# Chapter 24: Audience Analysis

## Objectives

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

1. Identify and describe the four primary categories of technical communication audiences—experts, technicians, executives, and nonspecialists—and explain how they differ in knowledge and expectations.
2. Analyze audience characteristics, including background, needs, interests, and demographics, to inform content development and communication strategies.
3. Apply techniques to adapt technical writing for mixed and variable audiences, including using section targeting, cross-references, and supplemental materials.
4. Use specific rhetorical and structural strategies to articulate complex technical information for nonspecialist audiences, such as comparisons, examples, definitions, and shorter sentences.
5. Revise documents to improve audience engagement and comprehension, employing controls in information selection, structure, sentence style, and visual design.

## Introduction to the Audience Analysis

The audience of a technical report—or any piece of writing for that matter—is the intended or potential readers. For most technical writers, the audience is the most important consideration in planning, writing, and reviewing a document. You must adapt your writing to meet the needs, interests, and background of the document’s readers.

The principle seems simple and obvious. It's like saying, "Don't talk rocket science to your six-year-old." Do we need a course in that? Probably not. Regardless, lack of audience analysis and adaptation is one of the root causes of most of the problems you find in professional, technical documents, particularly instruction manuals 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](https://forms.gle/XuiJfYPRGgssHh7A9)

### 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.

Example: Sir Jonathan Ive, lead designer of MacBooks, among other things.

#### 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.

Example: Apple Certified Technicians, the people who repair and refurbish Macbook computers.

#### 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.

Example: Tim Cook, current CEO of Apple, Inc.

#### 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. They may just be curious about a specific technical matter and want to learn about it—but for no specific, practical reason.

Example: Average, everyday MacBook users like you and me.

### Audience Analysis

After you’ve determined your audience category, you must analyze your audience in terms of the following characteristics:

#### 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

Of course, other characteristics about your readers may influence how you design and write your document: age groups, type of residence, area of residence, gender, and political preferences.

### Special Considerations for Audience Variability

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

#### Multiple Audiences

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.

#### Widely Variable Audiences

You may realize that, although your audience fits into only one category, background is variable. This situation poses a challenge: if you write to the lowest common denominator, you're likely to produce a cumbersome, tedious document that will turn off the majority of readers. Nevertheless, if you don't write to that lowest level, you lose that segment of your readers. So, what should you do? Most writers focus on the majority of readers and sacrifice the minority that may need more help. Others put supplemental information in appendices or insert cross-references to materials for beginners.

### Audience Adaptation

Now 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?

Writing to your audience may rely in some part on innate talent or intuition, but you can use some controls to increase your chances of connecting with your readers. The following "controls" have mostly to do with making technical information more understandable for nonspecialist audiences:

#### Information Control

**Add information readers need to understand your document**. Check to ensure that key information is included. 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 confuse and frustrate readers—after all, it's there so they feel obligated to read it. For example, omit theoretical discussion from basic instructions.

**Change the level of the information you currently have**. You may have the right information, but it might be pitched at an inappropriate technical level or audience. This often happens when product-design notes are mistaken for 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—analogies 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.

**Write stronger introductions for the whole document and for major sections**. People seem to read more confidently and comprehend deeper 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 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 give them an overview of the subtopics about to be covered.

**Use more or different graphics**. For nonspecialist audiences, use simpler graphics. Specialists prefer more detailed and technical ones. Technical documents for nonspecialists often include decorative graphics that are attractive but serve no informative or persuasive purpose.

#### Structure Control

**Change the organization of your information**. Sometimes, you can have all the right information but arrange it in the wrong way. For example, readers can get lost if you don’t provide adequate, appropriate background information. 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.

**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, so put people and action into your writing. Similarly, go for active verbs as opposed to be 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**. 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.

**Break text up or consolidate text into meaningful, usable chunks**. For nonspecialist readers, you may need to have shorter paragraphs; 6- to 8-line paragraphs 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.

#### Design Control

**Use headings and lists**. Readers can be intimidated by dense paragraphs of writing, uncut by anything other than a blank line now and then. Search your rough drafts for ways to incorporate headings, such as changes in topic or subtopic. Search your writing for listings of things that can be made into vertical lists. Look for paired listings such as terms and their definitions that 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. Consult accessibility documents or colleagues 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!

## Articulating Technical Discussions

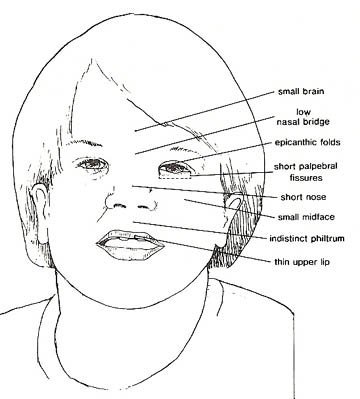
The ability to explain complex, technical matters with ease and simplicity so that nonspecialist readers understand almost effortlessly is one of the most important skills you can develop as a technical writer. This ability to "translate" or articulate difficult-to-read technical discussions is important 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.

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 articulation.

### 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 syndrome (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 **vermilion**.



*Facial features characteristic of FAS*

### 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—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 the following passage:

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**.  
  
Stephen S. Hall, "The Flu," Science 83, (November 1983), pages 56-57.

### 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.

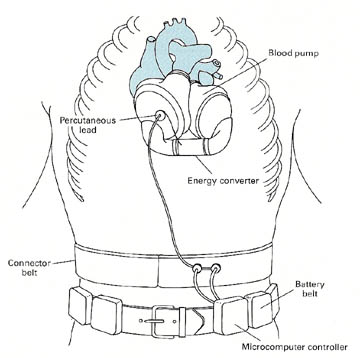
This brief reference can be converted into a more complete explanation as is illustrated here:

The Video Alert and Control dashboard systems use 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 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.



Electrically driven artificial heart system. Source: Jarvik, Robert K. "The Total Artificial Heart," Scientific American, January 1981, p. 80. Jacqueline R. Mudd, Report on Artificial Methods of Combating Heart Disease, University of Texas at Austin, May 6, 1983.

### 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 previous fetal-alcohol-syndrome example: 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 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.  
  
Hoo-Mi D. Toong and Amar Gupta, "Personal Computers," Scientific American, (December 1982), pp. 99-100.

### Shorter Sentences and Paragraphs

Reducing sentence length can make a technical discussion easier to understand. Consider the following pairs of example passages. the second versions 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-fluorescence was determined on aliquots of the hexane extracts of subsurface water using the Perkin-Elmer MPF-44A dual-scanning fluorescence 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 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," with a correction factor applied to account for the reference mousse containing only about 30 percent.

**Revised Version: Shorter Sentences**

UV-fluorescence was determined on aliquots of the hexane extracts of the subsurface water. These measurements were performed using a Perkin-Elmer MPF-44A dual-scanning fluorescence 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 estimate, was calculated from its respective fluorescence. 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.

#### 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. The 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

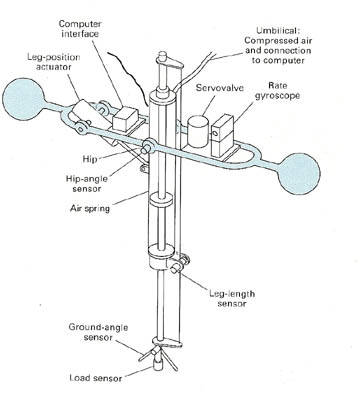
Examples of transition words and phrases are "for example," "however," and ”essentially.” When the discussion is particularly difficult and when repetition and arrangement of keywords is not enough, use transition words and phrases.

#### 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. Source: Marc H. Raibert and Ivan E. Sutherland, "Machines that Walk," Scientific American, (January 1983), p. 50.

### 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 sickled. 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**.  
  
David S. Newman, An Invitation to Chemistry, pages 387-388.

### 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:

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.

### Reviewing Theoretical Background

To understand some phenomena, technologies, or their applications, readers must first understand the principle or theory behind them. Theoretical discussions can be made accessible to 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 discusses 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.

### Combining the Articulating Techniques

This last section concludes the techniques for articulating difficult technical prose to be presented here. However, examine writing in fields you are familiar with, 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 anneals 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 opthalmologist 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.

Allen A. Boraiko, "Lasers: A Splendid Light," *National Geographic*, (March 1984), pp. 338-346.

## Attribution

This chapter is revised from the first edition of *Open Technical Communication*, Chapter 5.2: “[Audience Analysis](https://alg.manifoldapp.org/read/open-technical-communication/section/415d5b4f-758e-49ac-8149-18d4c3c4c10c)” by David McMurrey and Chapter 5.4: “[Articulating Technical Discussions](https://alg.manifoldapp.org/read/open-technical-communication/section/39c29f74-f502-4050-80b3-1162a9cdd8b0)” by David McMurrey, Jonathan Arnett, and Tamara Powell, which are both openly available under a Creative Commons Attribution license.

The content in Chapters 5.2 and 5.4 of the first edition of *Open TC* was originally sourced and revised from David McMurrey’s *Online Technical Writing*, sections titled “[Audience and Situation Analysis](https://mcmassociates.io/textbook/aud.html)” and “[Translating the Technical](https://mcmassociates.io/textbook/translating.html),” which are both openly available under a Creative Commons Attribution license.

## AI Assistance Notice

Some parts of this chapter were brainstormed, drafted, and/or revised in conversation with ChatGPT 4o and Google Gemini 2.5 Flash. All AI-generated content was reviewed and revised as needed by a human author.