subordinating conjunctions. In this list, only the list of coordinating conjunctions is complete.

### Conjunctions

<table>
<thead>
<tr>
<th>Coordinating conjunctions</th>
<th>Subordinating conjunctions</th>
<th>Adverbial conjunctions</th>
</tr>
</thead>
<tbody>
<tr>
<td>and</td>
<td>although</td>
<td>therefore</td>
</tr>
<tr>
<td>or</td>
<td>since</td>
<td>however</td>
</tr>
<tr>
<td>nor</td>
<td>because</td>
<td>in other words</td>
</tr>
<tr>
<td>but</td>
<td>when</td>
<td>thus</td>
</tr>
<tr>
<td>yet</td>
<td>while</td>
<td>then</td>
</tr>
<tr>
<td>for</td>
<td>if</td>
<td>otherwise</td>
</tr>
<tr>
<td>whereas</td>
<td>as if</td>
<td>nevertheless</td>
</tr>
<tr>
<td>as</td>
<td></td>
<td>on the other hand</td>
</tr>
</tbody>
</table>

### Coordinating Conjunctions

Coordinating conjunctions link words, phrases, and clauses. Here are some examples:

Nuclear-powered artificial hearts proved to be complicated, bulky, and expensive.

In the 1960s, artificial heart devices did not fit well and tended to obstruct the flow of venous blood into the right atrium.

The blood vessels leading to the device tended to kink, obstructing the filling of the chambers and resulting in inadequate output.

The small clots that formed throughout the circulatory system used up so much of the clotting factor that uncontrolled bleeding from external or internal injury became a risk.

Current from the storage batteries can power lights, but the current for appliances must be modified within an inverter.

### Adverbial Conjunctions

Adverbial conjunctions link two separate sentences, but require a semicolon or colon:

The Kedeco produces 1200 watts in 17 mph using a 16-foot rotor; on the other hand, the Dunlite produces 2000 watts in 25 mph winds.

The first artificial hearts were made of smooth silicone rubber which apparently caused excessive clotting and, therefore, uncontrolled bleeding.

(This example does not contain two sentences; no semicolon, therefore, is needed.) For short periods, the fibers were beneficial; however, the eventual buildup of fibrin on the inner surface of the device would impair its function.

The atria of the heart contributes a negligible amount of energy; in fact, the total power output of the heart is only about 2.5 watts.

### Subordinating Conjunctions
Subordinating conjunctions combine separate sentences in a different way: they turn one of the sentences into an adverb clause. Here are some examples of subordinating conjunctions:

The heart undergoes two cardiac cycle periods: a diastole, when blood enters the ventricles, and systole, when the ventricles contract and blood is pumped out of the heart.

Whenever an electron acquired enough energy to leave its orbit, the atom is positively charged.

If the wire is broken, electrons will cease to flow and current is zero.

**Phrases and Clauses**

Phrases and clauses are groups of words that act as a unit and perform a single function within a sentence. A phrase may have a partial subject or verb but not both; a dependent clause has both a subject and a verb (but is not a complete sentence). Here are a few examples (not all phrases are highlighted because some are embedded in others):

<table>
<thead>
<tr>
<th>Phrases</th>
<th>Clauses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity has to do with those physical phenomena involving electrical charges and their effects when in motion and when at rest. (Involving electrical charges and their effects is also a phrase.)</td>
<td>Electricity manifests itself as a force of attraction, independent of gravitational and short-range nuclear attraction, when two oppositely charged bodies are brought close to one another.</td>
</tr>
<tr>
<td>Electricity manifests itself as a force of attraction, independent of gravitational and short-range nuclear attraction, when two oppositely charged bodies are brought close to one another.</td>
<td>The symbol that denotes a connection to the grounding conductor is three parallel horizontal lines, each of the lower ones being shorter than the one above it.</td>
</tr>
<tr>
<td>In 1800, A. Volta constructed and experimented with the voltaic pile, the predecessor of modern batteries.</td>
<td>These studies led Planck to postulate that electromagnetic radiation is emitted in discrete amounts, called quanta.</td>
</tr>
<tr>
<td>In 1833, Faraday's experimentation with electrolysis indicated a natural unit of electrical charge, thus pointing to a discrete rather than continuous charge. (to a discrete rather than continuous charge is also a phrase.)</td>
<td>Since the frequency is the speed of sound divided by the wavelength, a shorter wavelength means a higher wavelength.</td>
</tr>
<tr>
<td>The symbol that denotes a connection to the grounding conductor is three parallel horizontal lines, each of the lower ones being shorter than the one above it.</td>
<td>Nuclear units planned or in construction have a total capacity of 186,998 KW, which, if current plans hold, will bring nuclear capacity to about 22% of all electrical capacity by 1995. (if current plans hold is a clause within a clause)</td>
</tr>
</tbody>
</table>

**Prepositional Phrases**

A prepositional phrase, composed of a preposition and its object, shows relationships involving time, direction, or space:

An artificial heart was installed in a human subject for the first time in 1969.

The current leads to the field coils and into an external circuit. Alternators are not compatible with wind systems because of their high rpm requirements.

The operation of a wind generator is based upon Faraday's law of induced voltage which states that the voltage between the ends of a loop of wire is proportional to the rate of change in the magnetic field lines within the loop. (four prepositional phrases in the last highlighted area.)

**Appositives**

An appositive, a word or phrase that renames a noun or pronoun, adds information about a noun but in a way different than do adjectives:
In 1972, Richard Nixon, president of the U.S., approved the development of a reusable space vehicle, the Space Shuttle.

Broad principles about space flight were laid down by the Austrian astronautical pioneer, Dr. Eugen Sanger.

The external tank of the Space Shuttle's main engines is composed of two tanks—a large hydrogen tank and a smaller oxygen tank.

An upper air inversion, a layer of stable air, is usually present over large areas of the tradewinds as a hurricane develops.

**Participial Phrases**

A participial phrase is a group of words acting as an adjective and modifying a noun or pronoun. A participle is the -ed or -ing form of a verb:

The Eagle Generator uses a 6-pole, shunt-wound generator designed to reach maximum power at 20 mph.

Because of the design created by Kwan-Gett, endothelial cells could grow on the fibrin layer, making the interior surfaces of the artificial heart similar to those of the natural heart.

The wire is wrapped around field cores made of steel laminations.

**Gerunds and Gerund Phrases**

Similar in appearance to a participial phrase, the gerund plays the role of noun. A gerund is a single word with -ing used as a noun. A gerund phrase is a single word with -ing accompanied by its objects, complements, and modifiers; it is a group of words acting as noun.

In the iron-core type transformer, the winding is wrapped around an iron bar.

The splitting of an atom produces a great amount of energy.

The cloning of a cell produces an identical cell.

Jarvik changed his artificial heart design in 1974 by fitting his model with a highly flexible three-layer diaphragm made of smooth polyurethane.

The Jarvik-7 design then in 1979 achieved a record time of sustaining life in a calf for 221 days.

Reversing the rotation of the electrohydraulic heart pump reverses the direction of the hydraulic flow.

**Adjective Clauses**

An adjective clause is almost a complete sentence—but not quite. It functions the same way a single-word adjective does: both modify, that is, add more information to our understanding of a noun. Adjective clauses contain (1) a relative pronoun, (2) in some cases, a subject, (3) a complete verb, and (4) any other accompanying predicates or objects.

Typically, one portable drilling rig, which requires two tug boats to bring it to the site, and several other boats are used in the exploratory drilling phase.

The company holds many patents on its wind energy systems, such as the flyball governor which varies the pitch of the blades in high winds and the slow-speed generator whose performance curve matches that of the propeller.

The idea of the artificial heart arose in part from the need to treat people who cannot receive a donor heart.

Nose designed a "biolized" heart in which the surfaces that came into contact with blood were made from natural tissues treated with chemical fixatives to make them tougher and immunologically inert. (an adjective clause within another adjective clause)
The regular CPR class people are taking everywhere now only lasts an evening.

Adverb Clauses

An adverb clause is also nearly a complete sentence; it functions like an adverb does by explaining the how, when, where, and why of the discussion. The adverb clause usually contains a subordinating conjunction, a subject, a complete verb, and any other related phrases or clauses:

Because the shortage in donor hearts is so severe, transplant surgery is limited to people with the best chances of surviving.

As long as the wind speed is sufficient, the electrical energy will be continuously generated.

If an oil spill occurs away from shore, it is unlikely to affect many birds, unless they are directly in a major migratory path at a migrating season.

Noun Clauses

A noun clause is a group of words used as a noun. Introduced by a relative pronoun, a noun clause can play any of the functions a noun plays: subject, direct object, object of preposition, subjective or object complement. Here are example noun clauses, with their functions labelled:

Estimates indicate that 20 million Americans owned hand-held calculators by 1974. (direct object)

Computer systems are often measured by how much main memory their architectures allow and by how fast that memory can be accessed. (object of preposition—two of them!)

Lemaitre proposed that all matter in the Universe was once concentrated into what he termed the primeval atom. (direct object; in this sentence, what he termed the primeval atom is also a noun clause.)

The choice of furnace wall construction depends on how sophisticated the gas-cleaning equipment is and on whether a large amount of waste is to be recovered. (object of preposition—two of them)

Most microcomputers use what are called flexible diskettes for program and data storage. (direct object)

The major disadvantage of sequential files is that they are slow. (subject complement)

Coordinated Elements

Many of the sentence elements described above can be "coordinated": that is, they can be doubled, tripled, or even quadrupled and linked with coordinating conjunctions like and and or. For example, in the phrase "a black and white Datsun 240Z," two adjectives are are coordinated. Here are some examples of coordinated sentence elements:

In 1800, A. Volta constructed and experimented with the voltaic pile, the predecessor of the modern battery. (two verbs)

Maxwell's theory not only synthesized theories about electricity and magnetism, but also showed optics to be a branch of electromagnetism. (two predicates)

Heat exchangers can be so designed that chemical reactions or energy-generation processes can be carried out in them. (two noun phrases)

Heat exchangers find wide applications in the chemical process industries, in the food industry, in the generation of steam for production of power and electricity, in aircraft and space vehicles, and in the field of cryogenics for low-temperature separation of gases. (nine total prepositional phrases)
Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Explain and apply essential punctuation rules.
2. Explain and apply essential grammar rules.
3. Explain and apply essential capitalization rules.
4. Explain and apply essential numbering rules.
5. Explain and apply essential symbol and abbreviation rules.

Common Grammar, Usage, and Punctuation Problems

In this chapter, we will cover only those grammar, punctuation, usage, and spelling problems that give people the biggest headaches.

Technical writing professionals try to simplify grammar rules as much as possible without hurting the language or putting themselves in straitjackets. Typically, they work in teams and frequently move in and out of projects—so that the same document may be worked on by different writers and editors during the space of just a few years. That's why any guidelines based on interpretation or personal style or judgment must be avoided.

Commas

Punctuation is a good example of this effort to use clearly defined rules in technical writing. In journalistic punctuation style, you punctuate according to what you feel are the needs for clarity. But punctuating that way is likely to be viewed differently by different people. Therefore, punctuation style in technical writing is based on the structure of the sentence.

Introductory Elements

Use a comma after all introductory elements. Any element, regardless of length, coming before the main clause should be punctuated with a comma. (The main clause is that core part of a sentence that makes it a complete sentence; that is, it expressed a complete thought.) Here are some examples:

When an atom acquires enough energy to leave its orbit, the atom is positively charged.

As for the energy required to produce plastic automobile parts, the auto makers view the additional cost as justified by the savings in petroleum by a lighter car during its lifetime.

Because the high-pressure turbopumps rotate at speeds of 30,000 rpm, the weight distribution on the turbine blades must be balanced with great accuracy.

Because there is no belt of doldrums in the Atlantic south of the equator, hurricanes do not usually occur there.

Between 40 and 50 degrees west and just south of 10 degrees north in the western end of the doldrums belt, calms do occur with frequency, and hurricanes originate there with great frequency.

In 1831, Michael Faraday discovered that if a magnet were moved in the vicinity of a coil, a current could be induced in the coil. (Punctuate even short introductory phrases like this one and the next two sentences.)

Using this concept, Faraday arrived at a relation between the changing flux and the induced electromagnetic field.

Today, the computer consortium of IBM, Motorola, and Apple is announcing its new PowerPC chip.
Unnecessary Commas

Double check commas between parts of a sentence. A single comma should never break the flow of the main subject, verb, and object or complement of a sentence. Instead, commas should occur in pairs. Here are some examples (the bracketed commas indicate where commas are typically but mistakenly placed):

The discovery that moving a magnet within a coil could produce current[,] was a major breakthrough in the history of electronics. (Yes, it's a long way from the subject “discovery” to the verb “was,” but there should be no comma.)

Decreasing the radar operating frequency[,] increases the effective velocity coverage for the same sampling rate. (The whole phrase “decreasing the radar operating frequency” is the subject of the verb “increases”—no comma.)

It can be assumed that[,] precipitation particles move with the air in their environment and are, therefore, good tracers for air motion. (Don't know why people would put a comma here—does it feel like a pause?)

The separator between black mix and the zinc electrode[,] consists of a paper barrier coated with cereal or methyl cellulose. (No comma here either.)

That European refuse incineration costs are substantially lower than U.S. costs[,] is particularly evident when income from by-product recovery and salvage operations is included. (The whole clause, "that European refuse incineration costs are substantially lower then U.S. costs," is the subject for the verb "is"—no comma.)

Compound Sentences

Use a comma between all independent clauses. Whenever you have a compound sentence (those are the ones joined by and, but, yet, or, not, for, whereas), put a comma before the conjunction (the words I just listed). The length of the compound sentence does not matter. Here are some examples:

The tank is made of aluminum, but the outer surface is protected by a spray-on foam.

By the mid-1970s, the free-spending ways of the Apollo program were gone, and NASA now had to grapple with large technical challenges on a limited budget.

It first appeared that Hurricane Betsy would reach the eastern U.S., but a looping path took her around the tip of Florida and into the Gulf instead.

Gamma rays produce few pairs, but they travel farther.

One grate turns at 50 mph, but the others turn at 15 mph.

Type your name, and then press the Enter key.

You should type your name and then press the Enter key. (In this case, "you" is the subject for the compound verb—"it's the subject for both "should type" and "press." This is not a compound sentence, and therefore there is no comma before "and." )

Compound Predicates

Do not use a comma between two compound verb phrases. Watch out about what you think are compound sentences. A complete sentence has to be on both sides of the conjunction (that means subject, verb, object, or complement—the works). Compare the following examples.

Offspring exposed to significant amounts of alcohol in utero are much more active than controls[,] and sometimes seem to fly around the room. (This is a compound verb phrase, not a compound sentence: "offspring" is subject for both verbs.)

Plastic parts are not weldable[,] and must be repaired by other methods.
The observation and measurement of such small frequency shifts require excellent radar frequency-stability characteristics that are not usually found in conventional radar, but can be added without a drastic increase in equipment costs.

Pulse Doppler radar effectively samples the backscattered signal at the radar repetition rate, and therefore can provide unambiguous Doppler frequency observations only in the frequency range allowed by the sampling rate.

The manganese dioxide used in batteries is usually obtained from natural ore (mainly from Gabon, Greece, and Mexico), but can be a synthetic product by chemical precipitation or by electrolytic methods.

The last three sentences above probably seem incredibly long to you and needy of commas at and but. Rather than break our rule (and remember it's not breaking the rule that matters; it's creating more and more exceptions that will drive us all crazy), why not split these into two sentences each as in the following?

The observation and measurement of such small frequency shifts require excellent radar frequency-stability characteristics that are not usually found in conventional radar. However, this same observation and measurement can be added without a drastic increase in equipment cost.

Pulse Doppler radar effectively samples the backscattered signal at the radar repetition rate. This type of radar therefore can provide unambiguous Doppler frequency observations only in the frequency range allowed by the sampling rate.

The manganese dioxide used in batteries is usually obtained from natural ore (mainly from Gabon, Greece, and Mexico). It can also be a synthetic product prepared by chemical precipitation or electrolytic methods.

**Nonrestrictive Elements**

Use commas around all nonrestrictive elements. Nonrestrictive elements are phrases and clauses that are nonessential to the grammar of the sentence. These elements can be taken out of the sentence without hurting its basic message. Use commas around these nonrestrictive elements. Here are some examples:

Eighty percent of the work done by the heart is carried out by the left ventricle, which pumps blood into the arteries serving the organs and the tissues. (Nice of the writer to remind us what the left ventricle does, but the sentence could live without it; it would still make sense.)

The test produced a speed in the high-pressure hydrogen turbopump of 7000 ROM, which is 19 percent of the design speed. (This detail is additional and not essential to the sense of the sentence.)

The Coriolis force, caused by the rotation of the earth, always acts at right angles to the pressure gradient in the northern hemisphere. (This definition is helpful but again is not essential to the sentence.)

The bulky equipment, although placed on a rolling cart, must always remain within six feet of the heart transplant patient. (Nonessential stuff—put commas around it!)

The formation of hurricane, a type of atmospheric vortex, involves the combined effect of pressure and circular wind.

Researchers also found that heavy drinkers—women drinking at least 1.6 ounces of absolute alcohol during pregnancy—have infants averaging 59 grams less than the infants of lighter drinkers. (Nonessential stuff—put commas around it, or in this case dashes, which are commas by another name.)

Adding waterproofing material to a fabric increases the contact angle, making the fabric water-repellent. (Nonessential stuff—put commas around it!)

Molecules may also have some degree of ordering as well as disordered motion, in which case the total energy is the sum of the mechanical and thermal energies. (Nonessential stuff—put commas around it!)

**Restrictive Elements**
Do not use commas around restrictive elements. Restrictive elements are phrases and clauses that a sentence desperately needs to make sense, to say what it means to say. If you take restrictive elements out of a sentence, you wreck the sentence!

<table>
<thead>
<tr>
<th>Problem:</th>
<th>You can use the system[,] when the login prompt appears.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(The way this sentence is punctuated implies that you can use the system any old time! The comma indicates that the clause beginning with &quot;when&quot; can be lifted from the sentence.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Revision:</th>
<th>You can use the system when the login prompt appears.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(The clause beginning with &quot;when&quot; is restrictive—it can't be omitted from the sentence and therefore should not be punctuated. Now the sentence means that you can use the system only when the prompt appears.)</td>
</tr>
</tbody>
</table>

Here are some additional examples of this rather tricky rule.

A turbopump is essentially a pump that is turned by the action of a turbine that shares a common shaft with the pump. (It's not any old pump; it's the one that does what the latter part of this sentence says it does. Imagine this sentence ending at "essentially a pump.")

Eighty percent of the work done by the heart is carried out by the left ventricle. (Imagine this sentence without "done by the heart," which is the restrictive element in this sentence. No commas here!)

A drop of water almost flattens out when it is placed on a glass plate. (Imagine this sentence without "when it is placed on a glass plate," which is the restrictive element here. No commas need apply!)

In one study, 11 percent of the offspring whose mothers consumed 2 to 4 drinks per day showed partial features of fetal alcohol syndrome (FAS), while 19 percent of those whose mothers consumed 4 or more drinks per day showed FAS features. (Imagine this sentence without "whose mothers consumed 2 to 4 drinks per day" or without "whose mothers consumed 4 or more drinks per day." The sentence simply wouldn't make any sense. No commas!)

**Series Elements**

Use a comma before the "and" in a series of three or more. In a series of three or more words or phrases, go ahead and put the comma before the and that occurs before the final element. You may have heard that this series-and comma rule is optional. However, there are situations where the lack of the series-and comma (also known as the Oxford comma) can cause confusion. And when you consider that using the Oxford comma can hurt the sense of the sentence, it makes sense to use it in all cases. Here are some examples:

Instrument panels, bumper components, door liners, seat covers, and grille panels are the most common parts produced directly by automakers.

A 12-ounce can or beer, a 5-ounce glass of wine, and a mixed drink with 1.5 ounces of 80-proof liquor all contain approximately the same amount of alcohol.

The development years involved designing the components for the Space Shuttle's engines, testing the original designs, and retesting the redesigned components.

In humans, the period of rapid brain development begins at mid-pregnancy, peaks in the third trimester, and ends by the postnatal year.

**Two-element Series**

Do not use a comma between a series of only two. Be careful not to apply the Oxford comma rule to a series of only two elements. Watch out also for those situations where it looks like you have a series of three elements, but it is actually a series of two noun phrases and a compound verb phrase. See the example:
We brought bread and cheese and read poetry. (Sorry for the Dick-and-Jane sentence, but notice that "bread," "cheese," and "poetry" are not really in a series. No commas for either "and" here.

**Series Adjectives**

Punctuate series adjectives carefully. It gets tricky knowing how to punctuate when two or more adjectives pile up in front of a noun. One fairly reliable technique is this: if you can switch the order of the adjectives or if you can insert *and* between them without making the phrase sound weird, then you can consider using commas. (Remember that in no case is there a comma between the final series adjective and the noun it modifies.)

He's having his third mid-life crisis. Now he wants a new red sports car. (You couldn't say "mid-life third crisis" nor could you say "sports red new car"--so no commas in or amongst these adjectives.)

Each door is held shut with an adjustable, spring-loaded door latch. (You probably could switch "adjustable" and "spring-loaded"--use a comma here.)

As each rack passes through the wash chamber, the dishes get a thorough soil-stripping wash and a final, automatic hot-water rinse. (You probably could switch "final" and "automatic"--use a comma here.)

These last two examples may have felt a bit "iffy" to you--the technique is only "fairly" reliable.

**Colons**

Although the colon has other uses in writing, its most important function is to act as a signal to the reader--it says something like "Okay, reader! Here it comes!" In the first example, notice the words before the colon make a complete statement--at least grammatically.

To make a kite, you need the following items: string, paper, thin sticks, glue, and scissors.

The main engines of the Space Shuttle consist of six main components: the external tank, the low-pressure turbopump, the high-pressure turbopumps, the preburners, the combustion chamber, and the nozzle.

Hurricane size is expressed in three ways: the strength of the maximum winds, the diameter of the hurricane-force winds, the diameter of the gale-force winds, and the overall size the cyclone circulation.

To make a metal dashboard, three steps are required: (1) the metal must be stamped; (2) the texture must be stamped into the metal; and (3) the part must be painted.

Notice in the last example that the first sentence introduces a series of complete sentences. You can use the colon to connect two complete sentences--as long as the first sentence introduces or prepares for the second. Here are some examples of this possibility:

The grades of the students in the caffeine research project told a dramatic story: the higher the caffeine intake, the lower the grades, both for semester and overall grade point average.

In general, shelf-life increases as the cell size of the battery becomes smaller: with well-constructed cells, shelf-lives of three years with a No. 6 telephone cell and ten years with a penlight cell are possible.

The line-of-sight in a communication satellite can be a problem: communication satellites can see the earth's surface only between about 83 degrees north latitude and 83 degrees south latitude.

Many of the new applications of microcomputer are "interactive": there is frequent interaction between the computer and one or more users.
However, don't use a colon inside a complete sentence. It should connect only complete sentences to complete sentences or connect complete sentences to lists.

<table>
<thead>
<tr>
<th>Problem</th>
<th>The typical Doppler velocity sensor consists of a transistor, an antenna, and a receiver.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision</td>
<td>The typical Doppler velocity sensor consists of a transistor, an antenna, and a receiver.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem</th>
<th>Three significant types of generating plants are hydroelectric, fossil-fuel-electric, and nuclear-electric.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision</td>
<td>Three significant types of generating plants are hydroelectric, fossil-fuel-electric, and nuclear-electric.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem</th>
<th>You will need string, paper, thin sticks, glue, and scissors, to make a kite.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision</td>
<td>You will need the following items--string, paper, thin sticks, glue, and scissors--to make a kite.</td>
</tr>
</tbody>
</table>

Look at this last example closely: the grammatical core of the sentence is "You will need the following items...to make a kite." You don't want to break up the core grammar of a sentence this way with a colon.

**Semicolons**

The semicolon could be called a strong comma. Its two main uses are to connect two (or more) sentences that seem very closely related and to clarify the punctuation of a series of items that have their own internal commas.

You may have had some unhappy encounters with run-ons and comma splices in the past. These two "comma faults" usually result from the writer's sense that the sentences involved in the problem are very closely related--the full stop signaled by the period seems like too full of a stop. (It's almost like music; makes you wonder why we don't have the equivalent of whole, half, quarter, and eighth rests in punctuation.) Often, these run-on sentences and comma splices can be fixed by substituting a semicolon for the offending comma.

But not always. Some writers go way overboard in sensing close relations between sentences. Well, yes, every sentence in a document is related to every other--they ought to be! But they need to be reeeaaally closely related. Here are some examples:

"Plaque-fissuring" refers to the formation of an opening from the lumen to the intima; it leads to an intra-intimal thrombus containing not just red cells but mainly firbrin and platelets.

In 1940, philanthropy accounted for 24 per cent of the total operating budget of nonprofit hospitals in New York City; in 1948, it had dropped to 17 per cent.

Gray mold is one of the most important fungal diseases in Italian viticulture; its growth causes serious production losses and adversely affects wine quality.

The other use of the semicolon worth noting here is how it can clarify items in a series that have commas within them already:

Injury caused by pollutants can easily be mistaken for injury caused by other stresses; or, just the opposite, injury symptoms from adverse temperature or moisture relations may resemble, and can be incorrectly attributed to, air pollutants.

Possible research areas announced recently have included genetics, fermentation microbiology, and immobilized biocatalysts; but environment biotechnology, such as metal recovery and waste recycling, is also included.
A typical membrane potential of about one-tenth of a volt sounds relatively small; but, because it occurs across a membrane that is only about 10 nanometers thick, it represents an enormous voltage gradient of about 10 million volts per meter.

The heart undergoes two cardiac cycle periods: diastole, when blood enters the ventricles; and systole, when the ventricles contract and blood is pumped out.

An organization may be functional, with responsibility assigned on the basis of buying, selling, promotion, distribution, and other tasks; production-oriented, with production managers for each product category and brand managers for each individual brand in addition to functional categories; or market-oriented, with managers assigned on the basis of geographical markets and customer types in addition to functional categories.

Electric power substations are used for some or all of the following purposes: connection of generators, transmission or distribution lines, and loads to each other; transformation of power from one voltage level to another; interconnection of alternate sources of power; and detection of faults, monitoring and recording of information, power measurement, and remote communication.

A common misuse of the semicolon is to plunk it down between what appear to be two complete sentences:

| Problem: | The slide rule was an important device for scientists and engineers for many years; although its use has all but vanished since the advent of the pocket calculator. |
|Revision: | The slide rule was an important device for scientists and engineers for many years, although its use has all but vanished since the advent of the pocket calculator. |

(The "although" clause is not complete; it can't stand on its own.)

**Apostrophes**

Pity the poor apostrophe—it's practically an endangered species. The problem with the apostrophe is that it has some conflicting tasks: it is used primarily to show possession, mark contractions, and, minimally, to show plurals. But people have gotten it all mixed up. For example, the likes of "John love's Mary" was becoming pretty common in telephone booths before the rise of the cell phone. A scant two or three hundred years ago, people didn't even use apostrophes (yes—a world without apostrophes!). But the thing does add precision to writing; it does prevent confusion. The rules are super simple; here they are:

**To show possession for singular words not ending in s, add 's**

<table>
<thead>
<tr>
<th>Earth's shadow</th>
<th>the fish's ear</th>
</tr>
</thead>
<tbody>
<tr>
<td>the Moon's orbit</td>
<td>India's population</td>
</tr>
<tr>
<td>this company's profits</td>
<td>the family's car</td>
</tr>
</tbody>
</table>

**To show possession for singular words ending in s, x, or z; add 's or just an '**

<table>
<thead>
<tr>
<th>Venus's (or Venus') orbit</th>
<th>Mars's (or Mars') shadow</th>
<th>the box's (or box') flap</th>
</tr>
</thead>
<tbody>
<tr>
<td>James's (or James') calculator</td>
<td>tennis's (or tennis') popularity</td>
<td>the fez's (or fez') tassle</td>
</tr>
</tbody>
</table>
To show possession for plural words ending in s, add ’ to the plural form of the word (but don’t add another s)

<table>
<thead>
<tr>
<th>these companies’ employees</th>
<th>planets’ orbits</th>
</tr>
</thead>
<tbody>
<tr>
<td>these species' niches</td>
<td>these countries' populations</td>
</tr>
<tr>
<td>southern states’ capitals</td>
<td>these computers’ capabilities</td>
</tr>
</tbody>
</table>

To show possession for plural words not ending in s, add ‘s

<table>
<thead>
<tr>
<th>women's rights</th>
<th>men's rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>children's education</td>
<td>geese's honking</td>
</tr>
</tbody>
</table>

To show the plural of numbers or letters when they are discussed as such, add 's (again usage varies on this, but this is a safe choice)

Do you know how many c's and s's are in the word ne-e-ry?

On a computer, O's are represented by O's and 0's with 0's.

His speech was filled with annoying uh’s, okay’s, and you know’s.

To show possession for possessive pronouns, don’t use the apostrophe (don’t ask me why)

This book is yours.

This CRT is theirs, not ours.

And, now, everybody’s personal favorite—the one that English teachers and copyeditors can spot from outer space—the rules for its and it’s. Its is the possessive form of it; it’s is the contraction for it is (exactly opposite, I realize)

The SGO density gauge is missing one of its adjusting knobs.

It’s unfortunate that our language has so many exceptions to its rules—or is it?
Now, there are others rules involving apostrophes such as for contractions or for quotes within quotes, but we'll leave those for the reference books to handle.

**Hyphens**

Someone once said, "Take hyphens seriously, and you will surely go mad." They weren't lying!

Hyphens are supposed to keep us from misreading things and show us how words in complex phrases relate to each other. The problem is that the rules for hyphens just cannot be applied absolutely consistently—you end up hyphenating everything including the kitchen sink. Professional editors end up keeping long lists of exactly which word pairs they will hyphenate in a specific document (so that they don't end up in therapy).

Hyphens do matter, however (save the hyphen!). Our language culture seems to be very "into" piling up ambitious noun phrases. These sentences verge on having a problem called "noun stacks." To read this kind of stuff, we need hyphens—they show us what goes with what. Hyphens show that a pair of words is acting as a unit and must be read that way. The common types of unit modifiers—which are two or more words acting as a unit—are discussed in the following (but it's by no means exhaustive):

Although styles vary on this, do not hyphenate the common prefixes such as pre, anti, multi, and so on (unless it spells some other word or just looks hopelessly weird). However, do hyphenate prefix words such as self-

<table>
<thead>
<tr>
<th>self-lubricating hinges</th>
<th>nonprescription drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>multistep reaction</td>
<td>precooked foods</td>
</tr>
<tr>
<td>antibotulism agent</td>
<td>mid-1970s</td>
</tr>
<tr>
<td>nonmalarial areas</td>
<td>micro-universe</td>
</tr>
<tr>
<td>reusable</td>
<td>subnuclear</td>
</tr>
<tr>
<td>re-sent</td>
<td>anti-icing</td>
</tr>
</tbody>
</table>

Hyphenate a unit modifier ("5-year" in the first example) made up of a number followed by a unit of measurement

<table>
<thead>
<tr>
<th>5-year grant</th>
<th>10-month period</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-megabyte memory</td>
<td>3.5-inch diskette</td>
</tr>
<tr>
<td>8-oz. cup</td>
<td>4-gallon tub</td>
</tr>
</tbody>
</table>

Hyphenate an elliptical form of a longer phrase that is acting as a unit modifier

<table>
<thead>
<tr>
<th>below-average rainfall</th>
<th>warm-up period</th>
</tr>
</thead>
<tbody>
<tr>
<td>built-in scale</td>
<td>on-board timer</td>
</tr>
<tr>
<td>start-up costs</td>
<td>pay-off period</td>
</tr>
<tr>
<td>in-service accuracy</td>
<td>written-out number</td>
</tr>
<tr>
<td>immune-deficient animals</td>
<td></td>
</tr>
</tbody>
</table>

Hyphenate a non-verb element and a verb-like element acting as a unit

<table>
<thead>
<tr>
<th>drought-producing system</th>
<th>water-repellent fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>coffee-flavored ice cream</td>
<td>nutrient-rich waters</td>
</tr>
<tr>
<td>government-sponsored programs</td>
<td>corrosion-resistant metal</td>
</tr>
<tr>
<td>pressure-induced melting</td>
<td>water-soluble reactants</td>
</tr>
<tr>
<td>spring-balanced doors</td>
<td>salt-free diet</td>
</tr>
<tr>
<td>health-related costs</td>
<td>caffeine-containing substances</td>
</tr>
</tbody>
</table>
Common Grammar, Usage, and Punctuation Problems

Watch out for three or more words acting as a unit to modify a following noun

<table>
<thead>
<tr>
<th>case-by-case basis</th>
<th>a three-to-one ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>the right-to-die statutes</td>
<td>the air-to-ground voice transmission</td>
</tr>
<tr>
<td>on-the-job experience</td>
<td></td>
</tr>
</tbody>
</table>

Don't hyphenate units in which the first word ends in -ly

| highly developed country | fully equipped computer |

The toughest area for hyphenation are those combinations that look like adjective + noun + noun or like noun + noun + noun. (True, only the last noun is really a noun, but let's not worry about that.) If the initial adjective or noun modifies the final (and real) noun, do not use a hyphen. If the initial adjective or noun modifies the noun directly following it, consider using a hyphen.

<table>
<thead>
<tr>
<th>embryonic stem cells</th>
<th>poor economic performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>high process yields</td>
<td></td>
</tr>
</tbody>
</table>

These examples do not need a hyphen

These examples could use hyphens according to some styles

<table>
<thead>
<tr>
<th>cell-replacement strategies</th>
<th>cell-surface markers</th>
</tr>
</thead>
<tbody>
<tr>
<td>big-name automakers</td>
<td>large-scale production</td>
</tr>
</tbody>
</table>

If you are in doubt about whether to use a hyphen, don't use it. The best resource on hyphens is Garner's Modern American Usage; "Phrasal adjectives."

Once you get a partial feel for hyphens, watch out! You might start acting like Lucy in that show where she has been on the assembly line too long and starts going after everything and everybody with her wrenches. Everything will seem like it needs a hyphen! When that happens, back off, and ask yourself—could someone misread this sentence without a hyphen, even if they were just being mean? If it positively cannot be misread, then give your hyphen key a break.

Comma Splices and Run-ons

The comma-splice and run-on sentence (and the fused sentence, as a variant is called) are all examples of the problem in which two or more sentences are improperly joined. In the typical comma-splice sentence, two sentences are joined by a comma without an intervening coordinating conjunction (and, or, nor, but, yet). Technically, the run-on sentence is a sentence that goes on and on and needs to be broken up; it's likely to be a comma splice as well. A fused sentence is two complete sentences just jammed together without any punctuation and without any conjunction.

We write comma-splice and run-on sentences because we sense that the sentences involved are closely related—a full-stop period just doesn't seem right. Actually, the semicolon is the right choice in these situations (although it's easy to go semicolon crazy when you first start using them). Here are some examples of this type of problem and their revisions:
### Examples

<table>
<thead>
<tr>
<th>Problem</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sometimes, books do not have the most complete information, it is a good idea then to look for articles in specialized periodicals.</td>
<td>Sometimes, books do not have the most complete information; it is a good idea then to look for articles in specialized periodicals.</td>
</tr>
<tr>
<td>Most of the hours I've earned toward my associate’s degree do not transfer, however, I do have at least some hours the University will accept.</td>
<td>Most of the hours I've earned toward my associate’s degree do not transfer. However, I do have at least some hours the University will accept.</td>
</tr>
<tr>
<td>The opposite is true of stronger types of stainless steel, they tend to be more susceptible to rust.</td>
<td>The opposite is true of stronger types of stainless steel: they tend to be more susceptible to rust.</td>
</tr>
<tr>
<td>Some people were highly educated professionals, others were from small villages in underdeveloped countries.</td>
<td>Some people were highly educated professionals, while others were from small villages in underdeveloped countries.</td>
</tr>
<tr>
<td>This report presents the data we found concerning the cost of the water treatment project, then it presents comparative data from other similar projects.</td>
<td>This report first presents the data we found concerning the cost of the water treatment project and then comparative data from other similar projects.</td>
</tr>
</tbody>
</table>

### Fragments

Fragments are simply incomplete sentences—grammatically incomplete. They usually come about because the sentence may already seem too long. Also, in conversation, we typically speak in fragments. Here are some examples and their revisions:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary appeared at the committee meeting last week. And made a convincing presentation of her ideas about the new product.</td>
<td>Mary appeared at the committee meeting last week and made a convincing presentation of her ideas about the new product.</td>
</tr>
<tr>
<td>The committee considered her ideas for a new marketing strategy quite powerful. The best ideas that they had heard in years.</td>
<td>The committee considered her ideas for a new marketing strategy quite powerful, the best ideas that they had heard in years.</td>
</tr>
<tr>
<td>In a proposal, you must include a number of sections. For example, a discussion of your personnel and their qualifications, your expectations concerning the schedule of the project, and a cost breakdown.</td>
<td>In a proposal, you must include a number of sections: for example, a discussion of your personnel and their qualifications, your expectations concerning the schedule of the project, and a cost breakdown.</td>
</tr>
<tr>
<td>The research team has completely reorganized the workload. Making sure that members work in areas of their own expertise and that no member is assigned proportionately too much work.</td>
<td>The research team has completely reorganized the workload. They made sure that members work in areas of their own expertise and that no member is assigned proportionately too much work.</td>
</tr>
<tr>
<td>She spent a full month evaluating his computer-based instructional materials. Which she eventually sent to her supervisor with the strongest of recommendations.</td>
<td>She spent a full month evaluating his computer-based instructional materials. Eventually, she sent the evaluation to her supervisor with the strongest of recommendations.</td>
</tr>
<tr>
<td>The corporation wants to begin a new marketing push in educational software. Although the more conservative executives of the firm are skeptical.</td>
<td>Although the more conservative executives of the firm are skeptical, the corporation wants to begin a new...</td>
</tr>
</tbody>
</table>
Problem modifiers

Modifier problems occur when the word or phrase that a modifier is supposed to modify is unclear or absent, or when the modifier is located in the wrong place within the sentence. A modifier is any element—a word, phrase, or clause—that adds information to a noun or pronoun in a sentence. Modifier problems are usually divided into two groups: misplaced modifiers and dangling modifiers:

**Examples**

<table>
<thead>
<tr>
<th>Misplaced modifiers</th>
<th>They found out that the walkways had collapsed on the late evening news. <em>(Was that before or after sports?)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The committee nearly spent a hundred hours investigating the accident. <em>(Did they spend even a minute?)</em></td>
</tr>
<tr>
<td></td>
<td>The supervisor said after the initial planning the in-depth study would begin. <em>(Just when did she say that, and when will the study begin?)</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dangling modifiers</th>
<th>Having damaged the previous one, a new fuse was installed in the car. <em>(Who damaged that fuse?)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After receiving the new dumb waiter, household chores became so much easier in the old mansion. <em>(Who received the dumb waiter?)</em></td>
</tr>
<tr>
<td></td>
<td>Using a grant from the Urban Mass Transportation Administration, a contraflow lane was designed for I-45 North. <em>(Who used that money?)</em></td>
</tr>
<tr>
<td></td>
<td>Pointing out the productivity and health problems plaguing US workers, aerobic fitness programs may become much more common in American industry, according to the spokeswoman. <em>(Who pointed that out?)</em></td>
</tr>
</tbody>
</table>

To correct misplaced modifier problems, you can usually relocate the misplaced modifier (the word or phrase). To correct dangling modifiers, you can rephrase the dangling modifier, or rephrase the rest of the sentence that it modifies.

**Examples**

<table>
<thead>
<tr>
<th>Revisions</th>
<th>On the late evening news, we heard that the walkways had collapsed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The committee spent nearly a hundred hours investigating the accident.</td>
</tr>
<tr>
<td></td>
<td>The supervisor said that the in-depth study would begin after the initial planning.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Because the previous fuse had been damaged, a new one had to be installed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>or</td>
<td>Having damaged the previous one, I had to install a new fuse in my car.</td>
</tr>
<tr>
<td></td>
<td>After we received the dumb waiter, it was immediately installed.</td>
</tr>
<tr>
<td>or</td>
<td>After receiving the dumb waiter, we immediately installed it.</td>
</tr>
<tr>
<td></td>
<td>When the Urban Mass Transportation Administration granted funds to the city, planners began designing a contraflow lane for I-45 North.</td>
</tr>
</tbody>
</table>

https://softchalkcloud.com/lesson/files/djw2WRgO9LVES/5_8GrammarUsagePunctuation_print.html
or

Using a grant from the Urban Mass Transportation Administration, city planners designed a contraflow lane for I-45 North.

Because of the productivity and health problems plaguing US workers, aerobic fitness programs may become much more common in American industry, according to the spokeswoman.

or

Pointing out the productivity and health problems plaguing US workers, the spokeswoman said that aerobic fitness programs may become much more common in American industry.

One particularly effective way to correct dangling modifiers is to create a summary appositive, that is, a noun or pronoun summarizing what was just said followed by an adjective clause:

<table>
<thead>
<tr>
<th>Dangling modifier problems</th>
<th>Summary appositive revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stars that were formed relatively recently should have higher concentrations of heavy elements than do the older stars, which is confirmed by observation.</td>
<td>Stars that were formed relatively recently should have higher concentrations of heavy elements than do the older stars, a prediction that is confirmed by observation.</td>
</tr>
<tr>
<td>Most astronomers now believe that the energy of quasars comes from giant black holes in the cores of the quasars, which fits the growing belief that black holes are present in the cores of many galaxies, our own included.</td>
<td>Most astronomers now believe that the energy of quasars comes from giant black holes in the holes of quasars, a theory that fits the growing belief that black holes are present in the cores of many galaxies, our own included.</td>
</tr>
</tbody>
</table>

**Parallelism**

Parallelism refers to the way that items in a series are worded. You want to use the same style of wording in a series of items—it makes it easier on the reader. Widely varied wording is distracting and potentially confusing to readers. Here are some examples, with revisions and some comments:

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
</tr>
<tr>
<td>The report discusses <strong>how telescopes work, what types are available, mounts, accessories, and techniques</strong> for beginning star gazers. <em>(The &quot;how&quot; and the &quot;why&quot; clauses are not parallel to the &quot;mounts,&quot; &quot;accessories,&quot; and &quot;techniques&quot; phrases.)</em></td>
</tr>
<tr>
<td><strong>Revision</strong></td>
</tr>
<tr>
<td>The report discusses how telescopes work; what types of telescopes, mounts, and accessories are available; and how to begin your hobby as a star gazer.</td>
</tr>
<tr>
<td><strong>Problem</strong></td>
</tr>
<tr>
<td>Customers often call the showroom <strong>to inquire about pricing, what items are available, and to place orders.</strong> <em>(The &quot;what items are available&quot; clause does not go with the two phrases beginning with &quot;to.&quot;)</em></td>
</tr>
<tr>
<td><strong>Revision</strong></td>
</tr>
<tr>
<td>Customers often call the showroom to inquire about prices, check on the availability of certain items, and place orders.</td>
</tr>
<tr>
<td><strong>Problem</strong></td>
</tr>
<tr>
<td>While the dialysis solution remains in the peritoneal cavity, the dialysis is achieved, a process that includes <strong>the removal of nitrogenous wastes and correcting electrolyte imbalances and fluid overloads.</strong> <em>(The &quot;removal&quot; phrase and the &quot;correcting&quot; phrase are not parallel to each other.)</em></td>
</tr>
<tr>
<td><strong>Revision</strong></td>
</tr>
<tr>
<td>While the dialysis solution remains in the peritoneal cavity, the dialysis is achieved, a process that includes the removal of nitrogenous wastes and the correction of electrolyte imbalances and fluid overloads.</td>
</tr>
</tbody>
</table>
Problem | This report is intended for people with some electronics background but have little or no knowledge of geophysical prospecting. (The "with" phrase is not parallel with the "have little" clause—this one is not even grammatical.)
---|---
Revision | This report is intended for people with some electronics background but with little or no knowledge of geophysical prospecting.

Parallelism problems have to do when same types of phrasing are not used in the same areas of a document: such as for list items in a vertical list, or for all headings at a certain level within a specific part of a document. At times, working on parallelism of phrasing is pedantic and unnecessary. However, in many instances, parallel phrasing can give readers important cues about how to interpret information. A jumble of dissimilar styles of phrasing for similar elements can be confusing. Shown below are those different styles:

### Styles of Phrasing

#### Questions

- How are groundwater samples collected?
- How should soil samples be handled?
- Must monitor wells be used to collect groundwater for laboratory analysis?
- What should the samples be analyzed for?

#### Noun Phrasing

- Method of groundwater sample collection
- Soil sample handling
- Purpose of monitor wells in groundwater collection for laboratory analysis
- Purpose of soil sample analysis

#### Gerund Phrasing

- Collecting groundwater samples
- Handling soil samples
- Using monitor wells in groundwater collection for laboratory analysis
- Analyzing samples

#### Sentences

- Groundwater samples must be collected properly.
- Soil samples must be handled using the specified method.
- Monitor wells must be used to collect groundwater for laboratory analysis.
- Samples must be analyzed for specific elements.

#### Infinitives

- To collect groundwater samples
- To handle soil samples
- To use monitor wells in groundwater collection for laboratory analysis
- To analyze samples

#### Imperatives

- Collect groundwater samples.
- Handle soil samples properly.
- Use monitor wells in groundwater collection for laboratory analysis.
- Analyze samples.

### Subject-verb agreement

With subject-verb agreement problems, either a singular subject is matched with a plural verb, or vice versa. (Remember that some singular verbs end in -s.) Sometimes it's hard to spot the true subject, particularly in these cases:

#### When several words come between the subject and verb

<table>
<thead>
<tr>
<th>Agreement problems</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The communications between the programmer and the rest of the company tends to be rather informal.</td>
<td>The communications between the programmer and the rest of the company tend to be rather informal.</td>
</tr>
<tr>
<td>The purpose of the monorails have changed from one of carrying food to one of carrying people to work in crowded urban areas.</td>
<td>The purpose of the monorails has changed from one of carrying food to one of carrying people to work in crowded urban areas.</td>
</tr>
<tr>
<td>The shortage of available infants and the availability of children with special needs has changed the focus of adoption for many parents.</td>
<td>The shortage of available infants and the availability of children with special needs have changed the focus of adoption for many parents.</td>
</tr>
</tbody>
</table>

#### When there are two or more subjects joined by and or or

<table>
<thead>
<tr>
<th>Agreement problems</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the computer’s memory is stored the program and the data to be manipulated by that program.</td>
<td>In the computer's memory are stored the program and the data to be manipulated by that program.</td>
</tr>
<tr>
<td>Either BASIC or Pascal are the high-level computer</td>
<td>Either BASIC or Pascal is the high-level computer</td>
</tr>
</tbody>
</table>

https://softchalkcloud.com/lesson/files/djw2WRgOQ9LVES/5_GrammarUsagePunctuation_print.html
- Skyscraping charges for data preparation, the need to keep pace with rapidly increasing amounts of data, and requirements for fast system response have led to a search for more efficient input devices.

- The magnetic-ink character-recognition device and the optical character-recognition device are two important advances in the preparation of batch input.

---

<table>
<thead>
<tr>
<th>Agreement problems</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the computer's memory is stored the program and the data to be manipulated by that program.</td>
<td>In the computer's memory are stored the program and the data to be manipulated by that program.</td>
</tr>
<tr>
<td>Introduced in 1968 by the Computer Machine Corporation was the concept of key-to-disk processing and the concept of shared processing.</td>
<td>Introduced in 1968 by the Computer Machine Corporation were the concept of key-to-disk processing and the concept of shared processing.</td>
</tr>
<tr>
<td>Equivalent to more than 3000 punched cards are the single diskette, first introduced in 1972.</td>
<td>Equivalent to more than 3000 punched cards is the single diskette, first introduced in 1972.</td>
</tr>
<tr>
<td>Through the center of the core runs several sense wires.</td>
<td>Through the center of the core run several sense wires.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Agreement problems</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each of the steps in the process are treated in a separate chapter of this report.</td>
<td>Each of the steps in the process is treated in a separate chapter of this report.</td>
</tr>
<tr>
<td>Neither of the two high-level languages offer a facility for designing your own variables.</td>
<td>Neither of the two high-level languages offers a facility for designing your own variables.</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Agreement problems</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printing 54,000 chars. per 60 seconds were considered a high speed for printers at one time.</td>
<td>Printing 54,000 chars. per 60 seconds was considered a high speed for printers at one time.</td>
</tr>
<tr>
<td>Reversing the direction of currents through the wires change the magnetic state of the core.</td>
<td>Reversing the direction of currents through the wires changes the magnetic state of the core.</td>
</tr>
<tr>
<td>What is truly amazing about bits cells in integrated circuits are that 30 cells lined up side by side are about as wide as a human hair.</td>
<td>What is truly amazing about bits cells in integrated circuits is that 30 cells lined up side by side are about as wide as a human hair.</td>
</tr>
</tbody>
</table>

---

**Pronoun reference**

Pronoun reference is an area that has caused international conflict and created major rifts in the women's movement—so don't expect this little section to explain it all. A pronoun, as you may know, is a word like "he," "they," "him," "them," "which," "this," "everyone," "each," and so on. It's like a variable in programming—it points to some other word that holds its meaning.

Problems arise when you can't figure out what the pronoun is pointing to (its "reference") and when it doesn't "agree" in number or gender with what it is pointing to. You may have experienced the first type of problem: you're reading along in some incredibly technical thing, and it up and refers to something as "this." You look back up at the sea of words you have just laborediously reading through—you say "this what?!" You have just experienced one form of the pronoun-reference problem.

---

Example

https://softchalkcloud.com/lesson/files/djw2WRgOQ9LVES/5_BGrammarUsagePunctuation_print.html
Agreement problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lasers have also been used to study the reaction by which nitric oxide and ozone make nitrogen dioxide (NO2) and molecular oxygen. It plays an important role in the chemistry of the ozone layer that surrounds the earth and protects us from the sun's harmful ultraviolet radiation. (&quot;It&quot; what?)</td>
<td>Lasers have also been used to study the reaction by which nitric oxide and ozone make nitrogen dioxide (NO2) and molecular oxygen. This process plays an important role in the chemistry of the ozone layer that surrounds the earth and protects us from the sun's harmful ultraviolet radiation. (Okay, now we see...)</td>
</tr>
</tbody>
</table>

The second kind of pronoun-reference problem arises over lack of agreement between the pronoun and what it refers to.

Example

<table>
<thead>
<tr>
<th>Problem:</th>
<th>Motorola has just announced their new PowerPC chip.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision:</td>
<td>Motorola has just announced its new PowerPC chip.</td>
</tr>
</tbody>
</table>

The problem here is that "Motorola" is a singular thing, while "their" is a plural thing—they don't agree in number! Now, maybe anyone knows what's being said here, but this writing is imprecise, and it can lead to serious problems, given the right situation.

Example

<table>
<thead>
<tr>
<th>Problem:</th>
<th>These days, every student needs to own their own computer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revision 1:</td>
<td>These days, students need to own their own computers.</td>
</tr>
<tr>
<td>Revision 2:</td>
<td>These days, every student needs to own his or her own computer.</td>
</tr>
<tr>
<td>Revision 3:</td>
<td>These days, every student needs to own a computer.</td>
</tr>
</tbody>
</table>

The problem in this example is that "student" does not agree with "their": one is singular; the other, plural. Some call this usage acceptable (Merriam-Webster). However, it is imprecise—and we care greatly about precision in technical writing. We have to search for the plural noun we think is being referred to by "their." Not a good idea in technical writing. As you can see from the revisions, there sometimes is no good way to fix the problem. Whenever it works, try converting the singular noun to a plural—the plural pronoun will then be okay (but don't forget to change the verb to plural). Here are some additional examples:

Examples

<table>
<thead>
<tr>
<th>Problem</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA hoped that, by using production tooling rather than by making each tool individually, they could save time and money.</td>
<td>NASA hoped that, by using production tooling rather than by making each tool individually, it could save time and money.</td>
</tr>
<tr>
<td>If an energy efficient system can be developed, electrical vehicles could become as popular as its conventional counterpart.</td>
<td>If an energy-efficient system can be developed, electrical vehicles could become as popular as their conventional counterpart.</td>
</tr>
<tr>
<td>Currently, Houston has $328.2 million in their 1984-1985 budget to help fund a new form of mass transportation.</td>
<td>Currently, Houston has $328.2 million in its 1984-1985 budget to help fund a new form of mass transportation.</td>
</tr>
<tr>
<td>Aerobic fitness programs help to improve an employee's physical condition by strengthening their circulatory, muscular, and respiratory systems.</td>
<td>Aerobic fitness programs help to improve employees' physical condition by strengthening their circulatory, muscular, and respiratory systems.</td>
</tr>
<tr>
<td>American industry should implement aerobic fitness programs for the betterment of their employees even if there is some opposition</td>
<td>American industry should implement aerobic fitness programs for the betterment of its</td>
</tr>
</tbody>
</table>
Pronoun case (who, whom)

Yes, you too can learn the proper usage of who and whom. Who is used in the same slots that words like he, she, they, and we are used; whom is used in the same slots that him, her, them, and us are used. So if you can run a little replacement test, you can figure out which to use.

Replacement Test

1. Imagine that you start out with sentences like these (admittedly not an eloquent crew but they'll do):
   - It was the NBS engineers [who, whom?] Sen. Eagleton's office contacted on July 17.
   - It was the NBS engineers [who, whom?] performed the tests on the walkways.
   - Send a copy of the report to [whoever, whomever?] wants one.
   - No one is sure [who, whom?] will be the next mayor.
   - It was the NBS engineers to [who, whom?]Sen. Eagleton's office made the request for technical assistance.

2. Now, strike out all the words up to the who or whom including prepositions:
   - It was the NBS engineers [who, whom?] Sen. Eagleton's office contacted on July 17.
   - It was the NBS engineers [who, whom?] performed the tests on the walkways.
   - Send a copy of the report to [whoever, whomever?] wants one.
   - No one is sure [who, whom?] will be the next mayor.
   - It was the NBS engineers to [who, whom?] Sen. Eagleton's office made the request for technical assistance.

3. Next, juggle the remaining words so that they make a complete sentence:
   - Sen. Eagleton's office contacted the NBS engineers.
   - The NBS engineers performed the tests on the walkways.
   - [Who, whom] wants one?
   - [Who, whom] will be the next mayor?
   - Sen. Eagleton's office made the request for the technical assistance to [who, whom]?

4. If it sounds right to substitute I, he, she, they, we, use who. If it sounds right to substitute me, him, her, us, them, use whom:
   - Sen. Eagleton's office contacted them. => (whom)
   - They performed the tests on the walkways. => (who)
   - He wants one? => (who)
   - She will be the next mayor? => (who)
   - Sen. Eagleton's office made the request for the technical assistance to them. => (whom)

5. Here are the results:
It was the NBS engineers whom Sen. Eagleton’s office contacted on July 17.

It was the NBS engineers who performed the tests on the walkways.

Send a copy of the report to whoever wants one.

No one is sure who will be the next mayor.

It was the NBS engineers to whom Sen. Eagleton’s office made the request for technical assistance.

This trick works without having to toss around terms like *nominitive case* and *objective case*. (Incidentally, the third example, which contains "whoever wants one," is typically missed by people who pride themselves on their grammar. The rule about always using *whom* when it comes after a preposition does *not* work!)

**Caution:** You can get *whom* exactly grammatically right but sound fussy and pedantic. The famous day-time quiz show in which Johnny Carson got his start was called *Who Do you Trust?* not *Whom Do you Trust?*. You have to have an ear for the language. If it sounds fussy and pedantic to use *whom*, use *who*.

## Capitalization

One of the big problems in technical writing involves capitalization. Technical people, developers, and other nonprofessional writers tend to use capital letters for everything that feels important—particularly the stuff that they've worked on. Problem is that this practice breaks all our standard capitalization rules and, more importantly, makes text harder to read. Most professionals in publishing, writing, and editing believe that excessive and unnecessary capitalization is distracting and confusing for readers. Capitalization should *not* be used for emphasis (use underscores or italics for that, or for really important things, use special notices).

Capital letters should be used for proper names—formal, official names of things and people. For example, Tandem Corporation is a proper name; Mosaic is the proper name of a software product. However, a loose reference to the "development area" at IBM does not need caps; it's not the official name of that area. Similarly, WordPerfect is a proper name, but not its grammar-checking feature. In technical writing, the impulse is often to use caps for the components of a thing—no! For example, if we were discussing the disk drive, the monitor, the CPU unit, the modem, the mouse, or the printer of a computing system, none of it should be capitalized. However, if we were talking about the the Dell NL40 Notebook computer, the Microsoft Mouse, or the IBM 6091 Display, then certainly caps are in order.

Of course, there are some exceptions. For example, in instructions, you want to reproduce the capitalization style shown on buttons, knobs, and other physical features of products as well as on the display screens of computer programs as they are shown on the hardware—but not if all caps are used. If I have a Service button on my computer, I'd write it as Service but not SERVICE, no matter how it is shown on the machine.

A common misuse of capitalization involves acronyms. You know that whenever you use an acronym in your text, you should spell it out first then show its acronym in parentheses. Writers often want to put the spelled-out version in initial caps; you would do so only if the spelled-out version were a proper name in its own right:

### Examples

- The North Atlantic Treaty Organization (NATO) was formed just after Word War II.
- When you turn your computer on, it normally goes through a process called initial program load (IPL).

## Standard rules for caps

Use capital letters for names of people, races, cities, regions, counties, states, nations, languages, and other such proper names.

- The Early Bird satellite was launched by Intelst, a consortium of Western countries including the United States, France, the United Kingdom, and Germany.
- Samuel Morse invented the coding system called the Morse code.
- Among Muslims, Ramadan commemorates the first revelation of the Koran and is celebrated by fasting.
The population of Quebec is largely French speaking.

The Middle East, culturally speaking, refers to those lands in that part of the world that are predominantly Islamic in culture.

The Midwest includes Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas, and Nebraska.

In her sophomore semester Gilda took English, French, astronomy, biology, geology and a special course called "Key Concepts in Western Science."

Use capital letters for points of the compass only when they refer to well-established regions, but not when they simply refer to a direction of travel

In the 1970s and 1980s, the major population and economic growth regions of the United States have been the South and Southwest.

The dam is located to the west of the city.

Oil imports from South America have been decreasing recently.

Drive ten miles north from Baldwin City, Kansas, and you'll be in Lawrence.

Use capital letters for titles of offices when the title precedes the name of an officeholder but not when the title occurs alone. This rule is often ignored within organizations that need to use capitalize titles of positions. Another exception to this rule involves the president of the U.S.; some styles require this title to use a capital letter, even when it occurs alone

The first electronic computer was assembled in the years 1940 to 1942 by Professor John V. Atanasoff and Clifford Berry, a student, at Iowa State University.

A professor and a student assembled the world's first electronic computer in the years between the wars.

In the U.S., the president holds the power of veto over any legislation passed by the Congress.

Last week, mayors from several cities in the region met to discuss an integrated system of health care.

Use capital letters for academic subjects only when they are part of a specific course title or when they are derived from the name of a person, country, or language. (This capitalization rule often get bent a little in resumes and application letters. Typically, names of occupations and fields, and job titles get initial caps. By standard capitalization rules, that's not correct, but the usage is so strong in these two types of documents that it has become acceptabl)

She took a course in world history called "The Shaping of Western Thought" at Baker University in Kansas.

They consider Chemistry 301 a difficult course even though they are all chemistry majors.

This semester Majorie plans to take French, finance, and physics.

Use capital letters for the days of the week, months, special days, and holidays—but not for the names of the seasons

On Monday, July 24, 1978, they celebrated her birthday at a local restaurant.

Last fall they spent Thanksgiving in Denmark.

In the United States, the national independence day is July the Fourth; in Mexico, it's called Cinco de Mayo.
Use capital letters for religions, religious groups, historical events, periods of history, and historical documents

| The telegraph played an important role in the Civil War. |
| The term Protestantism is used to distinguish this faith from the other major Christian faiths: Roman Catholicism and Eastern Orthodoxy. |
| At the Casablanca Conference, the Allies agreed to continue the war until the unconditional surrender of the Axis powers. |
| The Allies landed on Normandy Beach on July 6, 1944, a day known as D-Day. |
| The Great Depression in the United States was supposedly precipitated by the stock-market crash of 1929. |
| Under compulsion by English barons and the church, King John signed the Magna Carta in 1215. |

Use capital letters for organization names (commercial, governmental, and non-profit) as well as their products and services

| In the late 1950s, the U.S. Department of Defense initiated a number of projects, such as Project Courier, which finally resulted in the Initial Defense Communications Satellite Program (IDCSP). |
| The IDCSP satellites were launched by the U.S. Air Force in 1966. |
| Saudi Arabia has its own air force and its own integrated defense system. |
| After the FCC's 1971 adoption of a "limited skies" policy, three domestic carriers initiated operations during 1974: American Satellite Corporation, a subsidiary of Fairchild industries, Inc.; Americom of RCA; and Western Union. |
| On March 24, 1980, Pennsylvania Governor Richard Thornburgh asked the Union of Concerned Scientists to make an independent evaluation of the krypton problem at the Three Mile Island nuclear power plant. |
| Recently, Apple Corporation introduced its Macintosh to compete with IBM's Personal Computer. |

Use capital letters for references to most numbered or lettered items (figures, tables, chapters, parts, volumes, rooms, buildings, etc.)

| In Figure 3 a simple telegraph arrangement is shown. Unfortunately, this small amount of krypton is uniformly mixed with the roughly 2 million cubic feet of air in the sealed Three Mile Island Unit 2 reactor containment building. |
| In this book, Chapter 6 discusses how to convert instructions written by engineers into instructions that can be read and understood by ordinary nonspecialists. |
| In Part I of this book, the basic patterns of technical writing are compared to those of traditional English composition. |

Use capital letters for objects that have individualized names

| The first operational communications satellite, Early Bird, was launched in 1965. |
| Until the Challenger space shuttle, expendable launch vehicles such as the Thor Delta, Alpha-Centaur, and Titan were used for launching space communications satellites. |
| The Golden Gate Bridge was opened in 1937, and it is one of the most extraordinary bridges in the world. |
Dr. Smith has her offices in the Woods Building.

Use capital letters for the earth, sun, moon, and universe when they are discussed with other celestial bodies or systems

The Sun is 1.4 km from Earth.
The theory that the Universe is constantly expanding is based on the observation of red-shifts.

Use capital letters for most acronyms, although a few such as ac and dc are not. When in doubt, check your dictionary. Use capital letters for the spelled-out version of acronyms only if the spelled-out versions are proper nouns in their own right

In 1969, an experiment at the Stanford Linear Accelerator (SLAC) shattered protons with electrons.
In 1977 and 1978, NASA launched the first two High-Energy Astronomy Observation (HEAO) satellites to study black holes.
The "brain" of the computer is the central processing unit (CPU).

Numbers vs Words

In the section on hyphens, it was pointed out that worrying too much about hyphens will drive you crazy—so will numbers. The main hurdle to overcome is to learn that in technical contexts, we use numerals in text—even ones below 10—if they are critical values. In other words, we break the rules that are taught in regular writing courses and that are used in normal publishing and copyediting practice. That's because in the technical and scientific context, we are vitally interested in numbers, statistical data, even if it's a 2 or 5 or—yes—even a 0.

The difficulty is in defining the rules. You should use numerals, not words, when the number is a key value, an exact measurement value, or both. For example, in the sentence "Our computer backup system uses 4 mm tape" the numeral is in order. Also in "This recipe calls for 4 cups of unbleached flour." But consider this one: "There are four key elements that define a desktop publishing system." A word, not a numeral, is preferable here because—well, how to explain it? The number of elements is exact all right, but it's just no big deal. Four, five—who cares?

To summarize the rules that we normally apply:

- Don't start sentences with numerals—write the number out or, better yet, rephrase the sentence so that it doesn't begin the sentence.
- For decimal values less than 1, add a 0 before the decimal point: for example, .08 should be 0.08.
- Make a firm decision on how to handle 0 and 1 when they refer to key, exact values and stick with it. (Style varies wildly in technical writing on these two villains.) Some technical styles choose to use words for these; they resign themselves to the slight inconsistency but better readability.
- Use numerals for important, exact values, even when those values are below 10.
- Use words for numerical values that are unimportant, such as in the sentence "There are six data types in the C programming language."
- When you must use fractions, avoid the symbols that may be available in the character set used by your software. Construct the fraction like this: 5-1/4. Be sure and put the hyphen between the whole number and the fraction.
- It would be nice if all fractions could be reset as decimals, but such is not the case when you have things like 1/8 floating around. Stay consistent with either decimals or fractions in these situations.
- Don't make numerical values look more exact than they are. For example, don't add ".00" to a dollar amount if the the amount is rounded or estimated.
- For large amounts, you can write things like 36 million or 45 billion, but, for some reason, not 23 thousand.
- Apply these rules in specifically technical, scientific contexts only. Be sensitive to what the standard practices are in the context in which you are writing.

Examples
Some 19 million tons of sulphur dioxide are discharged from US sources alone each year, and another 14 million tons from Canada. (Using the number “19” and the word “million” indicates an approximate amount. “19,000,000” might make some readers think it was an exact amount.)

It was not until after December 1952, when 4000 people died in London from air pollution in just a few days, that real gains in pollution-control legislation were made.

The US Army's standard airborne Doppler navigator weighs 28 lb (12.7 kg), requires 89 W of power, and operates at 13.325-GHz frequency.

All vitrain of the European classification, if more than 14 micrometers thick, has been regarded as anthraxylon.

In 1971, 11 countries accounted for about 91 percent of world production of coal.

The Department of the Interior has just published a report that reviews 65 different coal gasification processes.

Combustion turbines total about 8% of the total installed capability of US utility systems and supply less than 3% of the total energy generated.

Internal combustion engines in small power plants account for about 1% of the total power-system generating capability of the US.

The water-cement ratio will generally range from 4 gal of water per sack of cement to about 9 gal per sack. (These are exact values here; in technical writing, use the numeral even if it is below 10.)

The problem is located in piston number 6. (When there are enumerated items or parts, technical writing uses the number, as in this example. But notice that no "#" or "No." is used.)

The signal occurs in 6-second intervals.

The order is for 6-, 8-, and 12-foot two-by-fours.

Use Code 3 if a system shutdown occurs.

Mineral contents of coal vary from 5 to 15 percent, depending on the source.

The above illustration shows a 20-unit coaxial cable with 9 working coaxial pairs and 2 standby coaxials, which automatically switch in if the electronics of the regular circuits fail.

There are 59 different species of the coffee shrub, but only 4 are of commercial importance.

Most grinds of coffee contain particles ranging in size from 0.023 to 0.055 inches in diameter.

Using carrier frequencies between 0.535 MHz and 1.605 MHz in the US, AM broadcasting stations sprang up all over the country beginning in the 1910s.

As a base from which to work, 2-1/2 to 3 gal of water are needed for each sack of cement for complete hydration and maximum strength. (These are exact values; therefore, in the technical-writing context, we use numerals. Notice how fractional values are handled: put a hyphen between the whole number and the fraction to prevent misreading.)

The order for twelve 30-foot beams was placed yesterday.

The order was for 30 fifteen-gallon tubs.

They used six 8-pound sacks of nails.

The microprocessors of the 70s and 80s operated under the control of clocks running at 1 to 5 MHz, that is, 1 to 5 million counts per second.

Your eye has a bandwidth of 370 trillion Hz, the visible spectrum.

Transmission rates on ETHERNET range from 1 to 10 megabits per second (0.125 to 1.25 million bytes per second).

In 1978, the satellite carriers’ revenues were about $88 million, and by 1986, they are expected to reach $800 million.

Most communications satellites are in geostationary orbit: at an altitude of 22,300 miles above the surface of the earth and at a distance of 26,260 miles from the center of the earth (the earth's radius being 3960 miles).
Aggregates constitute about 70 percent of a concrete mix.

Uniform compaction of 95% or better of standard AASHO densities is recommended.

In this book, Chapter 7 discusses the different audiences of technical prose and translation techniques for communicating effectively with the less specialized ones.

The wheels of the four-wheel tractor give it increased speed over the Crawler, but because of the weight distribution over four wheels rather than over two wheels or tracks, this vehicle has less traction.

Hundreds of thousands of people will have purchased microcomputers by the end of 1980. Tens of millions of them will bought them by the end of the century.

There are two telephones in service today for every three people in the US.

In 1965, Dr. Gordon Moore announced his "law" that the complexity of a chip would double every year for ten years. (Use the word "ten" here because it is not an exact amount.)

The typical stand-alone microcomputer system consists of seven physical components. (Use the word "seven" here because, even though it seems like an exact amount, it is not a key value. It doesn't have the same significance as the "7" would have in "7 quarts of oil.")

If you are using page-zero addressing, use a RAM for memory page zero.

Primary fuel cells are those through which reactants are passed only one time.

Before recharging, a zinc-carbon battery must have a working voltage not less than one volt. (Even in technical-writing contexts, rules for one and zero vary. Just pick a style and stay with it. Using the word "one" is the standard in this example.)

Japan has roughly one-third of the US production of dry batteries. (In running text, always write out fraction like this, and hyphenate them. However, you'd still write "5-1/2 inches.")

The radial fractures are so extensive that they are the dominant structural element over half of Mars's surface. (And just to be sure, "half" by itself in running text is always a word.)

A nanosecond is one-billionth of a second.

Inside the UP are three 16-bit registers. (When you have two separate numerical values side by side, one has to be a word, and the other a numeral. Styles vary here, but make the numeral the higher number. Contrast with the next example.)

Data from the frequency counter take the form of 16 seven-bit ASCII words.

Sales of batteries have increased from $510 million on the average during 1957-1959 to $867 million in 1966 and are projected to exceed $1.8 billion in 1980.

The speed of light is roughly 300 million meters per second.

 Fifty-three representatives of different software development companies showed up at the meeting. (Never start a sentence with a numeral in any writing context. With this example, some rewriting might be a wise idea to get the numerical out of the beginning of the sentence, as in the following rewrite.)

At the meeting, 53 representatives of different software development companies showed up.

Symbols and Abbreviations

In technical-writing contexts, you may often have to decide whether to use " or ' for "inches" or "feet" or whether to use "inches," "in," or "\in\".

First of all, remember that symbols and abbreviations are distracting to readers; they are different from the normal flow of words. However, there are plenty of cases where the written-out version is more distracting than the symbol or abbreviation. Also, the context (specifically, technical or nontechnical) has a lot to do with which to use.
Imagine a technical document which has only one or two references to numerical measurements in inches. There is no reason to use symbols or abbreviations here—just write the thing out. But imagine a technical document with numerous feet and inch references: using symbols or abbreviations in this case is better, more readable, more efficient for both reader and writer. But which? Imagine the amount of foot and inch references there would be in a carpentry project (for example, a dog house). In this case, the symbols, " and ' would be greatly preferable. However, this example would be an extreme case; otherwise, use the abbreviations.

When you do use symbols, especially for feet, inches, and some math symbols, use a symbols-type font. Avoid the "smart" quotes for feet and inches. Use the multiplication symbol for measurement contexts.

Which are the standard symbols and abbreviations to use? Go with the standards in the field in which you are writing, or with those found in a standard reference book such as a dictionary. Don't make them up yourself (for example, "mtrs" for meters)!

What about plurals? Very few abbreviations take an s to indicate plural: for example 5 in. means 5 inches. For the few that you think might take the s, check a dictionary.

What about obscure abbreviations and symbols? If you are concerned that readers might not recognize the abbreviation or symbol, write its full name in regular text and then put the abbreviation and symbol in parentheses just after the first occurrence of that full name.

Examples

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>High resolution displays use larger video bandwidths, up to 30 MHz or more.</td>
</tr>
<tr>
<td>Most touch-sensitive displays use a matrix of either LED/photodiodes or transparent capacitor arrays to detect a physical touch.</td>
</tr>
<tr>
<td>The part of the memory that is easily alterable by the operator consists of RAM chips.</td>
</tr>
<tr>
<td>A satellite in geostationary orbit looks at the earth with a cone angle of 17.3⁰ corresponding to an arc of 18,080 km along the equator.</td>
</tr>
<tr>
<td>The arc from 53⁰ W to 139⁰ W will cover 48 states (excluding Alaska and Hawaii) and is said to provide conus coverage.</td>
</tr>
<tr>
<td>Fairchild Industries, Inc., was an early participant in commercial satellites.</td>
</tr>
<tr>
<td>The voice was compressed from the usual 64-kb/s pulse code modulation (PCM) to 32 kb/s per channel by near-instantaneous companding (a modified PCM technique).</td>
</tr>
<tr>
<td>Terrestrial microwave radio communications require repeaters spaced every 20 to 40 mi from each other.</td>
</tr>
<tr>
<td>Over a period of several days the spacecraft is tracked from the ground and positioned on station (i.e., in the preassigned orbital spot) in order to commence operations.</td>
</tr>
<tr>
<td>A velocity increment of approximately 155 ft/s per year is required to correct drift problems in satellites.</td>
</tr>
<tr>
<td>The ancient battery-like objects made by the Parthians in 250 BC were thin sheets of copper soldered into a cylinder 1.125 cm long and 2.6 cm in diameter.</td>
</tr>
<tr>
<td>The standard electrodes are the normal and the 0.1 normal (N) calomel electrodes in which the system is Hg</td>
</tr>
<tr>
<td>Such batteries contain 4400 cc of water in which NaOH is dissolved.</td>
</tr>
<tr>
<td>Water pressure in the heat recovery loop can be as much as 25 psig.</td>
</tr>
</tbody>
</table>

Resources

Here are some other sources to consult:
Grammar Girl Quick and Dirty Tips for Better Writing


Grammar Book. Provided by Jane Straus.

Bedford St. Martin companion website. Lots of diagnostics and exercises for grammar, usage, punctuation.

Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Identify and correctly spell commonly misspelled words.
2. Define and distinguish between similar-sounding words.

Who Made Up This Language?

For some writers, their main spelling problem is similar-sounding words, for example, *principle* and *principal* or *affect* and *effect*. These problems cannot be flagged by software spell-checking functions.

Here is a list of these commonly confused homophones (different spelling; same or very similar pronunciation), with examples of their correct use.

All definitions in this section are from the Merriam Webster dictionary via the Merriam Webster Dictionary mobile application.

**accept, except**

The construction form *accepted* the offer to build the bridge.
Everything has been finished *except* for the paint job.

<table>
<thead>
<tr>
<th>Merriam-Webster Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accept</strong></td>
</tr>
<tr>
<td><strong>Except</strong></td>
</tr>
</tbody>
</table>

**advice, advise**

The construction firm ignored the engineer's *advice*.
The engineer *advised* the firm to use single-suspension walkways.

<table>
<thead>
<tr>
<th>Merriam-Webster Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advice</strong></td>
</tr>
<tr>
<td><strong>Advise</strong></td>
</tr>
</tbody>
</table>

**affect, effect**
The effect of the increased oil prices has been devastating on our economy. The increased oil prices have affected our economy drastically.

<table>
<thead>
<tr>
<th>Affect</th>
<th>(verb) have an effect on; make a difference to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
<td>(noun) a change that results when something is done or happens: an event, condition, or state of affairs that is produced by a cause: a particular feeling or mood created by something: an image or a sound that is created in television, radio, or movies to imitate something real</td>
</tr>
</tbody>
</table>

#### cite, site, sight

The consulting engineer cited a paragraph from the building code. At the construction site, the workers carefully erected the scaffolding. The collapse of the walkways was a terrible sight.

<table>
<thead>
<tr>
<th>Cite</th>
<th>(verb) to write or say the words of (a book, author, etc.): to mention (something) especially as an example or to support an idea or opinion: law: to order (someone) to appear before a court of law</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>(noun) the place where something (such as a building) is, was, or will be located: a place where something important has happened: a place that is used for a particular activity</td>
</tr>
<tr>
<td>Sight</td>
<td>(noun) the sense through which a person or animal becomes aware of light, color, etc. by using the eyes: the ability to see: the act of seeing someone or something: a position in which someone or something can be seen</td>
</tr>
</tbody>
</table>

#### complement, compliment

The programmer has received many compliments on her new system. The colors that have been selected for the room do not complement each other.

<table>
<thead>
<tr>
<th>Complement</th>
<th>(noun) something that completes something else or makes it better: the usual number or quantity of something that is needed or used: grammar: a word or group of words added to a sentence to make it complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliment</td>
<td>(noun) a remark that says something good about someone or something: an action that expressed admiration or approval</td>
</tr>
</tbody>
</table>

#### counsel, council, consul

She was appointed consul to the embassy in Beirut. There was lengthy debate on the tax proposal at city council last night. He counselled her to get a degree in technical communication.
Counsel (verb) to give advice to (someone): to suggest or recommend (something)
Council (noun) a group of people who are chosen to make rules, laws, or decisions about something: a group of people who provide advice or guidance on something
Consul (noun) a government official whose job is to live in a foreign country and protect and help the citizens of his or her own country who are traveling, living, or doing business there: either one of two chief officials of the ancient Roman republic who were elected every year

its, it's
It's time to go home; it's getting late.
The car has lost one of its headlights.

Lose (verb) to be unable to find (something or someone): to fail to win (a game, contest, etc.): to fail to keep or hold (something wanted or valued)
Loose (adjective) not tightly fastened, attached, or held: not pulled or stretched tight: of clothing: not fitting close to your body: not tight

personal, personnel
They plan to take out a personal loan to build the deck.
Send your application to the personnel office.
The CEO wants to have a personal chat with all this company's personnel.
Personnel (noun) the people who work for a particular company or organization: a department within a company or organization that deals with the people who work for it

principal, principle

The principal component of the solar panel is the collector.
Explain to me the principle of convection.

Merriam-Webster Definitions

| Principal | (adjective) most important |
| Principle | (noun) a moral rule or belief that helps you know what is right and wrong and that influences your actions: a basic truth or theory: an idea that forms the basis of something: a law or fact of nature that explains how something works or why something happens |

stationary, stationery

Use company stationery for company business purposes only.
The derrick may not remain stationary during the gale-force winds.

Merriam-Webster Definitions

| Stationary | (adjective) not moving: staying in one place or position: not changing |
| Stationery | (noun) materials (such as paper, pens, and ink) that are used for writing or typing: paper that is used for writing letters and that usually has matching envelopes |

than, then

My utility bill was higher this month than it was last month.
The hurricane reached the Texas coast; then it plunged right into the heart of Houston.

Merriam-Webster Definitions

| Than | (conjunction) rather than: other than: when |
| Then | (adverb) at that time: at the time mentioned --used to indicate what happened or happens next --used to indicate what should be done next |

their, there, they're

Their calculus course is much harder than ours.
Over there on the table is your calculus book.
They're not taking calculus this semester.
**Common Spelling Problems**

<table>
<thead>
<tr>
<th>Their</th>
<th>(adjective) relating to or belonging to certain people, animals, or things: made or done by certain people animals, or things: his or her: his: her: its</th>
</tr>
</thead>
<tbody>
<tr>
<td>There</td>
<td>(adverb) in that place: at that location: to or into that place: at that point in a process, activity, story, etc.</td>
</tr>
<tr>
<td>They’re</td>
<td>(contraction) they are</td>
</tr>
</tbody>
</table>

### to, too, two

Are they going to pave the street today?
It is still too rainy to pave the street.
Two hours ago, the sky was clear.

<table>
<thead>
<tr>
<th>To</th>
<th>(preposition) --used to indicate the place, person, or thing that someone or something moves toward --used to indicate the place where someone participates in a particular activity --used to indicate the direction of something</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too</td>
<td>(adverb) in addition: more than what is wanted, needed, acceptable, possible, etc.: to a high degree or extent: very or extremely</td>
</tr>
<tr>
<td>Two</td>
<td>(adjective) being more than one in number: being the second</td>
</tr>
</tbody>
</table>

### whose, who's

Whose technical writing book is this?
There is the woman whose technical report won top honors.
Do you know who's in charge around here?
He's a man who's not afraid of criticism.

<table>
<thead>
<tr>
<th>Whose</th>
<th>(adjective) --used in questions to ask who owns something, has something, etc. --used to show which person or thing you are talking about --used to give more information about a person or thing that has already been mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who's</td>
<td>(contraction) who is</td>
</tr>
</tbody>
</table>

### your, you're

Your technical writing book is on the table.
You're going to have review to Part 1 before writing that report.
<table>
<thead>
<tr>
<th><strong>Your</strong></th>
<th>(adjective) relating to or belonging to you: made or done by you --used to refer to any person or to people in general --used in the titles or royalty, judges, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>You're</strong></td>
<td>(contraction) you are</td>
</tr>
</tbody>
</table>
Strategies for Peer Reviewing and Team Writing

David McMurrey

Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Explain and apply strategies for peer reviewing.
2. Explain and apply strategies for team writing.

Strategies for Peer Reviewing and Team Writing

Be a thoughtful reviewer; be a good team member

Peer reviewing (also called peer-editing) means people getting together to read, comment on, and recommend improvements on each other's work. Peer-reviewing is a good way to become a better writer because it provides experience in looking critically at writing.

Team writing, as its name indicates, means people getting together to plan, write, and revise writing projects as a group, or team. Another name for this practice is collaborative writing—collaborative writing that is out in the open rather than under cover (where it is known as plagiarism).

Strategies for Peer Reviewing

When you peer-review another writer's work, you evaluate it, criticize it, suggest improvements, and then communicate all of that to the writer. As a first-time peer-reviewer, you might be a bit uneasy about criticizing someone else's work. For example, how do you tell somebody his essay is boring? Read the discussion and steps that follow; you'll find advice and guidelines on doing peer reviews and communicating peer-review comments.

Initial meeting

At the beginning of a peer review, the writer should provide peer reviewers with notes on the writing assignment and on goals and concerns about the writing project (topic, audience, purpose, situation, type), and alert them to any problems or concerns. As the writer, you want to alert reviewers to these problems; make it clear what kinds of things you were trying to do. Similarly, peer reviewers should ask writers whose work they are peer-reviewing to supply information on their objectives and concerns. The peer-review questions should be specific like the following:

- Does my expansion of virtual machine make sense to you? Would it make sense to our least technical customers?
- In general, is my writing style too technical? (I may have mimicked too much of the engineers' specifications.)
- Are the chapter titles and headings indicative enough of the following content? (I had trouble phrasing some of these.)
- Are the screen shots clear enough? (I may have been trying to get too much detail in some of them.)

Peer-reviewing strategies

When you peer-review other people's writing, remember above all that you should consider all aspects of that writing, not just—in fact, least of all—the grammar, spelling, and punctuation. If you are new to peer-reviewing, you may forget to review the draft for things like the following:

- Make sure that your review is comprehensive. Consider all aspects of the draft you're reviewing, not just the grammar, punctuation, and spelling.
- Read the draft several times, looking for a complete range of potential problem areas:
  - Interest level, adaptation to audience
  - Persuasiveness, purpose
  - Content, organization
  - Clarity of discussion
  - Coherence, use transition
Strategies for Peer Reviewing and Team Writing

- Title, introduction, and conclusion.
- Sentence style and clarity
- Handling of graphics

- Be careful about making comments or criticisms that are based on your own personal style. Base your criticisms and suggestions for improvements on generally accepted guidelines, concepts, and rules. If you do make a comment that is really your own preference, explain it.
- Explain the problems you find fully. Don't just say a paper "seems disorganized." Explain what is disorganized about it. Use specific details from the draft to demonstrate your case.
- Whenever you criticize something in the writer's draft, try to suggest some way to correct the problem. It's not enough to tell the writer that her paper seems disorganized, for example. Explain how that problem could be solved.
- Base your comments and criticisms on accepted guidelines, concepts, principles, and rules. It's not enough to tell a writer that two paragraphs ought to be switched, for example. State the reason why: more general, introductory information should come first, for example.
- Avoid rewriting the draft that you are reviewing. In your efforts to suggest improvements and corrections, don't go overboard and rewrite the draft yourself. Doing so steals from the original writer the opportunity to learn and improve as a writer.
- Find positive, encouraging things to say about the draft you're reviewing. Compliments, even small ones, are usually wildly appreciated. Read through the draft at least once looking for things that were done well, and then let the writer know about them.

Peer-review summary

Once you've finished a peer review, it's a good idea to write a summary of your thoughts, observations, impressions, criticisms, or feelings about the rough draft. See the peer-reviewer note below, which summarizes observations on a rough draft. Notice in the note some of the following details:

- The comments are categorized according to type of problem or error—grammar and usage comments in one group; higher level comments on such things as content, organization, and interest-level in another group.
- Relative importance of the groups of comments is indicated. The peer-reviewer indicates which suggestions would be "nice" to incorporate and which ones are critical to the success of the writing project.
- Most of the comments include some brief statement of guidelines, rules, examples, or common sense. The reviewer doesn't simply say "This is wrong; fix it." He also explains the basis for the comment.
- Questions are addressed to the writer. The reviewer is doublechecking to see if the writer really meant to state or imply certain things.
- The reviewer includes positive comments to make about the rough draft and finds nonantagonistic, sympathetic ways to state criticisms.

Excerpt from a note summarizing the results of a peer review

Spend some time summarizing your peer-review comments in a brief note to the writer. Be as diplomatic and sympathetic as you can!

Strategies for Team Writing

As mentioned earlier in this chapter, team writing is one of the common ways people in the worlds of business, government, science, and technology handle large writing projects.

Assembling the team

When you begin picking team members for a writing project in a technical writing course, choose people with different backgrounds and interests. Just as a diverse, well-rounded background for an individual writer is an advantage, a group of diverse individuals makes for a well-rounded writing team.

If you are the team leader, you might even ask prospective team members for their background, interests, majors, talents, and aptitudes. These following writing teams combine individuals with diverse backgrounds and interests:

<table>
<thead>
<tr>
<th>Writing Team 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project:</strong></td>
</tr>
<tr>
<td><strong>Team members</strong></td>
</tr>
</tbody>
</table>

https://softchalkcloud.com/lesson/files/vEQfgsYblm3cUy/5_10Peer-ReviewTeam-Writing_print.html
Planning the project

Once you've assembled your writing team, most of the work is the same as it would be if you were writing by yourself, except that each phase is a team effort. Specifically, meet with your team to decide or plan the following:

Planning Stages

- Analyze the writing assignment.
- Pick a topic.
- Define the audience, purpose, and writing situation.
- Brainstorm and narrow the topic.
- Create an outline.
- Plan the information search (for books, articles, etc., in the library).
- Plan a system for taking notes from information sources.
- Plan any graphics you'd like to see in your writing project.
- Agree on style and format questions (see the following discussion).
- Develop a work schedule for the project and divide the responsibilities (see the following).

Much of the work in a team-writing project must be done by individual team members on their own. However if your team decides to divide up the work for the writing project, try for at least these minimum guidelines:

- Have each team member responsible for the writing of one major section of the paper.
- Have each team member responsible for locating, reading, and taking notes on an equal part of the information sources.

Some of the work for the project that could be done as a team you may want to do first independently. For example, brainstorming, narrowing, and especially outlining should be done first by each team member on his own; then get together and compare notes. Keep in mind how group dynamics can unknowingly suppress certain ideas and how less assertive team members might be reluctant to contribute their valuable ideas in the group context.

After you've divided up the work for the project, write a formal chart and distribute it to all the members.
Scheduling the project and balancing workload

Early in your team writing project, set up a schedule of key dates. This schedule will enable you and your team members to make steady, organized progress and complete the project on time. As shown in the example schedule below, include not only completion dates for key phases of the project but also meeting dates and the subject and purpose of those meetings. Notice these details about that schedule:

- Several meetings are scheduled in which members discuss the information they are finding or are not finding. (One team member may have information another member is looking everywhere for.)
- Several meetings are scheduled to review the project details, specifically, the topic, audience, purpose, situation, and outline. As you learn more about the topic and become more settled in the project, your team may want to change some of these details or make them more specific.
- Several rough drafts are scheduled. Team members peer-review each other's drafts of individual sections twice, the second time to see if the recommended changes have worked. Once the complete draft is put together, it, too, is reviewed twice.

### Schedule for a team writing project

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual prototypes due</td>
<td>October 1</td>
</tr>
<tr>
<td>Team meeting: finalize the prototype</td>
<td>October 1</td>
</tr>
<tr>
<td>Rough-draft style guide due</td>
<td>October 5</td>
</tr>
<tr>
<td>Team meeting: finalize style guide</td>
<td>October 5</td>
</tr>
<tr>
<td>Twice-weekly team meetings: progress &amp; problems</td>
<td>October 5-26</td>
</tr>
<tr>
<td>Graphics sketches due to Jim</td>
<td>October 14</td>
</tr>
<tr>
<td>Rough drafts of individual sections due</td>
<td>October 26</td>
</tr>
<tr>
<td>Review of rough drafts due</td>
<td>October 28</td>
</tr>
<tr>
<td>Team meeting: discuss rough drafts, reviews</td>
<td>October 28</td>
</tr>
<tr>
<td>Update of style guide due from Sterlin</td>
<td>October 31</td>
</tr>
<tr>
<td>Revisions of rough drafts due to reviewers</td>
<td>November 3</td>
</tr>
<tr>
<td>Final graphics due from Jim</td>
<td>November 5</td>
</tr>
<tr>
<td>Completed drafts to Sterlin: final edit/proof</td>
<td>November 7</td>
</tr>
<tr>
<td>Team meeting: review completed drafts with final graphics and editing</td>
<td>November 12</td>
</tr>
<tr>
<td>Completed drafts due to Julie for final production</td>
<td>November 15</td>
</tr>
</tbody>
</table>
When you work as a team, there is always the chance that one of the team members, for whatever reason, may have more or less than a fair share of the workload. Therefore, it's important to find a way to keep track of what each team member is doing. A good way to do that is to have each team member keep a journal or log of what kind of work she does and how much time she spends doing it.

At the end of the project, if there are any problems in the balance of the work, the journal should make that fact very clear. At the end of the project, team members can add up their hours spent on the project; if anyone has spent a little more than her share of time working, the other members can make up for it by buying her dinner or some reward like that. Similarly, as you get down toward the end of the project, if it's clear from the journals that one team member's work responsibilities turned out, through no fault of his own, to be smaller than those of the others, he can make up for it by doing more of the finish-up work such as typing, proofing, or copying.

**Setting up a style guide or style sheet**

Because the individual sections will be written by different writers who are apt to have different writing styles, set up a style guide in which your team members list their agreements on how things are to be handled in the paper as a whole. These agreements can range from the high level, such as whether to have a background section, all the way down to picky details such as when to use italics or bold and whether it is "click" or "click on." See the excerpt from a project style sheet in the following.

Before you and your team members write the first rough drafts, you can't expect to cover every possible difference in style and format. Therefore, plan to update this style sheet when you review the rough drafts of the individual sections and, especially, when you review the complete draft.

**Highlighting**

1. Use **bold** for interface elements that function like commands (for example, the **Exit** button).
2. Use **bold** for menu options that get you to commands (for example, **File>Open**).
3. Use the > symbol to abbreviate menu traversal.
4. Use Courier New for example text that users type in (for example, **myfile.doc**).
5. Use italics for variables—placeholder text for which users substitute their own information (for example, **filename.doc**).

**Hyphenation**

1. **Individual words.** Turn automatic hyphenation off. Do not hyphenate words except in tight places like tables or graphics.
2. **Compounds.** Mr. Hyphen (Sterlin) will keep the hyphenated-compounds list. Use only those in his list, and submit new ones to him for approval and inclusion on the list. (Hyphenate compounds only for approval and inclusion on the list. [Hyphenate compounds only when they modify (for example, "back-up copy"), not when they act as nouns or verbs (for example, "to back up your files.")]"

**Terminology**

1. Use only the words in **graph_project.dic**. Sterlin approves all new words for that database.
2. Use the same word for the same object, same process, or same action. No elegant variation, please!

Excerpt from a style guide for a writing project. The items listed represent agreements team writers have made in order to give their paper as much consistency as possible.

**Reviewing drafts and finishing**
Try to schedule as many reviews of your team’s written work as possible. You can meet to discuss each other’s rough drafts of individual sections as well as rough drafts of the complete paper.

A critical stage in team-writing a paper comes when you put together into one complete draft those individual sections written by different team members. It’s then that you’ll probably see how different in tone, treatment, and style each section is. You must as a group find a way to revise and edit the complete rough draft that will make it read consistently so that it won’t be so obviously written by three or four different people.

When you’ve finished with reviewing and revising, it’s time for the finish-up work to get the draft ready to hand in. That work is the same as it would be if you were writing the paper on your own, only in this case the workloads can be divided up.
Information Structures
David McMurrey

Chapter Objectives

Upon completion of this chapter, readers will be able to:

1. Define information structure.
2. Explain the contents and organization of different types of information structures.

Use a logical, natural structure—content and organization

The main parts of a technical-writing course focus on applications—ways technical writing skills are applied in the real world. However, these applications use varying combinations of information infrastructures. An information structure is (1) a type of information content (such as descriptive writing), (2) a way of organizing information (such as a comparison or classification), or (3) both.

The information infrastructures reviewed in this appendix are the ones commonly used in technical writing. Of course, there are other infrastructures—maybe some that scholars of technical writing have not yet pinned a label on, but these are the most common and the most readily visible. And of course some of these infrastructures blend together. The main thing is that by knowing these, you have the intellectual tools for quickly organizing and structuring just about any writing project.

Description

What does it look like?

The biggest hurdle you may face in writing a description is remembering what the term means as it is used in this context. We all use the word description loosely to refer to practically any discussion or explanation. But in this context, it means the detailed discussion of the physical aspects of a thing. That means discussing things like color, shape, size, weight, height, width, thickness, texture, density, contents, materials of construction, and so on.

For example, this sentence is not really description in our sense of the word:

A computer diskette is a device used for storing electronic data.

It explains the function or purpose but provides little or no physical detail. However, this sentence is very definitely description:

The common computer diskette is 3.5 inches by 3.5 inches and approximately 1/8 inch thick.

Contexts for Description

As mentioned earlier, descriptions are common elements in technical writing—just not quite in the same way that instructions are. Descriptions appear more often as a sentence or two here, a paragraph there, or a whole section elsewhere. Certain kinds of technical writing feature description:

- Accident reports requiring plenty of description.
- Product specifications—documents that describe design and feature of a new or changed product—have plenty of description.
- Instructions often require description to enable readers to visualize what they are doing and what they are working with.

Contents and Organization of Descriptions

The following is a review of the sections you’ll commonly find in descriptions. As you read, check out the example descriptions.

Introduction. Plan the introduction to your description carefully. Make sure it does all of the following things (but not necessarily in this order) that apply to your particular description:
- Indicate the specific object about to be described.
- Indicate what the audience needs in terms of knowledge and background to understand the description.
- Provide a general description of the object.
- Include an overview of the contents of the description.

Background

If the thing you are describing is not likely to be familiar to most of your readers, consider adding some background before you plunge into the actual description. If you are about to describe an SGO/3 density gauge to nonspecialists, you'd better first discuss what in the world the thing is, what it does, and on what part of the planet it is used.

Discussion of the parts or characteristics

The main part of your description is the discussion of each part or characteristic. You must divide the thing you are describing into parts, or characteristics, or both. Parts are easy: for example, a wooden pencil has lead, a wooden barrel, an eraser, and a metal clip. Characteristics are describable aspects of a thing but are not parts: for example, the pencil has a certain weight, length, width, and so on. If you were a budding real-estate tycoon and had to describe a vacant lot for company files, you'd probably describe it by its characteristics: its location, square footage, terrain, vegetation, access to utilities, and so on. (Check out the description of the primitive stone scraper in the examples; part of it is arranged by characteristics, and part by parts!)

Once you've divided the thing you are describing into parts, characteristics, or both, your next job is to describe each one. For mechanical things, it works well to start by defining the part, by explaining its function. After that, you describe the part from general to specific, using any of the sources of description that are appropriate.

Notice that in description, you can mix other kinds of writing. You'll find yourself explaining functions, defining terms, discussing a bit of process as you describe. That's not a problem as long as the primary focus and the majority of the content is truly description.

Discussion of the related operation or process.

At some point in a description, often at the end, it is useful to summarize the operation or process associated with the object you're describing. For example, if you've just described a mechanical pencil, you could briefly explain how it is used. If you've just described a snowflake, you could discuss the process by which it formed.

Sources of Description

When you write a description, you need to think about the kinds of descriptive detail you can provide. Sometimes, descriptions are rather weak in this area. Use the following list to plan your description or to review a description you have written. Think of the categories of descriptive detail you could provide, or use the following list to identify categories you have not used:

<table>
<thead>
<tr>
<th>Descriptive Details</th>
<th>Descriptive Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>depth</td>
</tr>
<tr>
<td>height</td>
<td>amount</td>
</tr>
<tr>
<td>width</td>
<td>pattern, design</td>
</tr>
<tr>
<td>shape</td>
<td>ingredients</td>
</tr>
<tr>
<td>weight</td>
<td>age</td>
</tr>
<tr>
<td>materials</td>
<td>subparts</td>
</tr>
<tr>
<td>texture</td>
<td>length</td>
</tr>
<tr>
<td>location</td>
<td>finish</td>
</tr>
<tr>
<td>methods of attachment</td>
<td>temperature</td>
</tr>
<tr>
<td></td>
<td>moisture content</td>
</tr>
<tr>
<td></td>
<td>smell</td>
</tr>
</tbody>
</table>
Miscellaneous Concerns

In descriptions, you'll probably find yourself puzzling over how to handle numbers, abbreviations, and symbols:

Numbers

Remember that technical writing breaks some of those rules you worked so hard to learn in past writing classes. In the technical writing context, we are often vitally concerned about numbers and want them to stand out. This concern means that you should use numerals in running text when the number indicates an exact, measured, or measurable amount or when it represents a critical value. For example, in these sentences, it seems to matter that the numbers are exact:

The cup is 3 inches in diameter. Use 4 tacks to fasten the poster to the wall.

However, this does not mean using numerals for indifferent values. For example, in this sentence, there is nothing heart-stopping about how many sections the report has: The report contains four major sections.
Anatomy of a descriptive paragraph

Typically, it starts with some statement about the purpose or function of the part, with the descriptive detail following. Descriptive detail draws upon the "sources" of description—such things as color, shape, width, and height.

Abbreviations

In technical writing, we expect to see abbreviations. Use them in your description freely. Remember the rule on punctuating abbreviations—punctuate them only if they spell a word (for example, "in."). Remember too that abbreviations do not go up against the number they are used with (for example, make that "8 mm tape" or "8-mm tape" but not "8mm tape").

Symbols

The most common problem with symbols in instructions and descriptions has to do with inches and feet. If you're writing instructions for a carpenter's dream project where there are feet and inches all over the place, use the symbols " (inches) and ' (feet). However, if you cite inch and foot measurements only a few times, use the word or abbreviation instead.

Graphics and Format in Descriptions

In most descriptions, you'll need at least one illustration of the thing you are describing, with labels pointing to the parts.

Headings

In descriptions, you'll want to use headings and subheadings to mark off the discussion of the individual parts or characteristics. Remember that, ideally, you want to describe each part in a separate paragraph or section—and flag that discussion with a heading. If you have a background section, use a heading for it too.

Lists

Lists are not nearly so important in descriptions as they are in instructions. However, if you itemize parts or subparts or list specifications, these are good situations for lists.

Special notices

In descriptions, there is nothing like the important role for special notices as there is in instructions. After all, if it really is a description, readers should not be trying to follow any procedure, and, therefore, should not be running any risks of damaging equipment, wasting supplies, screwing up the procedure, or injuring themselves or others. However, you may find the note special notice to be useful to emphasize important points or exceptions.

Comparison
What's it like—what's it not like?

Another important information structure often used in technical writing is comparison.

What Is Comparison?

In technical writing, comparisons can be very important. Short comparisons to similar or familiar things can help readers understand a topic better; comparisons can also help in the decision process of choosing one option out of a group. An extended comparison, which is the focus in this chapter, is one or more paragraphs whose main purpose and structure is comparison. One type of comparison is the analogy, which is a special type of extended comparison of an unfamiliar thing to a familiar thing.

Extended comparisons can be informative or evaluative. An informative comparison seeks to compare the topic to something similar or familiar to help people understand the topic or, in some cases, to help people understand both better. An evaluative comparison seeks to recommend one or more of the options by comparing them.

How to Identify Points of Comparison

When you write an extended comparison, you must start by identifying the specific ways in which you are going to compare the things you plan to write about. These points of comparison are like categories of comparative detail. For example, in an evaluative comparison of smart phones, you’d probably want to compare the best four or five machines according to the following:

- cost
- ease of use
- reliability
- special features, and so on

If you don't start by identifying the points of comparison, your comparison can become uneven—for example, you might say that model 1 is easy to use but not say anything about the ease of use of models 2, 3, or 4.

How to Organize Comparisons

One of the most important concepts to learn in writing comparisons has to do with organizing the contents. There are two basic ways to organize a comparison:

- whole-to-whole approach
- point-by-point approach

To get a sense of how these two approaches work, take a look at the following illustration of these two approaches. In the whole-to-whole approach, details about each of the options being compared are lumped together. This is our natural tendency—however, it does a sloppy, uneven job of stating the comparisons. The better way is to use the point-by-point approach. In the schematic diagram in the illustration, you’d have one paragraph comparing the costs of Models A, B, and C; then another paragraph comparing the warranties of the three models; and so on.

Use the point-by-point approach unless something about your topic, purpose, or audience dictates otherwise. With the whole-to-whole approach, the comparison is often uneven—you might forget to tell about the warranties for Model B; you might neglect to state the actual results of comparison—that Model C is better in terms of special features. In the whole-to-whole approach, writers often leave the actual comparisons up to the reader, thinking that just supplying the raw data is enough.

In the point-by-point approach, each of the comparative sections should end with a conclusion that states which option is the best choice in that particular category of comparison. Of course, it won't always be easy to state a clear winner—you may have to qualify the conclusions in various ways, providing multiple conclusions for different conditions.
**How to Write Comparisons?**

As with causal discussions, comparisons are not distinctive because of a certain kind of content. Instead, it's the special transitional words that make comparative writing work: for example, "similar," "unlike," "more than," "less than," and other such words that draw readers’ attention to comparisons and highlight the results of the comparisons. Notice how many are used in the illustrations in this chapter.

When you write comparisons, take special care to use these transitional words. Emphasize the similarities and differences—don’t force readers to figure them out for themselves.

---

**Stirling Engines: An Evaluation**

Many characteristics make the Stirling engine an appealing alternative to the internal combustion engine:

- Foremost is its fuel efficiency and fuel economy: the Stirling engine runs at an efficiency of 37.4 percent, more than double that of the internal combustion engine. It is projected to yield 50 percent better gas mileage.
- The Stirling engine produces extremely low emissions; it can meet all emission standards with none of the special modifications required by internal combustion engines.
- Unlike the internal combustion engine, the Stirling engine can run on practically any fuel that can produce heat.
- Without valves and fuel explosions that take place in an internal combustion engine, the Stirling engine operates with very little noise.
- Finally, the Stirling engine has a flat torque characteristic, meaning that torque is practically independent of engine speed. Compared to the internal combustion engine, the Stirling engine provides much higher torque, and thus more power, at lower engine speeds.

All of these characteristics should lead to the increasing importance of the Stirling engine in the years to come.

— Text developed in the 1980s
Remember that this is just a typical or common model for the contents and organization—many others are possible.

**How to Format Comparisons?**

Comparisons don’t call out for any special format; just use headings, lists, notices, and graphics as you would in any other technical document.

**Classification**

**What are its categories—into which does it fit?**

Another important information structure often used in technical writing is classification.

**What is Classification?**

In some technical reports, certain paragraphs or sections use a kind of writing and pattern of organization known as classification. Classification means either (1) explaining which class a thing belongs to or (2) dividing a group of things into classes. You may find that classification is an effective way to present background information to your readers.

**True classification**

You are “classifying” (in the strict dictionary sense of the term) when you place an object, action, or person in one of several classes. For example, the XYZ Corporation may have just come out with its new ABC computer but cannot decide whether to classify it as a laptop or a notebook computer. A botanist may have discovered a new species of fungus and must now decide how to classify it. Written documents on these questions would resemble comparison because features of the new item (the computer or the fungus) must be compared to those of the established classes. The Jupiter example in the following shows an example of a true classification in which the writer shows why the object belongs to one specific category.

**Division**

Classification can also refer to breaking a thing down into its types, classes, categories, or kinds and then discussing each one. For example, computers for some time now have been divided into several classes: minicomputers, microcomputers, and
macrocomputers. And, if you have ever taken biology, you know that terrestrial life is divided into plant and animal "kingdoms"; the kingdoms, broken down into phyla (the plural of phylum); phyla, into classes; classes, into families; families, into genera; and genera, into species. Each of these divisions—except perhaps the last—represents a grouping of types.

Several key words indicate that classifications are being discussed: classes, kinds, types, categories, sorts, or groups. Classification can be quite useful in technical reports: it breaks the discussion of a subject into smaller chunks, and it can make the job of evaluation and selection much easier.

Jupiter can be classed as a Jovian planet because of its size and its average density. Indeed Jupiter is the largest planet in our solar system (as shown in Figure 16) and one of the brightest objects in the sky, having attained a magnitude of -2.5, more than a full magnitude brighter than Sirius, the brightest star in the sky. Jupiter's brightness results from its great size of course but also from its high reflectivity: it reflects about 44 percent of the light it receives. The size and composition of Jupiter's interior are open to much speculation. Some astronomers picture the interior as having a radius of over 30,000 miles and as possibly being composed of liquid hydrogen. The core is small and dense and may contain iron silicates. The other Jovian characteristic of the planet is its density. Even though its diameter is only 11 times that of the Earth, its total volume is 11 × 11 × 11, or over a thousand times that of Earth.

In this example, the writer argues that Jupiter should be categorized as a "Jovian"-type planet. This is one type of classification; in the other, you divide a collection of things into categories, or types.

How to Identify Classes and the Principle of Classification?

Once you know what you are going to divide into classes, your next step is to identify the classes and the principle of classification. For example, if you were classifying dialysis machines (used to treat people with kidney disease), you might list these classes:

- parallel flow design dialyzers
- coil design dialyzers
- hollow-fiber capillary dialyzers

The principle of classification is the design of the structure through which blood is filtered.

The principle of classification then is the method you use to sort the items into classes. If you sorted marbles into red, green, and blue ones, you'd be using color as the principle of classification. You must be careful to use only one principle of classification at a time. For example, you couldn't sort your marbles by color and size— you might have some big red ones and some small red ones!

Here are some additional examples of classifications and their principles:

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic</strong></td>
</tr>
<tr>
<td><strong>Classes</strong></td>
</tr>
<tr>
<td><strong>Principle of classification</strong></td>
</tr>
<tr>
<td>Electrical circuits</td>
</tr>
<tr>
<td>Series</td>
</tr>
<tr>
<td>Parallel</td>
</tr>
<tr>
<td>Series-parallel</td>
</tr>
<tr>
<td>Pathway of electrical current</td>
</tr>
<tr>
<td>Anemias</td>
</tr>
<tr>
<td>Blood-loss anemia</td>
</tr>
<tr>
<td>Iron-deficiency anemia</td>
</tr>
<tr>
<td>Pernicious anemia</td>
</tr>
<tr>
<td>Main cause of the anemia</td>
</tr>
<tr>
<td>Hurricane track prediction methods</td>
</tr>
<tr>
<td>Total climatology and persistence methods</td>
</tr>
<tr>
<td>Particular climatology and persistence method</td>
</tr>
<tr>
<td>Combination of hurricane characteristics</td>
</tr>
</tbody>
</table>
Circulation and climatology method
Dynamic model method

<table>
<thead>
<tr>
<th>Wind machines</th>
<th>Lift machines</th>
<th>Drag machines</th>
<th>Interaction between the wind and propeller blade</th>
</tr>
</thead>
</table>

**How to Discuss the Classes?**

When you write the discussion of the individual classes, you must choose sources of discussion that enable you to explain each class fully, add comparisons so that readers can see the differences between the classes, and plan for the length of your classification.

**Choosing sources of discussion.**

Writing the discussion of individual classes is much the same as it is with extended definitions: you combine a variety of sources to explain the classes fully. To discuss the three types of dialysis machines for victims of kidney disease, you might use these sources:

<table>
<thead>
<tr>
<th>Classification of dialysis machines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td><strong>Process</strong></td>
</tr>
<tr>
<td><strong>Comparison</strong></td>
</tr>
</tbody>
</table>

Of course, some classifications may use only one kind of writing. For example, in the discussion of different hurricane track prediction methods, the discussion would most likely be process—step by step how the methods work.

**Adding comparisons**

No matter which sources you use in discussing the classes, comparison is an important ingredient. It helps readers distinguish the different classes from each other. Check out the following example of how comparisons work in classifications.

**Pressurized-water reactors (PWR).** The first pressurized-water reactor was the submarine thermal reactor built in Idaho in 1953, which led directly to the first nuclear-powered submarine, the USS *Nautilus*. As the name implies, a pressurized-water reactor is both cooled and moderated by water under high pressure, thus permitting high temperatures. The hot water is pumped from a pressurized vessel containing the nuclear core to a steam generator in which heat is exchanged to produce the steam that drives a turbogenerator...

**Boiling-water reactors (BWR).** Boiling water reactors have much in common with pressurized-water reactors:

- The main difference is that the intermediate steam generator is omitted, and steam is supplied directly from boiling water in the reactor core.
- Less pressurization is needed because the water is allowed to boil, and less pumping is needed because of the large amount of heat absorbed by boiling water.
- An increase in steam production compared to that of the pressurized-water reactor is a result of an increase in power level, which reduces the water volume which lessens its moderating ability—a condition which in turn lessens reactivity.

—Text developed in the 1980s
Comparing the types to each other gives readers a clearer sense of the types as well as their distinguishing features.

**Short and extended classifications.**

In short classifications, an overview of the types is packed into one sentence or into one paragraph. In an extended classification, you might have one or more paragraphs on each type. For an extended classification, you'll use a paragraph or more to discuss each of the classes, and a separate paragraph to introduce these classes—as illustrated in the extended classification in the following.

Three types of circuitry are used in automobile electricity:

- **Series circuit.** In this type, the current flows in one path—for example, from the battery through the switch and through two light bulbs. In a series circuit, current must pass through all its electrical devices. If an devices fails to work, it will act as a switch and open the whole circuit.

- **Parallel circuit.** In the parallel type, there are two or more paths for current flow. If one device fails to work, the current still goes to the other devices, and they continue to work.

- **Series-parallel circuit.** Most automotive electrical circuits use a combination of series and parallel circuits. The series part works like a series circuit, as described above; the parallel part, like a parallel circuit.

**Types of Anemias**

One of the most important classes of disorders of the hematological system involves the various types of anemias (disorders of the red blood cells). The term *anemia* is used to indicate a deficit in the amount of iron expressed as hemoglobin in the blood. Anemia is further defined by the mechanism that causes the inability of the erythrocytes to deliver enough oxygen to the individual cells.

Anemia can be the result either of a lack of the total number of red blood cells or by low amounts of hemoglobin in the individual erythrocytes. *Hypoxia* is the universal symptom of this condition where the patient's blood cannot carry sufficient amounts of oxygen.

The most common classes of anemia include (1) blood-loss anemia, (2) iron-deficiency anemia, (3) pernicious anemia, (4) aplastic anemia, (5) hemolytic anemia, (6) sickle cell anemia, and (7) secondary anemia.

**Blood-loss anemia.** Obviously, with any great loss of blood, one will become anemic. If a patient loses some of the red blood cells needed to carry oxygen, the only oxygen that can get to the tissues is that carried by the erythrocytes that are left.

**Iron-deficiency anemia.** The normal nonanemic male loses approximately 1 mg of iron per day principally from the gastrointestinal tract...
How to Format for Classifications?

Classifications don't call out for any special format; just use headings, lists, notices, and graphics as you would in any other technical document. For details, see:

- Headings
- Lists
- Notices
- Graphics

Causal Discussion

What happened—why did it happen?

Another important information structure often used in technical writing is the discussion of causes and effects.

What Is a Cause–Effect Discussion?

Discussions like these answer questions such as the following:

- What are (or were) the causes of this? How and why does (or did) this happen?
- What brought about a situation, problem, or accident?
- What are (were or will be) the effects, results, or consequences of this? What will happen if a certain situation or problem continues?
- How does this work? What causes this to function as it does?
- Why won't this thing work? What's wrong with it?
- What changes will occur if a certain plan or action is taken?
- How can a certain problem or situation be avoided?
- What are the advantages, benefits, or disadvantages of an action or object?
- What are one or more potential solutions to a problem?
Some examples:

- What causes tornadoes? What sorts of damage do tornadoes cause?
- What will happen if the world continues to use petroleum resources at its current rate?
- What were the causes of the Great Depression?
- What are the effects of an economic recession?
- How does a photocopier work?
- What makes a microwave oven work? (Does this sound like your seven-year-old?)

As you can see from these examples, we can discuss the causes and effects of human or social processes, natural processes, mechanical or physical processes, historical or economic processes, meteorological or biological processes, and on and on.

If you think about it, there's not much difference between process discussion and causal discussion. Both occur over time; steps in a process often involve causes and effects. The distinction depends on your purpose and emphasis: process discussions are primarily concerned with how an event occurs; causal discussions, with why an event occurs. Process discussion focuses on the chronology of something; causal discussion focuses on the causes and effects.

- I can tell you step by step how to take a photo or what events occur inside the camera when you take a picture—that's process.
- But I can also explain to you what physical and chemical principles are at work when you take a photo, what principles actually enable you to take a photo—that's causal discussion.

For some topics, however, such as explaining tornadoes, it's almost impossible to make a distinction. Here are some contrasting examples:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Process discussion</th>
<th>Causal discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightning</td>
<td>How to safeguard home appliances from lightning</td>
<td>What natural phenomena cause lightning</td>
</tr>
<tr>
<td>Instruction writing</td>
<td>How to set up understandable instructions</td>
<td>What causes instructions to be unclear</td>
</tr>
<tr>
<td>Acquisition of language by chilren rapidly</td>
<td>How to help children learn language more rapidly</td>
<td>Why certain children learn language more rapidly</td>
</tr>
<tr>
<td>Growing tomatoes</td>
<td>How to plant and care for tomatoes</td>
<td>Reasons why tomatoes are less productive</td>
</tr>
<tr>
<td>Air conditioning</td>
<td>How cool air is produced by conventional systems</td>
<td>Why your air conditioning is costing you more this summer</td>
</tr>
</tbody>
</table>

Here are some common reasons why you may need to discuss causal and effects:

- You need a record of the damage done by something. Photographs work, but words may also be needed.
- You need an account of the scientific principles at work in a process so that you can understand what you are doing in an instructional procedure.
- You need to understand the causes of something so you can have a better understanding of how to control or eliminate it.
- You need to understand the effects of something so that you can work to prevent it or increase its likelihood.

### How to Organize Causal Discussions?

How you organize the contents of a causal discussion depends on how many and what combination of causes and effects you discuss:

- Single cause–single effect—A single cause can lead to a single effect; for example, a radiator leak can cause the car to overheat.
- Multiple causes–single effect—Many different causes can be seen as leading to one effect: for example, high unemployment, high interest rates, and high real estate costs (causes) might lead to decreased real estate sales (effect).
- Single cause–multiple effects—A single cause can be seen as producing numerous effects. For example, proponents of the greenhouse effect believe that increased CO$_2$ in the atmosphere (cause) will lead to changes in weather patterns, higher temperatures, drought, increased storm activity, and higher sea levels (effects).
- Sequential causes and effects—One cause can bring about an effect, which in turn becomes the cause of another effect, and so on. For example, proponents of the greenhouse effect argue that increased burning of fossil fuels (cause) leads to increased CO$_2$ in the atmosphere (effect) which in turn is the cause of less thermal energy being reradiated out of the system (effect) which in turn becomes the cause of increased global temperatures.
- Alternate causes and effects—Causes and effects can be alternating. For example, if the car won't start (effect), it may be because of a dead battery (alternate cause 1), no gas in the gas tank (alternate cause 2), or a faulty part (alternate cause 3).
Consider a simple example: imagine you want to discuss how a single situation has led to a number of problems, in other words, one cause leading to several effects. In a single paragraph, the first couple of sentences might focus on the cause; each of the following sentences would focus on the effects. In an extended discussion, there might be a paragraph on the cause, and a paragraph on each of the effects. The preceding schematic diagram of a causal discussion in shows you how the single-paragraph approach would look.

**How to Discuss Causes and Effects?**

Actual discussion of causes and effects is not as immediately identifiable as descriptive or process writing are. Typically, causal discussions talk about events and describe things. What makes causal discussions distinctive is the use of transitional words to indicate the causes and effects.

In this sentence:

*Increased deficit spending by the government leads to increased inflation*

the verb "leads to" establishes the connection between a cause and an effect. In this excerpt, the connective "consequently" establishes a causal link between the increasing domestic anger over the Vietnam war and Johnson's decision not to seek reelection:

Meanwhile at home, anger, hostility, and outright revolt against the war grew. Johnson, sensing he could not get reelected in this atmosphere, consequently decided against running for another term.
How to Format for Causal Discussions?

Here are a few suggestions on format as they relate specifically to causal discussions:

- **Headings.** If you write an extended causal discussion and have separate paragraphs for each of the causes or effects, then the headings should signal those causes. (See the examples in this chapter.)
- **Lists.** If you discuss sequential causes and effects, you’re likely to need in-sentence and vertical numbered lists. If you have multiple causes or effects but no necessary order amongst them, then bulleted lists are appropriate.
- **Graphics.** Causal discussions often use conceptual diagrams to show the relationships between the causes and effects. In these you give a spatial representation of the causes and effects as they occur in time.
- **Style.** As with any other technical writing, you treat numbers, symbols, and abbreviations in process discussions the same. Exact measurement values should be numerals, regardless whether they are below 10.
Extended Definition

How can you define it?

An important writing tool you'll need, particularly if you are writing for nonspecialists, is definition—or more specifically, extended definition. An extended definition is a one or more paragraphs that attempt to explain a complex term. Some terms may be so important in your report, there may be so much confusion about them, or they may be so difficult to understand that an extended discussion is vital for the success of your report.

When you write reports, you may often discover that you need to explain certain basics before you can discuss the main subject matter. For example:

- In a report on new treatments for sickle cell anemia, you'd need a section defining the disease.
- In a report on the benefits of drip irrigation, you'd need to write an extended definition of drip irrigation, explaining how it works and what equipment is used.
- In a report showing small businesses how to weather economic recessions, an extended definition of the term economic recession would be needed first.

Writing Formal Sentence Definitions

One of the first things to do when you write an extended definition is to compose the formal sentence definition of the term you are writing about. Place it toward the beginning of the extended definition. It establishes the focus for the rest of the discussion. It is "formal" because it uses a certain form. Here are several examples:
An algorithm is a finite description of a finite number of steps required to accomplish some well-defined task.

Carbohydrates are a food group including sugars, starches, and cellulose.

Computer memory is one of three basic components of a computer which stores information for future use—both the data that will be operated on as well as the programs that direct the operations to be performed.

Reservoir rock is that type of rock that has sufficient porosity and permeability to allow gas and oil to accumulate and be produced in commercial quantities.

Influenza is an acute highly contagious infection of the respiratory tract, which occurs sporadically or in epidemics and that lasts up to a month.

Characteristics: details about the term that distinguish it from other members of the class (red)

Choosing the Sources of Definition

Stress is a measure of the internal reaction between elementary particles of a material in resisting separation, compacting, or sliding that tend to be induced by external forces. Total internal resisting forces result from continuously distributed normal and tangential forces that vary in magnitude and direction and act on elementary areas throughout the material. These forces may be distributed uniformly or nonuniformly. Stresses can be categorized as tensile, compressive, or shearing, according to the straining action.

Strain is a measure of deformation such as:

a. linear strain, the length per unit of linear dimensions
b. shear strain, the angular skew in a radians of an element undergoing change of shape by tangential forces
c. volumetric strain, the change of volume per unit of volume

The strains associated with stress are characteristic of the material.
When you write an extended definition, you literally grab at any of the writing resources or tools that will help you explain the term to your readers. This means considering all of the various sources of information that can help define the term adequately (for example, description, process narration, causal discussion, and classification).

Notice how many different kinds of writing are indicated in the examples in this chapter.

The key to writing a good extended definition is to choose the sources of definition to help readers understand the term being defined. Use this checklist to select the kinds of discussion to include in your extended definitions:

<table>
<thead>
<tr>
<th>Sources of Extended Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Does anything related to the term being defined need to be described?</td>
</tr>
<tr>
<td>Process narration</td>
<td>Is there some process (natural, social) associated with the term that should be discussed?</td>
</tr>
<tr>
<td>Additional definitions</td>
<td>Do unfamiliar terms occurring in the definition also need definition?</td>
</tr>
<tr>
<td>Historical background</td>
<td>Is there some history, some key individuals related to term being defined? Would that discussion contribute to the definition of the term?</td>
</tr>
<tr>
<td>Cause, causes</td>
<td>Does the reader need to know about causes related to the term being defined?</td>
</tr>
<tr>
<td>Effects, results, consequences</td>
<td>Does the reader need to know about effects related to the term being defined?</td>
</tr>
<tr>
<td>Problems, solutions</td>
<td>Does the term being defined represent a problem or a solution?</td>
</tr>
<tr>
<td>Statistics</td>
<td>Should you discuss numerical data related to the term defined—percentages, amounts, etc.?</td>
</tr>
<tr>
<td>Uses, applications</td>
<td>Would it help to discuss uses or applications related to the term?</td>
</tr>
<tr>
<td>Similarities, differences, analogies</td>
<td>Is the term similar to or different from something else? Would an analogy help define the term?</td>
</tr>
<tr>
<td>Classes, types, categories</td>
<td>Are there categories that the term can be divided into? Does it belong to a certain category?</td>
</tr>
<tr>
<td>Examples</td>
<td>Would examples contribute to the definition of the term?</td>
</tr>
<tr>
<td>Future developments, implications</td>
<td>Would an understanding of the roots, the etymology, of the word help define it?</td>
</tr>
<tr>
<td>Word origins</td>
<td>Should future developments related to the term be discussed? Does it have implications—good, bad, both?</td>
</tr>
<tr>
<td>Negatives</td>
<td>Would explaining what the term is not, what it does not refer to, help?</td>
</tr>
<tr>
<td>Advantages, disadvantages</td>
<td>Are there advantages and disadvantages related to the term that can be discussed?</td>
</tr>
</tbody>
</table>
I. Introduction

II. Alzheimer's Disease: Overview of Current Knowledge
   A. Two Main Types of Alzheimer's Disease
      1. Alzheimer's disease (pre-65)
      2. Senile dementia of the Alzheimer's type (post-65)
   B. Demography of Alzheimer's Disease
      1. Age distribution
      2. Gender distribution
      3. Other demographics
   C. Process and Characteristics of Alzheimer's Disease
      1. Forgetfulness
      2. Speech disorders
      3. Difficulty calculating
      4. Visual disorientation
      5. Abnormal judgment and social behavior
   D. Brain Pathology of Alzheimer's Disease Victims
      1. Reduced brain size
      2. Neurofibrillary tangles
      3. Neuritic plaques
      4. Loss of specific populations of nerve cells
   E. Etiology of Alzheimer's Disease
      1. Aging
      2. Inheritance
      3. Infectious agents and toxins

III. Current Alzheimer's Disease Treatment

---

**Classification:** the disease is defined according to its main two types.

**Description:** demographic statistics are used in this definition.

**Process:** the stages of the disease are identified along with the effects of the disease at each stage.

**Effects:** clinical effects of the disease.

**Causes:** various possible causes of the disease.

*Formal sentence definition begins this extended definition.*

*Quick parenthetical definition of a potentially unfamiliar term.*

*Supplementary definitions used within this extended definition.*

*Demographics (statistics) used to further define the term.*

**Process of the disease**

Approximately 5% of the U.S. population over 65 have severe dementia; an additional 10% have a mild-to-moderate impairment in memory and cognition. Of these demented individuals, approximately 40-50% have Alzheimer's disease, making this disorder the most common cause of dementia in middle and later life.

*Affected individuals are, at first, forgetful. As the memory disorder gradually worsens, the individuals, although able to recall occurrences in the distant past, are unable to remember recent events. Subsequently, speech, the ability to calculate, visual orientation, judgment, and social behavior become progressively abnormal. Eventually, the individuals become profoundly demented and frequently die of intercurrent infection.*
Adding Short Definitions

As mentioned earlier, you'll find that in writing an extended definition, you must define other terms as well. Typically, short definitions—a sentence, clause, or phrase in length—will suffice. Notice how many are added to the "after" version in the following.

Before Translation

Measles is an acute, highly infectious disease, with cough, fever, and maculopapular rash. It has worldwide endemicity. The infective particle is an RNA virus about 100-150 nm in diameter, measured by ultrafiltration, but the active core is only about 65 nm as measured by inactivation after electron irradiation. Negative staining in the electron microscope shows the virus to have the helical structure of a paramyxovirus with the helix being 18 nm in diameter.

Measles virus will infect monkeys easily and chick embryos with difficulty. In tissue cultures, the virus may produce giant multinucleated cells and nuclear acidophilic inclusion bodies. The virus has not been shown to have the receptor-destroying enzyme associated with other paramyxoviruses. Measles, canine distemper, and bovine rinderpest viruses are antigenetically related.

After Translation

Measles is an acute, highly infectious disease caused by a virus. The illness is characterized by a cough, fever, and maculopapular (raised red) rash. It has worldwide endemicity—that is, people throughout the world are vulnerable to the disease. The infective particle (organism causing the disease) is a virus about 100-150 nm (a nanometer being $10^{-9}$ meter) in diameter and contains RNA (ribonucleic acid) as its genetic material rather than DNA (deoxyribonucleic acid). The size of the measles virus as measured by ultrafiltration, in which filters with extremely small pore are used. The active core, or actual genetic material (RNA), is only 65 nm as measured by electron irradiation which inactivates the core. Negative staining, a shadowing technique used with an electron microscope, shows the virus to have a specific helical structure common to a group of viruses known as paramyxoviruses. The helix, a spiral around a core (similar to a winding staircase) is 18 nm in diameter.

Measles virus will infect monkeys easily and chick embryos with difficulty. In tissue cultures (those involving living cells or tissues from other living organisms), the measles virus may produce giant cells containing many nuclei and acidophilic inclusion bodies (red stained areas in the nucleus which are a laboratory sign for certain viral infections). The virus has not been shown to have the receptor-destroying enzyme, a protein capable of destroying or inactivating a cell-surface molecule, usually associated with other viruses in the paramyxovirus group.

Measles, canine distemper (a flu-like disease affecting dogs), and bovine rinderpest (a virus affecting cows) are antigenetically related—that is, they possess similar antigens (molecules that stimulate production of an antibody on their surfaces).

This process of supplying short definitions "on the fly" is critical in good technical writing for nonspecialists. Notice how many quick definitions occur just in the first two sentences of the preceding illustration. "Maculopapular" is defined in parentheses as "(raised red)." "Endemicity" is defined by restating the idea in other words: "that is, people throughout the world are capable of contracting measles." And "infective particle" is quickly defined by providing an alternative: "or organism causing the illness." Obviously, the passage is almost tripled in length—but that's the price for thorough explanation and clarity.

Format for Extended Definition

Extended definitions don't call out for any special format; just use headings, lists, notices, and graphics as you would in any other technical document:

- Headings
- Lists
- Notices
- Graphics
Process Discussions

How does it happen?

In technical writing, process discussion is one of the most important kinds of prose: people need to know how things happen, how things work, how to operate things, and how to perform certain actions. A narration tells how something occurs over a period of historical time. A process is an event or set of events that can be performed or that occurs regularly or repeatedly. The words "procedure" and "routine" are closely related. When you "narrate" a "process," you explain how something works or how something occurs. We'll use "process discussion" here.

What Is a Process?

Process discussion is an information structure—it's one of those fundamental combinations of content and organizational patterns you use in many different situations in technical writing. For example, instructions are an application of technical writing; instructions make heavy use of process discussion.

The focus of this chapter is some basic guidelines for writing noninstructional process discussions. These process discussions answer such questions as:

- How does this mechanism work?
- What are the typical steps in this natural, mechanical, social, biological, psychological phenomenon?
- How does this event (mechanical, natural, human, social) happen?
When we ask questions like these, we expect a systematic step-by-step explanation of how the mechanism works or how the phenomenon happens. We're not looking to perform it ourselves, just to understand it. These are closely related to process discussions. In causal discussions, we're interested in why something happens, what causes it, what its results or consequences are. In process discussions, we are interested in how something happens, how it works, in a step-by-step fashion. Often the distinction between these two is blurry.

Speech Recognition Systems: Process

In most computerized speech recognition systems, the following pattern of events occurs:

1. A microphone picks up sound and converts the waves into analog voltage signals.
2. Each signal then goes into an analog-to-digital converter which samples the signal at about 10,000 times second, slices it into intervals, and converts the samples into pattern sets. In other words, the speech signal is cut up into small parts, and each part is assigned either the number 1 or the number 0 depending on the characteristics of the signal in that specific part.
3. The signal then passes through a data filter where all unimportant sound waves are eliminated.
4. The digital pattern sets are then compared to others in the computer's memory for close match-ups.

— Text developed in the mid-1990s

Process discussions focus on things like formation of lightning, snow, hurricanes, cold fronts, tornadoes; gestation of a human embryo; pollination of a flower; automatic operations of a photocopier or a computer; occurrence of supernova, black holes, red giants, or white dwarfs. Process discussions explain the workings of such mechanisms as automobile batteries, light bulbs, telephones, televisions, microwave ovens, stereo receivers.

As mentioned previously, the focus in this chapter is noninstructional process. However, while explaining how doctors perform open heart surgery or how a nuclear power plant operates might sound like instructions, they aren't! Normally, documents on these topics would give people an overview of what goes on in these processes. This next illustration conveys a general idea of how seawater is converted into fresh water:

Desalination: Direct Freezing Method

In the direct freezing method used to remove salt from seawater, the water itself acts as the refrigerant. In this process, there are essentially four steps: pressurization and evaporation, freezing, separation, and discharge of the briny portion of the seawater.

1. The process begins as the seawater enters a heat exchanger that cools the incoming water.
2. This cooled seawater then enters the crystallizer (freezing tower), which is kept at a pressure of 3 to 4 mm Hg, equivalent to about 0.005 atmospheres.
3. As the water is sprayed into the crystallizer, evaporation occurs because of this lower pressure. Because heat energy is used up as a liquid evaporates, the temperature in the crystallizer drops to a range from 1.5°C to 3.5°C. This temperature drop causes most of the water to freeze.
4. The conversion of the water to ice in the crystallizer in turn provides the heat needed for evaporation.
5. Once the crystallization process has produced a fine slush, the mixture of ice crystals and brine can be separated. For this purpose, the countercurrent washing method, in which the ice crystals move against a stream of fresh water that cleans the ice crystals of their brine coating, is employed.
6. After this separation phase...

— Text developed in the 1980s

How to Divide the Process into Steps?

https://softchalkcloud.com/lesson/files/laUg6x0utVJwCf/5_11InformationStructures_print.html
When you write a process discussion—whether it's a single paragraph or a whole report—one of the most important tasks is to divide the process into its main steps, phases, stages, or periods. There are of course other ways to handle a process discussion, but division by steps is usually the best. For example, you might try organizing a process discussion by the key parts of a mechanism. Use whichever plan seems to work best for your readers, topic, and purpose.

A step is one action or event (or a group of related ones) that is performed or that occurs in the process. Consider a simple process such as making coffee with a drip coffee pot. Such an activity involves the following steps, each of which actually represents a group of actions:

1. Boiling the water
2. Finding the kettle and taking it to the sink
3. Turning on the water and rinsing out the kettle
4. Filling up the kettle to the desired amount
5. Placing the kettle on a burner
6. Turning on the burner
7. Waiting for the water to boil
8. Rinsing the coffee pot and the basket
9. Measuring in the new coffee
10. Pouring in the boiling water

Obviously, no one needs to be told all these specific actions; the example shows that a step usually stands for a group of related specific actions or events. If you look back at the preceding desalination example, you see a more realistic example of this process of division into steps. The discussion focuses on four steps in the desalination process: (1) pressurization and evaporation, (2) freezing, (3) separation, and (4) discharge of the briny portion of the seawater.

How are process discussions used in technical documents? First and foremost, processes are typically explained in instructions. For some situations, explaining how a thing works is almost as effective as providing the direct step-by-step instructions. And in any case, people understand the actions they are performing better when they understand the actions behind those actions. Process discussions are also vital in new product documents—either internal (meant for the product's designers and marketers) or external (meant for the product's customers and users). And finally process discussions are important in scientific research literature. You can imagine researchers studying acid rain or oil spills—understanding these processes might lead to controlling them better.

How to Discuss the Steps?

When you discuss a process, your goal is to enable readers to understand how that process works, the typical events that occur in that process. You use any writing tools at your disposal to accomplish that end. One of the most common ways of explaining a process is to divide it into steps, phases, periods, stages. These are essentially time segments—groupings of closely related events or actions. Take a look at any of the examples in this chapter; you'll see process sentences everywhere.

However, most process discussions aren't much without explanations of the causes and effects operating behind them. For example, it's not terribly exciting to read that when tornadoes form, it gets cloudy, wind and rain and twisters occur, wrecking things. We want more that just the bare-bones process: we want to know what causes them to form, what are the conditions favorable to their formation, how they behave once formed, and of course what sorts of damage they cause.

Other sorts of information can supplement the discussion of processes as well:

- Description: Explain how things look before, during, or after the process, or any phase within the process.
- Definitions: Explain the meaning of any technical terms used in the discussion.
- Comparisons: Compare the process, any of its phases or outcomes, to something similar or something familiar to help readers understand.
- Examples: Provide examples of the process you are explaining. For example, in a discussion of tornadoes, examples of tornadoes in history can help.

**Mitosis** is the process of cell duplication, during which one cell gives rise to two identical daughter cells. The process consists of four main phases: prophase, metaphase, anaphase, and interphase.

1. In prophase, the genetic material thickens and coils into chromosomes, the nucleus disappears, and a group of fibers begins to form a spindle.
2. In metaphase, the chromosomes duplicate themselves and line up along the mid-line of the cell. The halves are known as chromatids.
3. In anaphase, the chromatids are pulled at opposite ends of the cell by the spindle fibers. At this point, the cytoplasm of the mother cell divides to form two daughter cells, each with the number and kind of chromosomes the mother cell had.
4. In interphase, the daughter cells begin to function on their own, once their nucleus membranes and nucleoli reform.

Expanding example of process discussion. Information structures can work like an accordion—they can expand or collapse according to your needs.
How to Format Process Discussions?

Here are a few suggestions on format as they relate specifically to process discussions.

- **Headings.** If you write an extended process discussion and structure it by steps or phases, in other words, time segments, then the subheadings can be related to those steps or phases, as illustrated in the following schematic view of process discussions. If your process discussion has one section in which you explain the process and another in which you discuss some supplementary aspect of the process, your headings would need to indicate that structure as well.

- **Lists.** Because they focus on sequences of events, process discussions are likely candidates for in-sentence and vertical numbered lists as the examples in this chapter show.

- **Graphics.** Process discussions are prime territory for flow diagrams such as you see in some of the illustrations in this book. In these you give a spatial representation of things as they occur in time. Useful also are diagrams and drawings of the mechanisms that take part in the process.

- **Style.** You treat numbers, symbols, and abbreviations in process discussions the same as in any other technical document. Exact measurement values should be numerals, regardless whether they are below 10.

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**Persuasion**

**Tell them why—get them on your side**

When the teaching of technical writing first emerged in university engineering schools, it was defined as rigorously objective in writing style—even to the extent of using the passive voice instead of the first person singular "I." The standard model was the primary research report. However, since then, it has become clear that technical writers must often engage in persuasive communication efforts in their primary work.

**What Is Persuasion?**

The infrastructure essential in proposals and progress reports is persuasion. To convince people to hire you to do a project and to reassure them that the project is going well, you need persuasive strategies. This chapter reviews the common persuasive strategies to get you ready to write those kinds of documents—as well as persuasive technical documents. Understanding general persuasive writing strategies, you will be well-equipped to develop these kinds of documents:

- **Resumes**
- **Application letters**
Persuasion is the communicative effort to convince people to think a certain or act a certain way—to vote for a city-wide recycling program, to oppose the building of more coal-fired electricity plants, and so on—or the opposite!

In the view of some, persuasion is not a legitimate tool for technical communication. For them, technical writing is supposed to be "scientific," "objective," "neutral." However, if you grant that proposals, progress reports, resumes, application letters, and even complaint letters are instances of technical communication because they often must convey technical information, then you see that persuasion is an important tool in technical communication.

What Are the Tools of Persuasion?

The classical approach to persuasion, laid down by Aristotle (384–322 BCE) in the *Art of Rhetoric*, involves these appeals to readers and listeners (remember your Rhetoric and Composition 101?):

- **Logical appeal**—When you use reasons and arguments, backed up by facts and logic, to make your case, you are using the logical appeal. We normally think of the logical appeal as the only legitimate method of argument, but the "real world" shows us differently.
- **Emotional appeal**—When you attempt to rouse people's anger or sympathies in a persuasive effort, you are using the emotional appeal. Showing a little girl fleeing from a burning village bombed by war planes or an oil-soaked seagull on a beach devastated by an oil spill—these images spark emotions like anger, horror, sympathy; but they don't make a logical case for or against anything. These images may, however, capture readers' attention and cause them to pay more attention to the rest of your persuasive effort.
- **Personal appeal**—When you present your qualifications, experience, expertise, and wisdom or those others, attempting to build readers' confidence, you are using the personal appeal. As with the emotional appeal, there is no logical justification for the personal appeal. It's like saying, "Trust me." Despite that, readers sometimes want to know who you are and what gives you the right to speak so authoritatively on the subject. Just as the emotional appeal can be used legitimately to get readers to pay attention and care about your message, the right amount of personal appeal can build readers' confidence in you—or at least a willingness to hear you out.

You may also have encountered the "stylistic" appeal: the use of language and visual effects to increase the persuasive impact. For example, a glossy, fancy design for a resume can have a positive impact just as much as the content.

In your rhetoric and composition studies, you may also have encountered something called the Toulmin approach to persuasion. The complete system involves claims, grounds, warrant, backing, and rebuttal, but a particularly useful element is the rebuttal, and another known as the concession.

- **Rebuttal.** In a rebuttal, you directly address counter-arguments that your persuasive opponents might bring up. You show how they are wrong or, at least, how they don't affect your overall argument. Picture yourself face to face with your persuasive opponents—what arguments are they going to come back at you with? How are you going to answer those arguments? In a written persuasive effort, you must simulate this back-and-forth, debate-style argumentative process. Imagine your opponents' counter-arguments (arguments they might put forth against your position) and then imagine your own rebuttals (your answers to those counter-arguments).
- **Counter-argument.** A persuasion can be structured entirely around tearing down the opponent's argument. Consider this example:

  **We're Not Running Out of Trees**

  Anti-recyclers rightly point out that more trees are growing in the U.S. than ever before and that new forests are started as soon as trees are cut. However, this perspective fails to take into account that, in the southern United States, for example, where most of the trees used to make paper are grown, the proportion of pine forest in plantations has risen from 2.5 percent in 1950 to more than 40 percent in 1990, with a concomitant loss of natural pine forest. At this rate, the acreage of pine plantations will overtake that of natural pine forests in the South during the 1990s and will approach 70 percent of all pine forests the next few decades afterwards. While pine plantations are excellent for growing wood, they are far less suited than natural forests are for providing animal habitat and preserving biodiversity. Paper recycling extends the overall supply of fiber and can thus help reduce the pressure to convert remaining natural forests to tree farms.

- **Concession.** In a concession, you acknowledge that certain opposing arguments have some validity, but you explain how they do not damage your overall argument. Concessions build personal appeal: they make you seem more open minded.
- **Synthesis.** Modern rhetoricians urge us not to view the persuasive process as a win-lose, all-out war. When people are entrenched, they shut out the arguments of the other side. Such rigidity prevents us from resolving the issue and getting on
with our lives. Instead, the process of counter-argument, rebuttal, and concession should be sincere and continuous until all parties reach synthesis—a middle ground where they drop their weapons and agree.

**Main assertion:** This paragraph begins with a straightforward thesis that recycling is not cost-efficient—that it costs too much.

**Support:** Relying primarily on the Tierney article, this writer goes through a series of reasons for the extra expense: extra city officials, public education programs, reduced efficiency of recycling pickup, and minimal market value for recyclables.

**Direct quotations:** Notice that this writer quotes two pithy phrases from Tierney's articles, quotations that carry some of the attitude and personality of the original author.

**Documentation:** even if this writer had not quoted, he's still obligated to cite his source for this information he has borrowed.

One of the biggest problems with recycling is that it is not cost-efficient. In fact, recycling is a serious financial drain on all but a very few municipalities. As John Tierney pointed out in his 1996 *New York Times* Magazine article, collecting and handling a ton of recyclable materials is three times more expensive than putting them directly into a landfill. Why is that? Recycling programs require extra bureaucrats to manage them and enforcement officers to inspect people's recycling efforts and fine them if they are not complying. They require expensive public education campaigns to train people in the arduous process of sorting and storing their garbage correctly. (According to Tierney, "New Yorkers still don't know the rules.") Recycling programs are also more expensive because less garbage can be picked up at each stop. Tierney, in his aptly titled article, "Recycling Is Garbage," estimated that in 1996 New York City was spending more than $200 to recycle a ton of glass, plastic and metal than it would spend to bury the material in a landfill. He points out that market prices for recyclables has "rarely risen as high as zero." In fact, the city has to pay an additional $40 [per ton] to get rid of valueless recyclables.


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**What Are the Common Flaws in Persuasion?**

You should be aware too of the logical fallacies commonly found in persuasive efforts:

- **Hasty generalizations.** When you draw a conclusion based on too little evidence, that's a hasty generalization. For example, if you conclude that there is a big social trend to return to the 70's look because you see two or three bellbottoms and paisley shirts one day, you've drawn a hasty generalization based on a very limited, incomplete sample.

- **Irrelevant, ad hominem arguments.** When you base all or part of your persuasive effort on your opponent's character, behavior, or past, that's an *ad hominem* argument (meaning "to the man" in Latin). If a middle-aged political candidate were attacked for smoking marijuana in college, that might be an irrelevant personal attack.

- **Bandwagon effect.** If you base all or part of your persuasive effort on the idea that "everybody's doing it," you're using the bandwagon effect. Commercial advertisement commonly uses this tactic: everybody's buying the product—so should you!

- **False causality.** If you argue that because one event came after another, the first event caused the second, you may be making an argument based on false causality. For example, imagine that your father joined IBM in 1984 as a low-level regular employee and shortly thereafter the company began its historic slide to near-extinction. Imagine further that in 1995 he left the company, at which time the company began its remarkable comeback. Was it your dad who nearly brought the company to its knees? Did his departure save the company?

- **Oversimplistic, either–or arguments.** If you reduce the choices to the one you favor and to a totally unacceptable one, you are using an oversimplistic, either-or argument. Advocates of the nuclear power plant might argue that either we build the thing or we go without electricity.

- **False analogies.** When you compare a situation to a simple object or process, that's an analogy. When you base an entire persuasive effort on an analogy, you may have problems. Some analogies are just wrong to begin with. And, at some point, all analogies break down. For example, arguments relating to global warming often use the analogy of how a car heats up when the windows are rolled up. The Vietnam war was justified using the analogy of how dominoes all topple over when they are lined up. Analogies can help readers understand, but not justify an argument.

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**How to Write a Persuasive Document**

https://softchalkcloud.com/lesson/files/IaUg6x0utVJwCf/5_11InformationStructures_print.html
Here are guidelines on writing persuasively in a technical-writing content:

- **Carefully pick your topic and your approach to it.** Finding a project for persuasion is like trying to pick a fight. Think of the main issues of the day—global warming, ozone-layer depletion, alternative fuels, mass transportation, pesticides, zero population growth, solar energy, cloning (bioengineering), abortion, effects of computer- and video-game violence, capital punishment, nuclear armaments, chemical warfare. Each of these topics has multiple issues that are hotly debated.

- **Technical-writing courses are not the place for the common pro-and-con and letter-to-the editor essays you may have written in past writing courses. However, these topics have a technical side that challenges your abilities as a technical writer.** What are the logical arguments for recycling—more specifically, a city-based curb-side recycling program? They range from altruistic (for the city, for the planet) to selfish (to reduce waste management costs, to decrease taxes). Which arguments you use depends on your readers. Altruistic arguments may be of no use to certain conservative or business readers or to city administrators, but they may be vital in getting ordinary citizens to back such the program.

- **Define each of your arguments; plan how you will support them.** You must prove each logical argument, using supporting data, reasoning, and examples. You can't just baldly state that something costs less, works better, provides benefits, and is acceptable to the public—you've got to prove it! In your persuasive effort to get the city to consider recycling, you might use the logical appeal that such a program would reduce landfill requirements. How can you prove that? Do some research. What's the city's daily input to the landfill; what are the costs? Can you determine the percent made up by recyclables? If you can get believable numbers, calculate landfill savings in terms of volume and dollars.

- **Consider emotional appeals.** At best, emotional appeals capture readers' attention and get them to care about the issue. At worst, they rouse strong emotions such as fear and anger, preventing readers from thinking clearly about the issue. What emotional appeals could you use for the recycling promotion (not that you actually would, of course)? Images of overflowing landfills might work; images of dwindling natural habitats, replete with deer, chipmunks, hummingbirds—-these might work. Would they pull at the heart strings of your readers, or would readers cynically mutter "give me a break"? How would you feel about using such tactics?

- **Consider personal appeals.** Like emotional appeals, personal appeals have no logical relevance to an argument. If you use the personal appeal, you attempt to build readers' confidence in you as someone who is knowledgeable and reliable. Citing years of experience and education is a common example of building a personal appeal. What personal appeals could this recycling persuasion use? To get people to accept your data, cite believable sources, such as government reports or leading experts. To give yourself credibility, describe your past experience and training in this area. Perhaps also describe yourself as a long-time resident of the city. These appeals shouldn't have any relevance, but they may cause people to hear you out.

- **Address any counter-arguments.** It's a good idea to address counter-arguments—objections people might raise in relation to your argument. Imagine people out there saying "but—but—but—!" Discuss their counter-arguments and show how they are wrong, how they can be addressed, or how they are irrelevant to your main point. Notice that the persuasive document advocating recycling is structured on counter-arguments: **Recycling: Not a Waste of Money or Time!** As for recycling programs, you must address the standard objections. It's a hassle. Your might counter-argue that recycling is no more of a hassle than taking out the garbage. It's a hassle sorting everything and keeping in separate bins. That one is easy—most recycling programs don't require sorting. It's messy and attracts pests. Hmmm, that's a hard one—time for some research.

- **Plan an introduction.** In an introduction to a persuasion, you cannot start out guns blazing and swords rattling. It's not necessary to state your main argumentative point right away. Instead, just indicate the subject matter—not your main point about it. Your readers are more likely to hear you out. Imagine that you've written the main sections of this persuasion. You have logical appeals, counter-arguments, and possibly some personal and emotional appeals as well. Instead of demanding that the city adopt a recycling program, begin with a quiet purpose statement that this document "looks at" or "investigates" the possibilities for recycling. Indicate that this document is for both city officials and ordinary citizens. Provide an overview, indicating that you'll be discussing current and projected landfill use and associated costs, amount of recyclables in municipal waste, their recyclable value, potential revenue from a recycling program, costs of a recycling program, and necessary administrative and citizen participation in such a program.

- **Consider the conclusion.** In a persuasion, the final section is often a "true" conclusion. If you have not yet overtly stated your main argumentative point, now's the time. When you do, summarize the main arguments that support it. While the introduction may be the place for quiet understatement, the conclusion is the place to pound home your main point. Come out and state vigorously that the city should implement a recycling program and then summarize the main reasons why.

### How to Format Persuasive Documents?

Here are a few suggestions on format as they relate specifically to persuasive documents:

- **Headings.** If you structure your persuasion by individual arguments, then the subheadings can be related to those arguments. Notice that the headings in the example persuasion address the counter-arguments: **Recycling: Not a Waste of Money or Time!**

- **Graphics.** Factual information—data—supplies a great deal of the legitimate support for your presuasive effort. Make that data more dramatic and vivid by creating **tables, charts, and graphs.** Graphics—illustrations, drawings, photos—can also supply that essential logical support—but also the emotional support mentioned earlier.
Organizing Paragraphs

Let's begin by learning more about organizing paragraphs.

This textbook has introduced you to various considerations regarding organizing information.

You need to know about a few more organizational strategies in order to have more tools in your toolbox for organizing information.

Classification and Partition

This type of organization is often confused with chronological. Remember, just because something is divided into parts does NOT mean it is divided up by time. My favorite meal, pasta alfredo with broccoli and garlic bread (hello, carbs!) has three main parts: the entrée and two sides. The entrée is whole wheat, radiatore pasta with from-scratch alfredo sauce including fresh basil, oregano, and garlic and topped with black olives. The first side is garlic bread with a dipping sauce of olive oil, balsamic vinegar, and oregano. The second side (notice these are partitions, not chronological steps) is broccoli with salt and butter. All together, pasta alfredo with broccoli and garlic bread comprise my favorite meal. Note the meal, a single unit, is divided into parts, and each one is described. I did not tell you how to make it. I did not divide it into time components (first, you boil the pasta. Then, you mix a tablespoon of butter with a tablespoon of all purpose flour. . . ).

Cause and Effect

Need more explanation

Beware of oversimplification. Just because two things occur in a similar time span does not mean they are linked by causation. Just because Terry was the last person to use the copy machine does not mean that Terry broke it.

Comparisons

Need more explanation

Use part by part unless you have a good reason to use whole by whole.

Spatial Organization

Use spatial organization to describe something physically. You might use spatial organization to explain what a fountain pen looks like, for example. You would start the description at the top of the pen, the clicker. You would move, then, along the object spatially, describing the barrel of the pen down to the writing tip. Or, you might describe the pen starting at the tip and moving to the top. You move through SPACE to describe something (the space the object occupies), so that is spatial organization. You might use the spatial pattern to describe the physical scene of an accident. Or in a feasibility study, you might use this method to describe the property upon which a proposed facility would be built.

Chronological

A chronological description is one organized by time. Chronos is the Greek word for time. How do I cook my favorite dish? Well, first, I boil water for the radiatore pasta. Then, I mix a tablespoon of butter with a tablespoon of flour. Next, I pour a cup of heavy whipping cream (unwhipped) into a pot. After it heats up, I lower the heat and add the butter and stir
until the mixture thickens. I remove it from the heat. Next, I add garlic, parmesan cheese, and fresh basil and oregano to the mixture. As the sauce cools, I add broccoli to the steamer, add butter and salt, and steam the vegetables until tender and crisp. While the broccoli is steaming, I butter a slice of bread and grate fresh garlic over it. I place the bread in the toaster oven, and then I add the noodles to the boiling water. Finally, I pour olive oil and balsamic vinegar into a ramekin and add dried spices for dipping. Once all the cooked elements are ready, I assemble them on a plate: the noodles are topped with alfredo sauce; the bread is served with the ramekin of dipping sauce, and the broccoli is served to the side of the pasta and sauce.

Example

Sometimes, information is organized by an example. Such a paragraph usually starts with a statement that is then clarified by the example. For example (see what I did there?)...

A third mechanism of psychological defense, "Conversion," is found in hysteria. Here the conflict is converted into the symptom of a physical illness. In a case of conversion made famous by Freud, a young woman went out for a long walk with her brother-in-law, with whom she had fallen in love. Later, on learning that her sister lay gravely ill, she hurried to her bedside. She arrived too late and her sister was dead. The young woman's grief was accompanied by sharp pain in her legs. The pain kept recurring without any apparent physical cause. Freud's explanation was that she felt guilty because she desired the husband for herself, and she unconsciously converted her repressed feelings into an imaginary physical ailment. The pain struck her in the legs because she unconsciously connected her feelings for the husband with the walk they had taken together. The ailment symbolically represented both the unconscious wish and a penance for the feelings of guilt which it engendered. (Wilson, 1964, p. 84).

Problem-Methods-Solution

This pattern does just what it says--it describes the problem, then outlines the methods used to solve it, and then provides the solution. For example,

The Problem

Earlier this year, we were proud to offer the industry's largest array of add-on multimedia products for both our own computers and those of other manufacturers. Our offerings in cards, CD-ROM drives, speakers, and other peripherals were unrivaled in both quantity and quality. And the response was terrific: in out first three months we sold more than 12,000 multimedia kits and 58,000 other peripheral units.

But growing pains soon became apparent: we logged more than 9,000 multi-media-related customer support calls in that same period. What was the cause of this unprecedented customer-support problem? After considerable analysis of our customer-support data, we concluded that two factors were at work: Add-on multimedia kits, even those meant for our own computers, were not necessarily compatible with the hardware or the software our customers were using. We heard too many horror stories about how the kits were installed properly, but when the customer tried to reboot, the operating system was gone.

Some 70 percent of the customers were novices, as opposed to less than 40 percent for our other product lines, and our documentation was simply inadequate to the task.

Meeting the Challenge

We recognized that being a pioneer in the industry had its costs: we were the first to encounter the problems that are now pervasive in the industry and well publicized in the literature. And because we were first, we took our lumps from the trade journals for the resulting problems with customer satisfaction.

We instituted a four-point plan to meet the challenge:

We instituted a new quality-control program. Now every product is treated just the way a customer teats it. It is taken out of the box, plugged in, and turned on. We make sure that the printer setup is accurate and that the hardware and the bundled software are compatible. At our weekly audit meetings we revive that week's quality-control data; each team leader is now empowered to stop production to investigate a recurrent or unexplained problem.

We expanded our use of novices in our preproduction focus groups and in the quality-control program. We are concentrating on learning how the novice uses our products; in our expansion into the family market we expect to find that an increasing percentage of our customers are first-time computer owners.

We instituted a Process-Improvement Team, a group of 12 veteran employees committed to improving customer support and customer satisfaction. Among the first innovations of the Process-Improvement Team was the creation of more than 200 documents to assist users with common problems encountered when installing our kits and using common software.
These documents are on our website and can be faxed to customers at no charge when they call a special toll-free number.

We instituted a Quality Team of 15 employees charged with the responsibility of seeking Manufacturing's ideas about quality and efficiency standards.

The Results

These measures have been in place for only two months, and it is too early to declare total victory, but the preliminary data are encouraging. Customer-support calls on our multimedia kits are down more than 15 percent the last two months. As reported by Customer Support, the incident of catastrophic problems--such as destruction of the operating system--is down more than 30 percent. The increased use of novices in design and in focus groups has led to three interface improvements that were noted in a PC Week article earlier this month. The work of the Quality Team has resulted in a 7 percent decrease in rejection rates of our multimedia kits.

In short, I think we are on the right track. But quality improvement is a frame of mind and a commitment, not a goal that can ever be reached. I pledge to you that we shall continue to strive to make RST the best place to buy PCs and PC-related products.

General to Specific

General to specific is just as it says. It starts with a general overview, and then moves to specific details. This strategy is sometimes called an inverted pyramid. For example,

The proposed project involves transforming two currently existing electronic texts into a free, high-quality, interactive, multimedia textbook for the TCOM 2010 and WRIT 3140 courses at Kennesaw State University.

In order to achieve this overarching goal, we intend to

- create a textbook that satisfies both student and faculty requirements
- develop and incorporate materials that make the textbook desirable for both students and faculty members
- provide material that serves the distinct focus of each course
- make the textbook readily available for adoption and use
- encourage the textbook's adoption and use in onsite, hybrid, and online versions of the courses

and as a result, we believe we can increase student retention, progression, graduation, and employment rates.

Specific to General

This pattern is the opposite of general to specific, and it is sometimes called the pyramid. It starts with details and moves to a general statement. For example

Marsha's writing was filled with spelling errors. In addition, she was having problems using commas correctly, and she needed assistance with quotation marks. When I reviewed her sentence structures, I found that there were minor problems with subordination and coordination, and she needed to review and practice her parallel sentence skills. With regard to her choices related to organizational strategy, it seemed she had not thought through how she wished to organize her information. In general, for a three year old, I found Marsha to be a very good writer.

Order of Importance

Our two last organizational strategies are more important to less important, and less important to more important. They are exactly as they sound--organizing information from the most important reason for x to the least, or the least to the best. We are often asked "provide three reasons why x should happen." But as we do that, it's important that we consider the order in which we present our reasons. We want to present the reasons in the order of maximum impact. If your audience is likely to agree with you, then use least important to more important. That way, you end your paragraph on the most important note, and your reader should be highly motivated to follow through with your idea. If your audience is hesitant or even hostile to your idea, start with your most important reason for x. Use most important to least important to "hook" your reader early with your best evidence or argument so that they stay tuned for the supporting reasons. Following are some examples.

More important to less important

Why should you learn Spanish? Recent research shows, learning a second language protects you against Alzheimer's and keeps your brain sharper, longer. Additional important reasons to learn Spanish are the same reasons for learning
any language. It is very good for your brain. It helps you to speak your native language better and understand it better. It
gives you insight into other cultures, which increases your global understanding and improves your human relationships.
For Americans, learning Spanish can help you keep pace with popular culture. If you like to Zumba or listen to popular
music, then Spanish will enrich your experience. Finally, learn Spanish so that you sound cool, amigo, when you order
your dishes at your favorite Mexican restaurant or tapas bar.

*Less important to more important*

Why should you learn French? Well, to sound sexy, of course. Everyone knows a French accent makes you more
interesting and assists you in sounding not-so-silly when you order food in a fancy (a.k.a. French) restaurant. A second
reason to learn French is to assist you in your trip to Paris. Paris is the world's number one tourist destination, and if you
go there, you need to speak French. French is also a language that is fun to learn and pretty easy for English speakers.
If you have never learned a foreign language before, French is a great one to start with. The most important reason to
learn French, however, is the same reason for learning any language. It is very good for your brain. It helps you to speak
your native language better and understand it better. It gives you insight into other cultures, which increases your global
understanding and improves your human relationships. And, recent research shows, learning a second language
protects you against Alzheimer's and keeps your brain sharper, longer.
Logic and Logical Fallacies

_The dull mind, once arriving at an inference that flatters the desire, is rarely able to retain the impression that the notion from which the inference started was purely problematic._

— George Eliot, in *Silas Marner*

Brilliant People Believe Nonsense [because] They Fall for Common Fallacies

Even the brightest among us fall for logical fallacies. As a result, we should be ever vigilant to keep our critical guard up, looking for fallacious reasoning in lectures, reading, viewing, and especially in our own writing. None of us are immune to falling for fallacies.

Until doctors come up with an inoculation against fallacies, I suppose the next best thing is to thoroughly acquaint ourselves with the most common fallacies. I chose the following fallacies by comparing a dozen or so university sites that list what they consider the most common fallacies that trip up students.¹

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**Snoozer Alert!**

Sorry, but this chapter and the next don't contain fascinating stories and intriguing intellectual puzzles. But please resist the temptation to skim to the following section. To think critically, we simply must familiarize ourselves with logical fallacies. Otherwise, we're fair game for all sorts of nonsense. Think of it like math. While the formulas themselves might be boring, we learn them in order to hopefully use them for something practical in the future. You'll assuredly find many of the below fallacies used in conversations and articles.

Think of logical fallacies as the grammar you must master to learn a foreign language. Before you can use a language practically (like writing a note to that ravishing foreign exchange student in her native language), you simply must learn the vocabulary and grammar. Similarly, logical fallacies are a part of the vocabulary of logical thinking. I'll try to make understanding them as painless as possible.

So learn these well. Reflect upon them. Look for them in the media. Familiarizing yourself with errant reasoning goes a long way toward helping you to write, reason, speak, and listen with more critical precision.

**Tip:** If some of my definitions and examples don't sufficiently clarify, look up the fallacy in Wikipedia or other sources for alternate explanations.

Below this list of fallacies, I'll give you a bit of practice by asking you to connect a fallacy with an errant argument. Finally, I'll give a few tips on checking your own argumentation (particularly in writing and speeches) for fallacies.

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**Twenty-Seven Common Fallacies**

**Ad Hominem**

translated into English: "against the person," aka "damning the source," the "genetic fallacy," "poisoning the well," related to "tu quoque" (you, too!). Defined as attacking the person (e.g. - can't be trusted, is a moron, etc.) rather than the argument.

**Example:** "I don't believe anything he says because he's a biased political liberal." Yet, shouldn't we assess his arguments based upon his evidence and argumentation, rather than solely because of his political label?
Caution: Sometimes a person has indeed been shown to be untrustworthy. Cautioning readers that he has been repeatedly caught in flagrant lies isn’t an ad hominem fallacy. Noting a person’s lack of integrity can be valid, if his argument requires us to trust him.

Tip: If the person’s character is either irrelevant to the argument or unknown, focus on the facts and arguments.

**Affirming the Consequent**

aka "converse error" or "fallacy of the converse." This is a formal fallacy (the form of the argument isn't valid) that assumes if the argument is valid going one direction, it's also valid when run the opposite direction.

**Example:**

Premise 1: If I get the flu, I'll be nauseated.  
Premise 2: I'm nauseated.  
Conclusion: Therefore, I have the flu.

This is invalid because while it may be true that if you get the flu, you'll get nauseated, the converse isn't always true. You can be nauseated and yet not have the flu. Perhaps you have a hangover, or are pregnant.

Tip: If you see an argument in the following form, it's affirming the consequent:

Premise 1: If P, then Q  
Premise 2: Q  
Conclusion: P

**Appealing to Extremes**

taking an assertion to an extreme, even though the arguer may never take it to that extreme.

**Example:** "Avid health advocates blow out their knees by their 50s by running marathons. Therefore, don't prioritize regular exercise." But not all avid health advocates run long distances as their primary exercise. It's an extreme statement.

**Argument From Authority**

aka "argumentum ab auctoritate," "appeal to authority." Claiming that a position is true because an authority says it's true.

Even when the referenced authority is a true authority in the field, arguments should ultimately be based upon facts and reasoning rather than quoting authorities. Also beware of people quoting false authorities, like football stars or models selling insurance or technology.

**Example:** "We know global warming is true because a number of great scientists assure us it's true."

**Caution:** Sometimes citing authorities can be a valid part of an argument. For example, if a hefty percentage of respected scientists who specialize in a related field are all warning us about the dangers of global warming, this in itself provides evidence that global warming is at the very least a viable theory that needs to be seriously considered. Alternately, if no respectable scientists took global warming seriously, then this would surely be a strike against it, even though ultimately we're looking for hard evidence rather than numbers of testimonies.

Tip: Ask yourself,

- Are these truly experts in the field I'm discussing? Would some view them as either biased or holding to fringe views on the subject?
- Have I explained clearly how I'm using these authorities as evidence, within the larger scope of my argument?
• Would it be relevant to explain the evidence that led the authorities to come to their position on the subject?
• Are you using their testimonies as helpful resources, quoting them as a part of a larger argument, or quoting them as a slam dunk argument to make your case? Make sure you're not saying something like: Dr. Authority believes x, so we should believe x as well.

Argument from Ignorance

aka "appeal to ignorance," "argumentum ad ignorantium," related to "non-testable hypothesis." Assuming that a claim is true because it has not been or cannot be proven false (or vice versa, assuming that a claim is false because it has not been or cannot be proven true.)

Example: Nobody can prove that my client was at the scene of the crime, therefore he's innocent. (Of course, he may be in fact guilty. We may just lack sufficient evidence that he was there.)

Caution: While some would say "absence of evidence is not evidence of absence," this isn't true in every case. For example, if I walk outside and see no evidence of rainfall (no puddles, the streets aren't wet), I'm justified in taking this as evidence that it hasn't rained recently. In this case, the absence of evidence for rain is indeed evidence for the absence of rain.

Band Wagon

aka "ad populum fallacy," "appeal to widespread belief," "appeal to the majority," "appeal to the people." If a large number of people believe it, it must be true. It appeals to our desire to fit in.

Example: "Most people use Microsoft products, so they must be the best."

Example: "Everybody I know uses Meth, so it can't be that bad."

Caution: Some people naturally despise majority opinion and relish holding contrarian positions. Those who disagree with opinions held by a majority of intelligent people should at least make sure they understand the reasons informed people give to justify their beliefs.

Tip: Remember that popular opinion is often wrong, and what's cool today may seem foolish tomorrow. In fact, it's often those who stand against the crowd who change the world. As Apple, Inc. said it in their motto: "Think different."

Begging (Evading) the Question

aka "circular argument," "petitio principii," translated "assuming the initial point." The conclusion is assumed in a premise. This typically isn't as obvious as it first sounds.

Example: The Writing Center at the University of North Carolina gives a good example.

"Active euthanasia is morally acceptable. It is a decent, ethical thing to help another human being escape suffering through death."

At first read, it may seem pretty straightforward. But let's examine it as a premise and conclusion:

Premise: It is a decent, ethical thing to help another human being escape suffering through death.

Conclusion: Active euthanasia is morally acceptable.

Look closely at these two sentences and you'll discover that they actually do nothing more than state the same thing twice; the conclusion merely dresses up the premise in different words. "Decent, ethical" in the premise is worded "morally acceptable" in the conclusion. "to help another human being escape suffering through death" in the premise becomes "active euthanasia" in the conclusion.
Thus, the argument doesn't tell us much, if anything, about why euthanasia is morally acceptable. It leaves us asking the implied question over again, "But why is it acceptable?", showing that the premise and conclusion merely begged (i.e., evaded) the question.

**Tip:** Typically, rewriting the argument in the form of premises and a conclusion reveals when a question is being begged. Do you agree with the premises? Are there gaps in the line of argument? Does the conclusion say nothing more than the premises already stated?

**Bifurcation**

aka "false dichotomy," "black-or-white fallacy," the "either-or fallacy," related to a "false dilemma." The argument makes it appear that there are only two possible answers, but there are actually more.

**Example:** We discussed examples in the last chapter.

**Tip:** Ask yourself, are there really two and only two options? If not, are any of the other options viable? Have all other options been sufficiently ruled out?

**Dogmatism**

Not even considering an opponent's argument, because of overconfidence in one's own position.

**Statement:** "Mercedes makes the best car ever."

**Retort:** "But according to Consumer Reports...."

**Dogmatic Defense:** "I don't care what those studies say; I know! Mercedes is the best."

**Emotional Appeals**

An appeal to emotion that is irrelevant (or largely irrelevant) to the argument.

**Example:** "The death penalty can't be right. Have you seen a person die in an electric chair?"

**Caution:** Emotion can often be a legitimate part of an argument.

**Example:** "Look at these poor birds dying from an oil spill. This demonstrates one reason we should take great precautions to avoid such mishaps."

**Equivocation**

related to "semantics," "playing with words." Using the same word with more than one meaning, thereby invalidating the argument.

**Example:** "Of all the animals, only man is rational. No woman is a man. Therefore, no woman is rational." In the first instance, "man" means "mankind," whereas in the second instance, "man" means "the male gender." This change in meaning invalidates the argument.

**Tip:** Look carefully at the argument's important words. Are they used in a consistent way, or do they shift meanings?

**Fallacy of Exclusion**

Focusing on one group's behavior as if the behavior is exclusive to that group.

**Example:** "Watch those women drivers. They're always thinking of something other than their driving." But are male drivers any better? Shouldn't this statement be based on psychological studies and statistics of accidents rather than personal observations of one sex?

**False Dilemma**

aka "false dichotomy," "either/or," "black/white," "excluded middle." A form of bifurcation, this fallacy allows for only two extreme positions, although a legitimate middle ground might be arguable. Sometimes they paint one side as so extreme
that nobody could ever agree with it

Example: "You either support Israelis in Palestine or you're an anti-Semite."

Example: "Are you for George Bush or are you for the terrorists?"

Tip: When only two extreme alternatives are given, look for middle ground.

Faulty Analogy

aka "weak analogy." Comparing two similar things to make a point, but the analogy breaks down because of one or more significant dissimilarities.

Example: "The war in Afghanistan is nothing more than a modern day Vietnam war."

Tip: Is the analogy truly alike in all relevant respects?

Glittering Generality

aka "Weasel Words." Using words in such a broad way that almost everyone resonates with them in the same way, thus lending credence to the argument. Thus, those who argue that their position is really about "freedom," "love," "human rights," etc., can gain a following, even though the words may mean different things to different people, or are being used in such a vague way as to be essentially meaningless.

Example: "Allowing this controversial artwork in our place of business is really about guaranteeing our freedoms, in this case our freedom of expression." Perhaps, but what if the artwork trivializes or misrepresents your business, or disgusts and demoralizes your employees? Framing it as solely an issue of freedom seems to make it a glittering generality.

Hasty Generalization

related to "non-representative sample," "fallacy of insufficient statistics," "fallacy of insufficient sample," "fallacy of the lonely fact," "leaping to a conclusion," "hasty induction," "secundum quid (converse accident)." A conclusion was reached via inadequate evidence, such as when a sample cited was inadequate (e.g., atypical or too small) to warrant a generalized conclusion.

Example: "Most Hollywood stars have terrible marriages. Just read the tabloids." Their conclusion may or may not be true, but reading tabloids is no way to decide the issue. News sources by their very nature select what's "newsy." Since a nasty divorce is more newsy than a stable marriage, the former gets the press, giving the impression that most Hollywood stars can't hold a marriage together.

Example: "I'll never fly again. I read about too many accidents and hijackings." Again, you don't hear about the thousands of flights with no incidents. Thus, you're judging from the news you hear, which is both an atypical and small sampling. The National Safety Council calculated the odds of dying in a motor vehicle accident as one chance in 98 over a lifetime. The odds for dying in air travel (including private flights) was one chance in 7,178.3

Tip: Notice the sample size and where it's drawn from. Is it adequate to warrant the conclusion? Is the conclusion stated in terms that are too general and sweeping?

Inconsistency

aka "non contradiction." The argument contradicts itself. (See the previous chapter for a more thorough explanation.)

Example: "Only statements that can be justified with scientific experiments can be believed." Yet, this statement itself can't be justified by scientific experiments.

Example: "Our brains developed, not to think logically, but for survival in an agrarian society. Therefore, we can't trust our reasoning." This statement uses logical reasoning, although it's claiming logical reasoning is not to be trusted.

Moral Equivalency

arguing incorrectly that two moral issues are sufficiently similar to warrant the same treatment. It often compares lesser misdeeds to major atrocities.
Example: "Killing in war is legalized murder." In some instances, this may be true. But in all instances?

Example: "Our local police act like Nazis—they have no respect for my human right to drive my car like I want."

Non Sequitur

translated: "it does not follow." A general category that includes "hasty generalization," "slippery slope," "affirming the consequent," "missing the point," etc.) The conclusion does not follow from the premises.

Example: "Patrick always smiled at me and was so respectful. He couldn't have burned down the gym." Is there some absolute law of nature that states that respectful, smiling people never burn down gyms? While Patrick's character in relation to you can be a relevant piece of evidence to be considered, it's a non sequitur to say that it proves he could have never burned down a gym.

Tips:
1. Forget the conclusion for a moment. Looking solely at the premises, ask yourself what can be concluded from the premises.
2. Now look at your conclusion. Ask yourself what kind and amount of evidence you'd need to support this conclusion. Do the premises provide that kind of evidence?
3. Is your conclusion too extreme? Would it be closer to the truth if it weren't overstated?

Failing Occam's Razor

Prefer a simpler explanation (or hypothesis) to a more convoluted or complicated one.

Example: Your best friend Ralph flunked Calculus. Possible reasons:

1. If we were to run a psychological profile of both Ralph and his professor, we might find that they have diametrically opposed learning styles, thus making communication extremely difficult.
2. Aliens kept Ralph up all night before both the midterm and final exam, questioning him and keeping him from adequate rest and preparation.
3. Ralph admitted to never doing his homework and seldom attending lectures.

Occam's Razor would prefer the third, more simple and obvious explanation.

Warning: Occam's Razor doesn't decide all cases, since many explanations that end up being proven over time are indeed more complicated than their disproven counterparts. Typically, when choosing between competing scientific theories, the best fit with the observable data trumps simplicity. So it's wise to consider Occam's Razor a "rule of thumb" rather than a hard and fast rule.

Post Hoc Ergo Propter Hoc

translated "after this, therefore because of this." Often shortened to "post hoc," also called "faulty causality," "faulty cause," "false cause," or "correlation vs. causation"). Correlation and causation are confused in that one event follows another and the former is falsely assumed to be the cause of the latter.

Example: "Ever since his trip to India, Alfred's been sick. Obviously, he caught something in India that our doctors can't diagnose."

Tips:
1. When one event is claimed as the cause of another, look for other possible causes. In the above example, perhaps Alfred caught something the day he arrived back home, or already had an illness before going to India, but never developed symptoms until he returned.
2. Give evidence beyond "this happened after that," to support your claim. For example, you might discover that Alfred consulted with seven American diagnostic specialists, who all agreed that it was a malady they'd never
before seen. This would lend credence to the "he caught it in India" theory.

**Red Herring**

Deflecting an argument by *chasing a rabbit* (an irrelevant topic.) The name "red herring" was originally used in fox hunting, when a herring (type of fish) was dragged across a trail to throw the dogs off the scent of the fox.

**Example:** After Harry's wife caught him gambling away his paycheck and asked for an explanation, he responded, "At least with gambling I have a chance to get my money back. What about your weekly purchase of clothes that ends up in a bag for Goodwill?"

And why isn't your recent raise helping us to pay our debts?"

Harry's arguments deflect from the immediate issue: he gambled away his paycheck.

**Example:** "Sure, the mercury found in seafood is often unsafe, but fishermen have to make a living like everyone else."

**Tip:** If you’re not sure, write the argument out as a line of argument. This typically shows clearly where the argument got off track.

**Reductionism**

aka "oversimplifying," "sloganeering." Reducing large, complex problems to one or a few simplistic causes or solutions.

**Example:** "The problem with our economy can be reduced to two words: trade imbalance." What about other relevant issues, such as the drain of a huge national debt?

**Tip:** Ask yourself, "What other factors may contribute to this problem, or be a part of the solution?"

**Slippery Slope**

aka "snowball argument," "domino theory," "absurd extrapolation," "thin edge of the wedge," "camel's nose." Arguing that one change or event will inevitably lead to another, eventually landing them at a place they never wanted to go.

**Example:** "If we allow more restrictions on purchasing guns, this will be followed by further restrictions and eventually the government will confiscate all our guns."

**Caution:** Slippery slopes do exist. The question is, just how slippery is the slope? Is it slippery enough to make the slide to the bottom inevitable?

**Tip:** Look closely at your argument for each link in the chain of consequences. Is there adequate evidence to conclude that each progression is either inevitable or fairly certain? Are there abundant historical precedents that back up the claim? Are there historical precedents that provide contrary evidence?

**Stacking the Deck**

aka "cherry picking." Listing the arguments (or evidence) that support one's claim while ignoring the ones that don't.

**Example:** "Capitalism inevitably leads to a violent revolution by the proletariat. Here are fifty examples from history."
Tip: Ask yourself, "Are there counterexamples that the arguer is ignoring, or is she/he simply pulling out examples that support his/her theory?"

### Straw Man

Presents a weak form of an opposing argument, then knocks it down to claim victory.

**Example:** Jack emailed his professor that he missed class due to a bad case of the flu and that he would bring a doctor's note. The next day, the professor announced in class that he would not excuse Jack's absence because his excuse was that he didn't feel like coming (not mentioning the flu or the note). Since the professor put Jack's argument in such a weak form, he was arguing against a straw man rather than Jack's actual defense.

**Tip:** Do you know the strongest arguments of your opponents? If so, are those the arguments you're arguing against?

### Sweeping Generalization

Aka *dicto simpliciter*. Assumes that what is true of the whole will also be true of the part, or that what is true in most instances will be true in all instances.

**Example:** "All the preppies I know are materialists. Since Shawn dresses preppie, he must be a materialist."

**Tip:** Particularly when arguers use all inclusive words like "all," "always," "never," "nobody," or "everybody," ask yourself if the premises and/or conclusions should have been presented in less stark terms. Do you know people who dress preppie who don't appear to be materialistic? If so, then perhaps Shawn is a part of the subset of non-materialistic preppies.

### Action Points

**A Checklist for Spotting Your Own Fallacies**

(Ask these questions before turning in a paper, making a speech, or arguing with friends.)

- **How would your opponents respond to your argument?** What parts would they likely attack? Have you actually read the strongest arguments of your opponents and considered their side? Is there a way to strengthen your weak arguments?
- **How would your argument look as a syllogism or line of argument?** Do you have adequate evidence for your premises? Does your conclusion flow logically from your premises?
- **Is your conclusion presented with the degree of certitude that's warranted by the evidence?** (Be especially cautious if you use all-encompassing words like "always," "never," "everyone," etc.)
- **Are there certain types of fallacies that you often fall for?** (Consider how professors responded to your earlier papers or speeches, and how your friends respond to your arguments.)

**Flex Your Neurons!**

**Pursuing the Point of Know Return**

**Can You Connect an Argument with Its Fallacy?**

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Making It More Personal

Practical Takeaways
Recommended Trails
For the Incurably Curious and Adventurous

1. For each fallacy that's still unclear to you, search it on Google to find more explanations and illustrations.
2. Watch or read some advertisements. Write out their lines of argument or put them in syllogisms. Do any of them fall for one of the above fallacies?

End Notes

Chapter 11: They Fall for Other Common Fallacies

1. I compared lists from 1) the writing center at the University of North Carolina, Chapel Hill, which includes tips for spotting fallacies http://writingcenter.unc.edu/handouts/fallacies/ 2) the University of Idaho http://www.webpages.uidaho.edu/eng207-td/Logic%20and%20Analysis/most_common_logical_fallacies.htm 3) California State, Fullerton, includes nice, down home examples - http://commfaculty.fullerton.edu/rgass/fallacy3211.htm 4) from Purdue University - https://owl.english.purdue.edu/owl/resource/659/03/ 5) the University of Texas, El Paso - http://utminers.utep.edu/omwilliamson/ENGL1311/fallacies.htm 5) Carson Newman, helpful for its division by categories - http://web.cn.edu/kwheeler/fallacies_list.html 6) the University of Louisiana, Lafayette, gives documented examples - http://www.ucs.louisiana.edu/~kak7409/Fallacies.html 7) Mesa Community College - http://www.mesacc.edu/~paoih30491/ArgumentsFallaciesQ.html 8) California State - http://www.csus.edu/indiv/g/gaskilld/criticalthinking/Six%20Common%20Fallacies.htm 9) Sacramento State University 9) the University of Wisconsin, Eau Claire http://www.uwec.edu/ranowlan/logical%20fallacies.html 10) St. Lawrence University 11) the University of Oklahoma 12) North Kentucky University. It's interesting that some of these universities use contradictory definitions of various fallacies.
2. Bertrand Russell demonstrated this tendency. He seemed to relish standing against the majority opinion. A person with his disposition should strongly consider that his assessment of evidence might be skewed by this character trait. See chapter 25 for an analysis of the passions that drove Russell.
Logic and Logical Fallacies

"Anyone who denies the law of non-contradiction should be beaten and burned until he admits that to be beaten is not the same as not to be beaten, and to be burned is not the same as not to be burned.

— Avicenna

Brilliant People Believe Nonsense [because]...They Contradict, Leave out Valid Options and Knock down Straw Men

Those Who Question Logic

To the mind that's yet to be "enhanced" by some strains of modern thought, the above quote probably comes across as amusing, but useless. After all, who would deny something as basic as the law of non-contradiction or the basic laws of logic? If saying "My roommate annoys me" is no different than saying "My roommate doesn't annoy me," then how can we ever say anything meaningful? Moreover, the very act of denying non-contradiction assumes the law to be true. Yet, some argue that our brains, like our opposable thumbs and other body parts, evolved not to perfect our logic, but to optimize our survival. According to these thinkers, when early man moved up in the world from hunter-gatherers to the African Delta, survival of the fittest favored those who learned to cooperate to grow crops, raise families, and breed domestic animals. Thus, our brains evolved to foster domesticity, rather than think through logically rigorous legal or scientific or philosophical arguments.

(Digression: Surely it's equally plausible, even when reflecting upon recent history, that evolution should favor brains that are ruthless and cunning; employing a logic that's better suited to achieve selfish ends than to seek truth. When dispassionately objective intellectuals taught ideas that displeased Stalin, he removed them from the gene pool by the thousands. Thus, a large portion of 20th century man, under such regimes as Lenin, Stalin, Mao, Hitler, and Pol Pot, survived by suppressing their creativity and independent thought and perfecting a "don't piss off the morons in charge" type of thinking. In my mind, it would be difficult to prove that long ago, living in small communities on the Delta, brilliant misfits would have survived any better.)

Thus, following this naturalistic line of argument, our brains developed primarily for primitive survival, not to reflect accurately on the great scientific theories of cosmology or macroeconomics or to develop rigorous rules of logic. Those who walked about the early Delta with their minds distracted by such matters were almost certainly eliminated from the gene pool by animals higher up on the food chain.

Rather than being equipped for higher level thinking, according to this theory, we find our brains uniquely suited to think in ways that enhance our self-confidence, enable us to compete, socialize, and convince the opposite sex to mate with us.

As a result, today's brains should resonate more with Glamour Magazine, Playboy and Sports Illustrated, than Physics Today or Philosophy Now. In its favor, this theory successfully predicts the type and quality of magazines available for purchase at service station check-out counters. Such academics as Psychologist Susan Blackmore and Philosopher Alex Rosenberg similarly argue that our brains, in their present state of evolution, deceive us in many ways and can't be trusted. Why then should we trust in the ability of our empirical investigations or logical argumentation to help us find truth? Without recounting the intricate details, I should also mention that eighteenth century philosopher David Hume argued, with breathtaking influence on modern thought, that taking empiricism to its logical conclusion leads to skepticism concerning any certain knowledge. His works, and many who built upon his foundation, have led some contemporary intellectuals to a thoroughgoing despair of finding truth through science or logic or any other means. This is all to say that if you read widely, you'll run across many who teach that all truth is relative and a search for truth is futile. Rather than set forth a defense of our ability to find truth, or at the very least that we have the ability to weed through nonsense in order to get [closer](https://softchalkcloud.com/lesson/files/tebYxur6wZJgsz/5_13LogicHowToDoItWrong_print.html) to the truth, I'll just note that I've never found a thoroughgoing skeptic who lives consistently with his skepticism.
As soon as he opens his mouth or wields his pen, he begins making statements that depend upon the very laws of logic he denies. When Blackmore argues that our minds deceive us and can't be trusted, why does she go on to write the next chapter? If she really believes what she wrote, she can't trust her reasoning. If I believe what she wrote, I can't trust in either the accuracy of her writings or my ability to interpret them. So why keep reading? After a professor teaches his students that we can't know truth, no sooner has he left the classroom and met his department chair than he engages her in an argument, based upon the facts and logic he denies in class, about his deplorable salary. And he certainly won't be satisfied if his boss responds that the argument is pointless because all truth is relative.

In the end, whether you claim to be a thoroughgoing skeptic or a believer in our ability to find truth, logic would seem useful, at least in arguing for a raise. So since this isn't a book on epistemology, let's proceed as if logic is indeed useful, and try to sharpen our ability to use it.

The Syllogism* as a Useful Starting Point

*Syllogism

Increasingly, I find myself putting complex, convoluted, or long-winded arguments into the form of syllogisms in order to evaluate them. The value of this process was demonstrated to me at a recent philosophical conference. I was astonished to hear a philosopher attack a 450 page book by reducing the author's line of argument to a simple, three-line syllogism. If the philosopher succeeded, then no matter how many studies the author quoted, no matter how much data he accumulated, no matter how many more pages he wrote; if his line of argument was illogical, his conclusion wasn't warranted.

Here's the classic example of a simple, correctly formulated logical syllogism:

Premise 1: All men are mortal.
Premise 2: Socrates is a man.
Therefore: Socrates is mortal.

The beauty of a correctly formulated syllogism is that if we agree with the premises, then we must agree with the conclusion. Do you agree that all men are mortal? Do you agree that Socrates is a man? If so, then you must believe that Socrates is mortal. It's a logically air tight argument.

To evaluate someone's argument, try to put it in a syllogistic format and focus on two questions:

1. Do you agree with the premises? (Are they either intuitively obvious or well-supported by evidence?)
2. Does the conclusion logically follow from the premises?

Of course, arguments can get quite complicated, requiring complicated syllogisms to replicate them in logical form. If you're interested in exploring the more complex forms, study deductive logic. But I find that basic syllogisms suffice to evaluate the vast majority of meaningful arguments, even when evaluating chapters or entire books.
Let's Analyze an Argument!

Let's start with an argument proposed by a bright person and analyze it. Here are a couple of formulations of an argument put forth by Richard Dawkins, a popular science writer who once taught at Oxford University.

In his book, *The God Delusion*, Dawkins seeks to establish atheism, primarily by attacking theism. But he does present one positive argument for atheism, which he claims demonstrates that there is almost certainly no God. Dawkins believes the argument is devastating to theism—"an unrebutable refutation." It makes for a good argument to examine, since Dawkins states it in a few sentences rather than arguing it extensively.

Here's how he puts it:

"...any creative intelligence, of sufficient complexity to design anything, comes into existence only as the end product of an extended process of gradual evolution. Creative intelligences, being evolved, necessarily arrive late in the universe, and therefore cannot be responsible for designing it."

Later in the book, he puts it this way:

"The whole argument turns on the familiar question "Who made God?", which most thinking people discover for themselves. A designer God cannot be used to explain organized complexity because any God capable of designing anything would have to be complex enough to demand the same kind of explanation in his own right. God presents an infinite regress from which he cannot help us to escape."

Think!

Before reading any further, try your own hand at responding to Dawkins. He says that he has "yet to hear a convincing answer" to his argument. Do you think it's irrefutable? If the argument seems rather muddled to you, start by reading one sentence at a time and asking yourself, "Do I agree or disagree with this statement, and why?" Perhaps trying to put it in syllogistic format would help, or trying to express it as a line of argument. (Caution: Try not to let your personal worldview interfere with your reasoning. The question I'm asking is not "Is there a God?" but rather "Is Dawkins' argument irrefutable?")

Using a Line of Argument* and Syllogism to Clear Muddy Waters

*Line of Argument

If I understand Dawkins correctly, here's his line of argument:

There are only two possible ways that God's existence could be accounted for:

1) **He was created by another being.** But that explanation doesn't really help because then we have to ask, "Who made that designer, and the one who made him?" which leads to an infinite regress of questions which we can never fully answer.

2) **He slowly evolved through time.** But if He evolved, He would not have developed His incredible intelligence and power until the end of a long process of evolution. Yet, in order to create the universe, He needed this intelligence and
Thus, He couldn't have created the universe. Besides, what are the odds that such a complex being could evolve through purely naturalistic causes?

Dawkins thus concludes that since both of these scenarios are highly unlikely, it's highly unlikely that God exists.

Put in a syllogism, it might read like this:

**Premise 1:** If God exists, he must have come into existence by either being created by another being or evolving slowly through time.

**Premise 2:** It's highly unlikely that God came into existence by either being created by another being or evolving slowly through time.

**Conclusion:** It's highly unlikely that God exists.

Think!

Does laying it out as a line of argument and as a syllogism help? Do you think I did it accurately? Now think through the line of argument and syllogism. Do you agree with each of the premises? (Is it sound?) Did Dawkins argue correctly from these premises? (Is it valid?)

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*Sound Syllogism

*Valid Syllogism

As we continue with this chapter, we'll introduce some logical fallacies and apply them to both Dawkins' argument and the introductory discussion.

**Fallacy #1: Bifurcation**

Dawkins’ argument seems to be a good example of a fallacy called bifurcation, whereby the argument assumes that only two (note the prefix "bi", meaning "two") possibilities exist, whereas there are actually more. This fallacy is particularly pernicious because it seems to contain an element of sleight of hand. If it is presented by a person we respect or agree with, we tend to assume that his premises represent all possibilities and we focus on the validity of the argument rather than the accuracy of the premises.

So here's how Dawkins' argument appears to be guilty of bifurcation.

He assumes that there are two and only two possible explanations for the proposed existence of God:

1 - He was either created by another being, or
2 - He evolved by natural means slowly over time.

To justify limiting the existence of God to these two options, Dawkins should have eliminated a third, seemingly viable option: that God could have simply existed from eternity past. After all, until well into the 20th century, the majority of scientists saw no problem in believing that matter existed from eternity past. Why then could God not have existed from eternity past? Is there evidence (either empirical or logical) that if God exists, He could not have existed from eternity past (or, alternately, could not exist outside of time and space)? If there is such evidence, then Dawkins should forward it. Otherwise, his premises are misleading and inaccurate in that they unnecessarily ignore this option.

To put it another way, Dawkins claims that there are two and only two ways the existence of God could be explained. By explaining those two away, he claims to have explained away the existence of God. Yet, he's ignored (or deflected his readers from) a third possibility which he needs to explain away as well: that God existed from eternity past. By overlooking this third option, his argument fails, falling to the fallacy of bifurcation.

**Other Examples of Bifurcation**

"The Atlanta Falcons' loss to the New England Patriots was due to either inept play or poor coaching."
But aren't there more options than two? Perhaps they lost primarily because of a brilliant strategy by the opposing coaching staff, or the Patriots quarterback was on a roll, or the injury to the Falcon running back caused the Falcons to resort to "Plan B" rather than "Plan A", or any number of other possibilities that the armchair critic needs to rule out.

"The president must be either insane or stupid to make that decision."

What other factors may explain the decision? Isn't it possible that the president was privy to facts we weren't aware of, or had made a wise political bargain that required that decision, or any number of other factors?

"What a despicable child! He obviously either inherited bad genes or has inept parents." What are some other possible contributing factors to the child's behavior? Perhaps he's sick or tired or teething.

**Tip:** Bifurcation becomes easier to spot once you're aware of it. When someone presents two options as if they're the only two options, I immediately ask myself, "Are there more options than he's presenting?" Ask the same question if someone presents three or more options as if they're the only ones. We could call it "trifurcation," etc.

### Fallacy #2: The Straw Man

I'm dealing in this chapter with arguments that are very common. Familiarize yourself with them and you'll begin to see them everywhere—in articles, news broadcasts, Facebook discussions—everywhere!

The Straw Man fallacy presents a weak form of an opposing argument so that it's easy to destroy it and declare victory. The writer or speaker never actually attacks the opponent's arguments. Instead, he avoids the opponent's arguments by "knocking down a straw man."

Dawkins seems to have erected and knocked down a straw man in the argument we considered above. In brief, he argued that it's very unlikely that an evolved or created God exists. But the vast majority of theistic theologians and philosophers of the Western world would likely agree with this statement. In fact, I don't believe I've ever met a theist who believes in a created or evolved God. So arguing against this kind of a God says nothing about the existence of the eternal God that most of Dawkins' opponents believe in.

Thus, Dawkins has set up an irrelevant straw man (or in this instance, a Straw God), and tried to disprove His existence. If successful, he merely succeeds in knocking down a position that his opponents never held. The philosophers and theologians he's attacking overwhelmingly define God as one who existed from eternity past (or exists outside time and space). Dawkins should have attacked the position held by those he attacks.

Michael Ruse, Professor of Philosophy at Florida State University, himself an atheist, criticizes Dawkins' argument in part for this very reason. He concludes:

"...I want to extend to Christians the courtesy of arguing against what they actually believe, rather than begin and end with the polemical parody of what Dawkins calls 'the God delusion.'"

### Another Example of Arguing against a Straw Man

A friend remarks to you: "The last three winters have been colder than average. So much for the theory of Global Warming!"

Your friend assumes that Global Warming advocates argue in this manner: "If temperatures are truly rising, every year and every geographical location should show increased warmth." But nobody argues this. It's arguing against a straw man. Global Warming advocates actually argue that over long periods of time the average temperature is increasing. Those who argue against global warming should argue against this rather than a straw man.

### Fallacy #3: The Law of Non Contradiction

*Man has been accustomed, ever since he was a boy, to having a dozen incompatible philosophies dancing about together inside his head. He doesn't think of doctrines as primarily "true" or "false," but as "academic" or "practical," "outworn" or "contemporary," "conventional" or "ruthless."*

— C.S. Lewis

https://softchalkcloud.com/lesson/files/tebYxur6wZJgsz/5_13LogicHowToDoItWrong_print.html
In Chapter 9, I mentioned philosopher Alex Rosenberg's recent book. In it he argues, among other things, that:

1 - There's no free will. Thus, according to Rosenberg, we think only what we've been determined to think (by our genetics, etc.) How we think is determined by evolutionary processes that often have nothing to do with producing logical thinking. I can't direct my own thinking because there's no "I" outside my brain to direct my thinking. Our brains are just advanced computers, and computers can't think "about" things. Consciousness is thus an illusion.

2 - Our thinking is flawed. "Mother Nature built our minds for purposes other than understanding reality."

3 - We can learn nothing from history or people's life stories.

With that background, here's where I see contradictions piling up.

- **On changing people's opinions** - In his preface Rosenberg states that he wrote the book to help people discover the real answers to such questions as "Why am I here?" or "What is the meaning of life?" But if there's no free will, and all of our beliefs were therefore predetermined, how can he possibly hope to change anybody's opinion about anything? If evolution absolutely determines everyone's thought processes and beliefs, then how can he possibly trust his own mental processes or hope to change other people's thinking?

- **On urging life change** - Why does he keep urging us to action, if everything's determined and his urgings are therefore worthless?

  Rosenberg preaches, "We need continually to fight the temptation to think that we can learn much of anything from someone else's story of how they beat an addiction, kept to a diet...." But what does it mean to "continually fight" a temptation if we're already destined to fight or not fight, to either beat the temptation or fall for it?

- **On recommending a course of action** - By the end of the book he's recommending that we adopt the philosophical nihilism of Epicurus, not take ourselves so seriously, and take Prozac if you're unhappy that life has no meaning. Can't he see that if we believed what he said earlier about that we can't learn anything from other people's life stories, we can also learn nothing from his own experiences and recommendations?

- **On learning from history** - He says we can learn nothing from history: "History, even when corrected by science, is still bunk." But then he recounts history to make his points. For example, how can we know if Prozac works, unless we accept the testimonies of other patients and rely on their stated medical histories?

Thus, it seems evident to me that Rosenberg's book is riddled with internal contradictions. Now perhaps if I asked Rosenberg personally about the apparent contradictions, he could clear them up. But in the present state of his book, they seem flagrant, leading me to question many of his conclusions.

Sometimes contradictions are not so obvious. For example, a central tenet of Logical Positivists, whose views were very influential in the early 1900s (not only in philosophy, but also psychology and other sciences), expounded the verification principle, which can be stated as: "the only meaningful statements are those that we can verify through observation." Yet, their critics pointed out that this very statement (the verification principle) can't be verified through observation, making it self-contradictory, or self-defeating. In other words, they couldn't verify the verification principle with the verification principle, making it (to be consistent with Logical Positivism) a meaningless statement.

Well, that was rather embarrassing to Logical Positivists. This insight, in part, led to Logical Positivism's demise in the latter 1900s.

**Summary**

The arguments we've examined in this chapter were put forth by bright people with topnotch education credentials—often PhDs holding prestigious positions. If they are subject to falling for logical fallacies, how much more the rest of us?

Why do brilliant people believe nonsense? Because they fail to sufficiently check their beliefs against logical fallacies. How can we guard ourselves from similar errors in thinking?

**Action Points**
How to Spot Logical Fallacies and Keep from Using Them in Our Own Communications

1. Take time to think through arguments that are important to you.

Most don't. In fact, they barely even pay attention. Philosopher and scientist Francis Bacon once wrote: "Some books should be tasted, some devoured, but only a few should be chewed and digested thoroughly." For the latter books, articles or lectures, if the argumentation is complicated or unclear, I often summarize it with a line of argument, sometimes chapter by chapter. It takes a bit of time, but it keeps me from ending the book in a mental fog.

2. Don't be intimidated by credentials and claims.

Surely this is, in part, why people take nonsense promoted by well-credentialed people at face value. Never listen to anyone without engaging your critical thinking.

3. Beware of the tendency to uncritically accept the arguments of those you agree with, or arguments that have an agreeable conclusion.

Professor H. Allen Orr, in the New York Review of Books, reflected on Dawkins' argument and his way of arguing. According to Orr:

"Indeed he suffers from several problems when attempting to reason philosophically. The most obvious is that he has a preordained set of conclusions at which he's determined to arrive. Consequently, Dawkins uses any argument, however feeble, that seems to get him there and the merit of various arguments appears judged largely by where they lead."21

4. Ask yourself, "Are there facts or personal experiences that don't fit with either the premises or the conclusion?"

When I read Rosenberg's argument that we can't learn anything from history or life stories, I couldn't help but reflect on the wealth of valuable lessons I've learned from observing people's lives and reading great biographies. For example, by watching people make wise and poor financial and health decisions, I've learned much from their successes and failures. My personal experience represents one strike against his conclusion, causing me to look more critically at his argumentation.

5. Put it in a syllogism (or line of argument) and ask yourself two questions:

- Are the premises supported by sufficient evidence?
- Does the conclusion follow logically from the premises?

(To remember this point, reflect back on the D. R. of Dr. Cackler. Is the data complete and accurate? Is the reasoning from that data clear and accurate?)

6. Have others look at the argument.

Learn from Hewlett Packard's practice of running an idea by the person next to you. If the idea is important to you, discuss it with others. We all think a bit differently and it's very likely that others will see aspects of the issue that you don't see.

For example, Einstein once observed that scientists are typically poor philosophers. Whether he's right or not, psychologists do find people typically having strong and weak areas of reasoning. If a scientist is trying to reason philosophically, he might be wise to run his arguments by a philosopher. It's often wise to run important arguments by people who think differently from you.

7. See how others in the field respond.

Dawkins' argument is philosophical and the field of philosophy has a rich history of arguments concerning the existence of God. It would seem unlikely, though not impossible, that an expert in animal behavior (Dawkins) would dream up a slam dunk argument than never occurred to any great philosophical thinker from Plato to Immanuel Kant to Bertrand Russell. If Dawkins' argument were truly original and significant, I'd expect a loud chorus of respected philosophers to be hailing this argument's arrival.

Yet, the responses I've seen by philosophers and academicians have been underwhelming at best. Philosopher William Craig went so far as to declare it "the worst atheistic argument in the history of Western thought."22 Academic biologist H. Allen Orr noted that the argument was "shredded by reviewers."23 For example, some attack the argument by noting that an explanation doesn't typically require an explanation of the explanation (responding to Dawkins' contention that theists must forward an explanation as to where God came from). In other words, if we were to visit the dark side of the
moon and find an advanced, but long-abandoned (at least a century old, deduced from its state of natural aging) mining operation, where all the inscriptions were in a non-human language, wouldn't we be justified in positing that alien intelligences were behind it, *even if we had no idea how the aliens came to be or where they were from?* And it's not just theistic philosophers who find Dawkins' argument lacking.

Atheist Michael Ruse attacks Dawkins' argument in this way:

> "Like every first-year undergraduate in philosophy, Dawkins thinks he can put to rest the causal argument for God's existence. If God caused the world, then what caused God? Of course the great philosophers, Anselm and Aquinas particularly, are way ahead of him here. They know that the only way to stop the regression is by making God something that needs no cause. He must be a necessary being. This means that God is not part of the regular causal chain but in some sense orthogonal to it. He is what keeps the whole business going, past, present and future, and is the explanation of why there is something rather than nothing."  

Surely such rejoinders are legitimate challenges that Dawkins should respond to. Had he run his argument by some philosophers prior to publishing, perhaps he could have responded to their objections.

### Think Different (Creative Thinking)

One of philosopher Immanuel Kant's most valuable contributions to practical human thought was his insight that we don't experience things entirely as they are. While some people insist that seeing is *believing*, we all know that seeing can also be *deceiving*. For example, Kant notes that we don't see objects directly. Rather, we're a step removed in that we see reflections of objects on our retinas. We take another step back from real objects when our brains bring our own interpreting mechanisms to those objects, such as "quality" or "cause and effect."

Modern psychology confirms and extends Kant's insight. We don't "see" the reflections on our retinas in the same way. While you may see a green object on your retina, I may see it as brown, since I'm color-blind to certain greens. And we're well aware of common optical illusions and misperceptions. That's why eye-witness testimony is often contradictory, even when the witnesses are honest. Often, what we see shouldn't be believed.

**Example:** You've probably seen illustrations such as this, where our minds fool us. How many "F"s do you see in this passage?

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**FINISHED FILES ARE THE RESULT OF YEARS OF SCIENTIFIC STUDY COMBINED WITH THE EXPERIENCE OF YEARS.**

Most people see only three. That's all I saw the first two times I read it. Actually, there are six. (Look slowly at each letter and count again, perhaps starting at the end.) This is similar to the problem drivers have spotting motorcycles on streets where they are rare. We're watching for cars and trucks and may not see the motorcycles at all.

**Example:** Are the horizontal lines below curved or straight? Use a ruler or straight edge to see.

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Fallacies such as bifurcation, like a good magician or an illusion, play on our brains' tendencies to see certain things incorrectly or to be distracted from crucial details. How can creativity help us to overcome distractions and wrong directions in order to innovate productively?

1. **Broaden your range of input.**

Who would you prefer to edit your writing?
a) A dyslexic, who struggles to read well?

b) Slow readers?

c) An autistic who often misses the big picture?

d) A top academic who teaches grammar and literature?

e) A person so proficient at reading that she can polish off an entire novel in an evening?

Intuitively, most authors seem to seek out exclusively d) and e) types, and I agree that their input has a place. After all, shouldn't avid readers and top grammarians have valuable input?

But I'm increasingly seeking editorial input from a wider range of people. True, autistics often miss the big picture because they're fascinated with the details. But this attention to detail makes them more likely to see the "F"s in the above illusion. Proficient readers hardly see the word "of," and may miss a broad range of errors in my manuscripts. Higher functioning autistics may see all those little details that most of us miss.

While fast readers may excel at telling you if your story is interesting and flows well, the slow reader may be better for thinking through your line of argument, spotting places that need more documentation, or helping you with the rhythm produced by combinations of long and short sentences. Literature professors tend to love clever analogies and brilliant descriptions, whereas the average reader may see these as distractions from the story line. That's why I like input from both.

Academics have a high tolerance for detailed argumentation and theory. While I'll get their input on this book, I can't quite trust their verdict if they tell me it's interesting. If I'm writing, not primarily for professors, but for their students and the broader public, I treasure input from those who aren't naturally interested in my subject matter. I'm blessed with dyslexic twins, and love their input. That's one reason I use lots of white space, bullet points, and illustrations. Dyslexics cringe when they see a page full of unbroken words. I've found that if I can hold the attention of struggling readers, I'm more likely to captivate a broad range of readers, and in the end delight academics as well.

2. At times, ignore the current theory that drives your research, and allow non-experts to offer ideas; or just throw a bunch of stuff against the wall to see what sticks.

Sometimes our theories and methods keep us from trying potentially fruitful experiments. Since we seldom recognize that the ruling theory may have deflected us onto a side road, it sometimes helps to toss it and try something new.

Isn't this the way inventor Thomas Edison often proceeded? I still picture him in his later years, stopping beside the road to sample plants that might be used as a substitute for the rubber used to make tires, which was in short supply during World War II.

- A thirteen year old, Jack Andraka, took an intense interest in trying to cure pancreatic cancer, after it killed a family friend. Being new to the field, he took a different direction from the standard research, resulting in his inventing a simple, cheap test to detect pancreatic cancer early, when it can be successfully treated.26

- Don Valencia, a cellular biologist who developed tests to diagnose autoimmune diseases, had worked on isolating molecules in human cells without destroying them. It occurred to him that this technique might work for making a concentrated extract of coffee that could capture its flavor more successfully than other extracts. He experimented with it in his kitchen, trying out different flavors on his neighbors. Once perfected, he took it to Starbucks. They eventually hired him and used the technology to expand their product line to coffee ice cream, bottled beverages, etc.27

3. Employ higher levels of reasoning.

Bloom's Taxonomy (most refer to the "revised" taxonomy), distinguishes different types of thinking, suggesting ways for us to move past rote memory. Unfortunately, many students seem to seldom move past merely identifying and memorizing the important parts (what might be on the test) of texts and lectures.

Yet, to succeed in real life, we must go further than recognition or rote memorization (see Level 1 in the below graphic.). We need to develop the skills of comprehending (Level 2), applying (Level 3), analyzing (Level 4), synthesizing (Level 5) and evaluating (Level 6). Search "Bloom's Taxonomy" in Google and you'll find many lists of specific characteristics of each level of thinking. Referring to such lists when working through an issue can suggest new ways to approach it.
For example, in our discussion of Richard Dawkins’ argument, I first stated it (Level One) and several times put it in my own words to try to clarify it (Level Two). We skipped application, but analyzed it (Level Four) by putting it in a line of argument and syllogism, so that we could identify and examine the premises. We did a bit of synthesis (Level Five) when we brought in outside ideas of how theists conceive of the eternal existence of God, and how other thinkers have responded to the argument. Finally, evaluation (Level Six) came to play when we noted that there seems to be an element of smoke and mirrors involved in the fallacy of bifurcation.

So if you're evaluating an argument or a proposal, consider running it through Bloom's Taxonomy to expand your ways of looking at the issue. Note how several levels involve creativity.

Flex Your Neurons!

Pursuing the Point of Know Return

1. Write your own example of a "straw man" argument.
2. Write your own example of a "bifurcation" argument.
3. If you agree that Dawkins' argument makes no sense, why do you think such a smart person would forward such a nonsensical argument? If you believe that the argument could make sense if reformulated, how would you change it to overcome the difficulties scholars have brought forth?
4. How could you use Bloom's Revised Taxonomy
as a practical tool for thinking more critically about issues you study and write about?

5. How could you use Bloom's Revised Taxonomy to think more creatively?
6. Since our brains often deceive us, how can we protect ourselves against such deceptions?

Making It More Personal
Practical Takeaways

What are one or more ideas provoked by this chapter that you can apply to help you think more critically?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

What are one or more ideas that you can apply to help you think more creatively?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

What else do you want to make sure you don't forget?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Recommended Trails
For the Incurably Curious and Adventurous

1. To more fully understand a fallacy, it's often helpful to read other people's explanations and examples. To do this, Google "bifurcation" or "straw man."

2. Learn more about "Bloom's Taxonomy." This Wikipedia article is a good starting point to introduce it, discover the main controversies, and find other resources: http://en.wikipedia.org/wiki/Bloom%27s_taxonomy

3. Here's a TED talk of Jack Andraka talking about his development of a test for pancreatic cancer. Why do you think a young teen was able to develop such a test, when the experts had failed? http://www.ted.com/talks/jack_andraka_a_promising_test_for_pancreatic_cancer_from_aTeenager?language=en

1. Analytical philosopher Alvin Plantinga argues that this line of reasoning is consistent with, and even demanded by, philosophical naturalism. http://www.nybooks.com/articles/archives/2012/sep/27/philosopher-defends-religion/.

2. Susan Blackmore and Alex Rosenberg argue that since our brains were constructed solely through naturalistic evolutionary processes—for survival than for finding truth—our brains build mental models that we can't control (there is no "I" or "self" directing the brain, in the view of both authors) and they can't be trusted to lead us to truth. Susan Blackmore, Dying to Live (Buffalo, New York : Prometheus Books, 1993), pp149-164; 221-225; Alex Rosenberg , The Atheist's Guide to Reality (New York: W. W. Norton & Company, 2011).

3. For example, Hume's radical empiricism led him to deny that we can establish cause/effect relationships—a belief which would obviously wreak havoc in science.


5. Ibid., p. 52.

6. Ibid., p. 136.


8. Ibid., see also pp. 186-188.

10. In *The God Delusion*, Dawkins doesn't even mention the option of God being eternal, much less argue against it. In one of his earlier books, *The Blind Watchmaker*, he least acknowledges that some would argue that God exists eternally, but brushes this option off (rather than forward an opposing argument) with a sentence: "You have to say something like 'God was always there', and if you allow yourself that kind of lazy way out, you might as well just say 'DNA was always there', or 'Life was always there', and be done with it." Richard Dawkins, *The Blind Watchmaker* (New York: W. W. Norton & Company, 1996), p. 200. But why does Dawkins consider "something was always there" an invalid option? After all, prior to the 20th century, the majority opinion of scientists was that the universe was always there, extending into eternity past. Was that "lazy" on their part? In fact, when we consider ultimate origins, we'd seem to be left with two options: either there was nothing prior to the Bang (the standard scientific view of the Big Bang, according to Dawkins), so that something appeared out of nothing, with nothing to cause it, (that's absolutely nothing—no empty space, no vacuum), or that the beginning of the universe was caused by something that existed in some non-material form outside of time and space, existing from eternity past. Is the latter option really stranger than something coming from nothing on its own accord? If not, then why does Dawkins think it so inconceivable (or lazy) that God could have existed eternally? He fails to address this question.


15. Ibid., p. 16.

16. Ibid., pp. 2,3,310,311.

17. Ibid., pp. 313-315.

18. Ibid., p. 311.


20. "Minus logical positivists, tremendously influential outside philosophy, especially in psychology and social sciences, intellectual life of the 20th century would be unrecognizable." Yet, "By the late 1960s, the neopositivist movement had clearly run its course. Interviewed in the late 1970s, A. J. Ayer supposed that "the most important 'defect' was that nearly all of it was false." http://en.wikipedia.org/wiki/Logical positivism#Critics. For a brief history of Logical Positivism, see articles such as "Logical Empiricism" or "Theism" in *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.). It's a wonderful (free!) resource for all things philosophical.

21. H. Allen Orr, op. cit. Dawkins would seem to be a master of the straw man. Perhaps he gives us a clue as to why in his introduction to *The Divine Watchmaker*, where he states his opinion that Darwin's first edition of Origin of the Species was more persuasive than the last edition, because in the first edition Darwin didn't deal with all the objections. Apparently, in Dawkins' mind, Darwin's stating other people's objections took away from his argument. So perhaps Dawkins knows many of the objections people would give to his arguments, but is afraid that if he presents the strongest arguments for all sides of his statements, that this will take away from his persuasiveness. Thus, he presents straw men, which are much more easily knocked down. Example: if you look carefully at his arguments against the existence of God in chapter three of *The God Delusion*, he doesn't present the arguments as his strongest opponents present them. In the form he presents them, they're easily destroyed. For example, on Dawkins' critique of the Cosmological Argument for God's existence, see philosopher Edward Feser's critique at http://edwardfeser.blogspot.com/2011/07/so-you-think-you-understand.html. Also, view Dr. William Craig's presentation at Oxford on the same topic at https://www.youtube.com/watch?v=FP9CwDTRoOE.


25. Note other objections to this argument:

1. Going along with our argument concerning the mining operation on the moon, philosophers argue that an immediate explanation doesn't require an ultimate explanation. Example: William Craig suggests that if we found
artifacts of a lost civilization, that's sufficient evidence that the civilization actually existed, even if we have no ultimate explanation of where the civilization came from. Contending with Christianity's Critics, op. cit., p. 4.

2. From a purely naturalistic perspective, we have no ultimate explanation of anything. For example, you may ask why this cat is sitting on my desk looking at me? I may respond, "It wants to lick the milk out of my bowl of cereal." But what if you counter, "That's no explanation, where did the cat come from?" I may say, "Its mom." And you may complain, "Yes, of course. But if you can't give me the ultimate explanation of where the cat came from, I refuse to believe that it even exists." Yet, from a naturalistic perspective, all scientific explanations end with the Big Bang, a place at which physics as we know it breaks down and at which scientists tell us all scientific questions stop. All reductionist scientific explanations end with the Big Bang, and if we ask one more "Why?" beyond the Big Bang, science lets us down, because the Big Bang is a singularity. Thus, if all arguments about the existence of this or that must answer the ultimate question of origins to be meaningful, aren't we stuck with no meaningful arguments at all? Thus, from a naturalistic perspective we can't ultimately answer the question, "Where did this cat come from?" But would Dawkins thus concede that we therefore can't argue for its existence? Surely not.


27. For the story of the development of Starbucks' instant coffee, see Schultz, Howard and Dori Jones Yang, Pour Your Heart Into It: How Starbucks Built a Company One Cup at a Time (New York: Hyperion, 1997), pp. 216-218.
Logic and Logical Fallacies

"Read not to contradict and confute; nor to believe and take for granted; nor to find talk and discourse, but to weigh and consider."

— Francis Bacon, Of Studies

Brilliant People Believe Nonsense [because]...They Either Fail To Recognize Fallacies, or Misapply The Ones They Know

Warning

Learning fallacies can be fatal to your argumentation and detrimental to your relationships. For these reasons, I teach logical fallacies with a great deal of hesitation. It's a bit like selling firearms to a person with no training in how to use them. I'd hate to be known as one who arms Internet trolls.*

So before I present a large list of fallacies, I'll acquaint you with a particularly pernicious type of fallacious reasoning that's running rampant on the Internet, but which is strangely absent from lists of fallacies. I call it "The Fallacy Fallacy."

The Fallacy Fallacy: Debunking Debunking

I often read comments on blog posts or articles or Facebook discussions which accuse the writer of committing a specific logical fallacy and thus declaring the argument thoroughly debunked, typically with an air of arrogant finality. While the debunker may feel quite smug, intelligent participants consider him quite sophomoric.* In reality, he's typically failed to even remotely understand the argument, much less apply the fallacy in a way that's relevant to the discussion.

Surely this fallacy deserves a proper name and should be listed with other fallacies. Thus I'll define "The Fallacy Fallacy" as "Improperly connecting a fallacy with an argument, so that the argument is errantly presumed to be debunked."

Don't be a troll. Here are a few ways people misapply fallacies, thus committing "The Fallacy Fallacy":

1. They misunderstand the fallacy.
   "YOU'RE ALWAYS ARGUING WITH JAMIE, WHICH IS OBVIOUSLY AD HOMINEM." (Trolls delight in using all caps, confusing louder with smarter.) If the person was actually arguing against Jamie's arguments, rather than putting Jamie down as a person, then the arguments weren't ad hominem at all.

2. They fail to appreciate nuance. (They understand the fallacy, but apply it errantly.)
   Someone quotes Albert Einstein to bolster his argument. "THAT'S AN APPEAL TO AUTHORITY!" shouts the troll. But citing authorities isn't always fallacious. If a person cites Einstein concerning a question of relativity theory, then Einstein is a legitimate authority. Thus, quoting him can be a legitimate part of an argument, although it's typically not a slam dunk in itself. While arguments concerning establishing facts should be argued on the basis of the evidence, in many cases citing authorities can help to substantiate the evidence.

3. They assume a thorough debunking when there’s typically more to the argument.
   While trolls are celebrating their "brilliant" comments with a victory dance and a handful of Skittles, their opponents are often typing a clarification that makes the Trolls' comments irrelevant. We simply must take the time to thoroughly understand the arguments we're evaluating.
Making Arguments More Fruitful

For those who sincerely want to learn from one another by hashing out issues, consider this: Trolls "flame" opponents by either calling them morons or presenting their arguments dogmatically, as if they have crushed their opponents. If you're concerned about the truth, seek more to understand than to demonstrate your brilliance. To accomplish this, **suggest** rather than **slam**; express tentativeness rather than dogmatic finality; ask questions rather than accuse.

Does it in any way weaken a counter-argument to word it in a cautious, humble manner, such as: "At first glance your argument appears to be an unwarranted appeal to authority. Are you really saying that your position is correct solely because Einstein believes it as well?"

In this way, the opponent is more likely to respond in a reasonable manner and you save face in case you took the comment out of context or otherwise misunderstood it.

**Benjamin Franklin on Fruitful Argumentation**

Franklin was one of the most influential people in American history. He learned a lesson early in life which he considered of such significance that he discussed it at some length in his autobiography. He describes learning Socratic argumentation, which he delighted to use in humiliating his opponents. (As an annoying ass during this phase of a few years, he was a predecessor to the modern day Internet troll.)

But over time, he realized that this method failed to either persuade others or to help him learn from them. Rather, it disgusted people. So he changed his method of argumentation. In Franklin's own words, he discovered the value of:

"never using, when I advanced anything that may possibly be disputed, the words *certainly*, *undoubtedly*, or any other that give the air of positiveness [meaning "dogmatism"] to an opinion; but rather say, *I conceive or apprehend a thing to be so and so*; *it appears to me*, or *I should think it so or so*, for such and such reasons; or *I imagine it to be so*; or *it is so*, if *I am not mistaken*. This habit, I believe, has been of great advantage to me when I have had occasion to inculcate my opinions, and persuade men into measures that I have been from time to time engaged in promoting." (italics his; brackets mine)

As a result, Franklin became a skilled negotiator and persuader, allowing him to help start America's library system, organize firefighters, run a successful printing business, improve our postal service, negotiate with the French to aid us in the Revolutionary War, and assist in finalizing and adopting the Declaration of Independence, just to name a few of an astonishing array of accomplishments.

**Some Helpful Ways to Organize Fallacies**

The plethora of known fallacies can be quite unwieldy, so let's first of all look at some helpful ways of classifying them. In this way, when you sense an argument is invalid but can't remember the name of the specific fallacy, at least you might be able to identify the category in order to better evaluate or research it.

(Example: "That sounds like a fallacy of definition.") Although no single categorization scheme has become standard, you'll find some of the categories (such as "formal" and "informal") used widely.
Aristotle was perhaps the first to categorize logical fallacies in his *De Sophisticis Elenchis* (*Sophistical Refutations*). He lists 13 fallacies under two categories: **Verbal** (those depending on language) and **Material** (those not depending on language). In modern times, those building on Aristotle's two divisions often add a third: **Logical or Formal**—fallacies that violate the formal rules of the syllogism.

**Philosopher J. L. Mackie**

Mackie divided fallacies into:

**Fallacies in a Strict Sense**

*invalid forms of deductive reasoning; the conclusion doesn't logically follow from the premises.*

**Formal Fallacies** - The conclusion is invalid because of the argument's form. Example: Exerting the consequent—If there are too many cooks, there's chaos in the kitchen. There's chaos in the kitchen, therefore there are too many cooks. (If p then q, q, therefore p)

**Informal Fallacies** - The conclusion is invalid for reasons other than its form. (Example: Using vague or ambiguous terms.)

**Fallacies in Non-deductive Reasoning and in Observation**

*errors in inductively reasoning from evidence to a conclusion or hypothesis.*

**Induction and Confirmation** - example: *post hoc ergo propter hoc* - the fact that event "b" followed event "a" doesn't absolutely prove that event "a" caused event "b".

**Analogy** - A weak analogy, one that has few or trivial points of resemblance, may have no evidential value at all.

**Classification** - Example: A company may argue that all people classified as autistic are unemployable. Yet, autistic people vary greatly in their skills, so that highly functioning autistics, or those wrongly categorized, may be overlooked.

**Statistics** - Example: If students from City High School outperform students from County High School on standardized tests, this doesn't necessarily imply City High School has better teachers. Perhaps administrators skew the scores, or one district has more high risk students.

**Probability** - Example: Although the probability of flipping a coin five times and getting heads every time is low, that doesn't mean that if you got heads four times in a row, it's very unlikely that you'll get heads in the next flip. The odds are still 50/50.

**Observation** - Example: Often what we observe is skewed by what we want or expect to observe.

**Fallacies in Discourse**

*The argument fails because of some reason other than invalid deductive reasoning or arguing from evidence.*

**Inconsistency** - You can't have it both ways. "*Petitio Principii*" - Including your conclusion in your premises (aka begging the question or arguing in a circle).

**A Priori Fallacies** - Bringing to the argument unfounded preconceptions that influence the conclusion.

"*Ignoratio Elenchi*" - Missing the point: An argument concerning something that was never meant, in the context of the argument, to be proven.

**Fallacies of Interrogation** - Demanding a narrow and specific answer to questions that demand broader answers. Example: "Answer yes or no: Have you stopped beating your wife?"

**Fallacies in Explanation and Definition** - Example: using the same word in two different ways in an argument, thus invalidating the argument.

**Historian David Hackett Fischer**

In Fischer's instructive and delightful book, *Historians' Fallacies*, he discusses 112 fallacies under 11 categories. Note that these apply far beyond professional historians. Whenever we blog about an event, summarize our family vacation on.
Facebook, or write that first high school paper on "What I Did for My Summer Vacation," we're telling history, and risk committing these fallacies. Here are Fischer's categories:

**Question-framing** - Historians begin their research by asking one or more questions. If these questions are vague or ill-conceived, they will yield the wrong answers. Example: asking a complex question and expecting a simple answer.

**Factual Verification** - Failure to rigorously employ the best methods for verifying historical data.

**Factual Significance** - Historians can't report every fact from a period of history; they must be selective. If they select based on the wrong criteria, their conclusions will likely be wrong as well.

**Generalization** - Improper statistical reasoning from historical data. Example: Drawing a general conclusion from an insufficient sampling of data.

**Narration** - Historians gather threads of historical data and weave them into stories. Yet, "nothing but the facts" is often at odds with great storytelling, which assigns feelings and even time sequences that may not be warranted by the historical data.

**Causation** - Example: The reductive fallacy reduces a complex historical cause to a simplistic one.

**Motivation** - Historians often assign motives without sufficient evidence; for example, assuming that a Roman Emperor thinks, reacts, and is motivated by the same things that motivate a middle-aged academic historian at Berkeley.

**Composition** - Historians tend to study and write about groups, or individuals as part of groups, whether the groups be social, religious, national, ideological, cliques, castes or economic. One fallacy of composition is assuming that the character of one member is shared by the rest of the group.

**False Analogy** - Example: People often reason from a partial analogy to declare there's an exact correspondence; but in reality, analogies are seldom exactly parallel.

**Semantical Distortion** - Problems with unclear or imprecise prose. For example, the failure to clarify definitions of terms.

**Substantive Distraction** - The argument shifts the reader's attention to issues that are irrelevant to the discussion.

While categorization schemes are helpful for getting an overview of types of fallacies, none seem to be without their downsides. For example, some fallacies seem to fit snugly into multiple categories.

**A Great Big List of Fallacies**

In my first Appendix, I list a great number of fallacies. I don't recommend trying to memorize them. Rather, familiarize yourself with each of them so that in the future, when you run across an argument that doesn't sound quite right, you can return to the list to search for a fallacy that might apply. If you're reading this for a class, your teacher or professor may single out certain fallacies that they deem the most important or the most frequently abused in literature and the media.

**Conclusion**

There are many ways to go wrong in our arguments. Some are a bit technical. But by familiarizing ourselves with fallacies, learning to apply them correctly, and discussing disagreements in a civil and humble manner, we can learn from each other and mutually come closer to the truth.

**Matching Exercises**

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**Flex Your Neurons!**
**Pursuing the Point of Know Return**

1. What do you think motivates trolls to flame people in social media or to start arguments in social settings?
Making It More Personal

Practical Takeaways

Recommended Trail
For the Incurably Curious and Adventurous

For any fallacies that seem unclear or are of special interest to you, Google them to find other explanations and illustrations.

End Notes

Chapter 12: They Either Fail to Recognize Fallacies, or Misapply The Ones They Know

1. Aristotle was the first I'm aware of to discuss examples. Apparently, back in 350 BCE, Greek predecessors to today's trolls strolled about annoying the great philosophers, imagining that they were spouting profundities. Thus, Aristotle wrote a work about "Sophistical Refutations," which he defined as "what appear to be refutations but are really fallacies instead." While mainly writing about logical fallacies, he also spoke of assigning fallacies incorrectly. See Aristotle, *Sophistical Refutations*, written c. 350 B.C.E., translated by W. A. Pickard-Cambridge, available digitally here: http://classics.mit.edu/Aristotle/sophist_refut.1.1.html.

2. Aristotle describes this issue: "By a sophistical refutation and syllogism I mean not only a syllogism or refutation which appears to be valid but is not, but also one which, *though it is valid, only appears to be appropriate to the thing in question.*" (Italics mine, Part Eight, *Sophistical Refutations*.)


4. Tetlock, in his respected work, *Expert Political Judgment*, suggests that those who use more temperate language tend to be more accurate in their predictions. He brings together a wealth of research showing that the foxes (who know many little things) predict better than the hedgehogs (who know one niche area in depth), although the latter are typically considered the experts and practically everyone (e.g., news sources) wants to hear from them. Those who speak in terms of "perhaps," and "possibly" are far better predictors than the dogmatic, assured experts. Philip E. Tetlock, *Expert Political Judgment* (Princeton, New Jersey: Princeton University Press, 2005, 2006).


7. From his article "Fallacies," op. cit.