SCENARIO

It’s a relaxed Saturday morning and you stop by a friend’s apartment to say hi. You find her struggling to unplug a clogged sink drain by using a plunger.

“Look,” you say, “you ought to buy yourself a plumber’s snake. It would unclog that drain in a couple of minutes.

“Really? What’s a plumber’s snake?”

“Well, it’s a tool for unplugging drains. Mostly, it’s a flexible, springlike, steel cable about five feet long and with the diameter of a pencil. The cable has a football-shaped boring head on its working end. The head is about two inches long, and at its widest point it’s twice the diameter of the cable. The whole business looks a bit like a snake—hence its name.”

“That so? Anything to it besides the cable and head?”

“Uh-huh. There’s a crank. It’s a hollow steel tube in the shape of an opened-up Z. It’s about ten inches long, so you can get both hands on it. You slip the crank over the cable. With it, you can rotate the cable after you’ve inserted it in the drain, so that the head operates something like a drill to bore through the clog.”

“Sounds like a handy gadget. I’ll have to get one.”

In an impromptu way, you have applied the organizational strategy used to describe things to the description of a mechanism. And that’s what this chapter is all about. It reviews organizational strategies, such as chronology and definition, and gives them a technical writing twist.

If you need such a review, you may find this chapter useful.

chapter 9

Presenting Information

Chronology

Topical Organization

Exemplification

Analogy

Classification and Division

Definition
Sentence Definitions
Extended Definitions
Placement of Definitions

Description
Visual Language
Mechanism Description
Process Description

If you follow our advice in Chapters 2 and 4 about situational analysis and writing for your readers, you will likely come up with an organizational strategy that fits your purpose and your audience. Nevertheless, being aware of the full array of organizational strategies available to you can be useful at both the discovery and organizing stages of composing. Therefore, this chapter reviews the strategies that have stood the test of time for presenting information: chronology, topical organization, exemplification, analogy, classification and division, definition, and description. In the next chapter we deal with analyzing information.

Taken together, Chapters 9 and 10 lay the groundwork for organizing the numerous technical reports you may be called upon to write. You can use any of the strategies in these two chapters as an overall organizing principle for an entire report. But you will also use them as subordinate methods of development within a larger framework. For example, within a paper arranged topically you may have paragraphs or small sections based upon chronology, exemplification, classification, and so forth. Within a set of instructions you are likely to have both mechanism and process descriptions. The two uses are mutually supportive and not in conflict with each other.

CHRONOLOGY

When you have reason to relate a series of events for your readers, arranging the events chronologically—that is, by time—is a natural way to proceed. In your chronological narrative, be sure your readers always know where they are in the sequence of events. In the example that follows, a description of the volcanic eruption of Mount St. Helens, we have printed in boldface the phrases the authors use to orient their readers.

> MOUNT ST. HELENS, WASHINGTON. The catastrophic eruption on **May 18, 1980**, was preceded by 2 months of intense activity that included more than 10,000earthquakes, hundreds of small *phreatic* (steam-blast) explosions, and the outward growth of the volcano’s entire north flank by more than 80 meters. A magnitude 5.1 earthquake struck beneath the volcano at **08:32 on May 18**, setting in motion the devastating eruption.

Within seconds of the earthquake, the volcano's bulging north flank slid away in the largest landslide in recorded history, triggering a destructive, lethal lateral blast of hot gas, steam, and rock debris that swept across the landscape as fast as 1,100 kilometers per hour. Temperatures within the blast reached as high as 300 degrees Celsius. Snow and ice on the volcano melted, forming torrents of water and rock debris that swept down river valleys leading from the volcano. **Within minutes**, a massive plume of ash thrust 19 kilometers into the sky, where the prevailing wind carried about 520 million tons of ash across 57,000 square kilometers of the western United States.[1]

Chronology can be used to project forward as well as to describe the past. In the next example, the Bureau of the Census forecasts how the population of the United States will change during the first half of the twenty-first century:

> The United States population would increase by 50 percent, from 263 million in 1995 to 394 million in 2050, under the Census Bureau's middle-series population projections. The population would grow to 275 million in 2000, and 347 million in 2030. The average annual growth rate, however, would decrease from 1.05 percent for the 1990–1995 period to 0.63 percent for the 2040–2050 period.
>
> In 1995, there were 34 million people ages 65 and over representing 13 percent of the population. The middle-series projection for 2050 indicates that there will be 79 million people ages 65 and over, representing 20 percent of the population. . . . The population ages 85 and over is growing especially fast. It is projected to more than double from nearly 4 million (1.4 percent of the population) in 1995 to over 8 million (2.4 percent) in 2030, then to more than double again in size from 2030 to 2050 to 18 million (4.6 percent).[2]

In technical writing, graphics of all kinds are frequently useful in presenting and analyzing information, and you should always be alert for opportunities to use them. In the case of the population projection just quoted, the Census Bureau used the graph shown in Figure 9-1 to illustrate the predicted trends.

Because the arrangement of your material follows the sequence of events you relate, arrangement is not a particular problem for you when you use chronological order. Choosing the level of detail you need may be a problem. Obviously, the narrator of the events at Mount St. Helens and the person who reported the population projection could have used more or less detail. As in most kinds of writing, purpose and audience are your best guides in these matters. If your purpose, for example, is to give a broad overview for a lay or executive audience, you will limit the amount of detail. If you have, on the other hand, an expert audience who will wish to analyze carefully the sequence you describe, you will need to provide considerable detail.

TOPICAL ORGANIZATION

Technical writing projects often begin with a topic, say, Christmas tree farming. One way to deal with topics is to look for subtopics under the major topic. Under these subtopics you can gather yet smaller sub-subtopics and related facts. In the case of the Christmas tree topic, the subtopics might very well be production and marketing. Production could be broken down further into planting, maintaining, and harvesting. Marketing could be broken down into retail, wholesale, and cut-your-own. With some thought, you can break most topics down into the appropriate subtopics and sub-subtopics.

Be sure to choose topics and subtopics that suit your purpose and audience. Suppose your audience to be a group of executives who may have an interest in the use of robotics in their industries. Your audience analysis tells you that their major interest in robotics is application, not history or theory. You limit yourself, therefore, to application as a topic. You refine your purpose. You decide you want to give them some idea of the range of robotics. To do so, you reach into your knowledge of robotics and choose several illustrative applications:

- Installing windows in automobiles as the automobiles pass on an assembly line
- Arc welding in an airplane plant
- Mounting chips in a computer factory

By using these three applications as your subtopics, you can illustrate a wide range of current robotics practice. Within a few minutes, you have limited your topic to manageable size and made a good start on arrangement.

EXEMPLIFICATION

Technical writing sometimes consists largely of a series of generalizations supported by examples. The writer makes statements, such as this one about earthquakes:

> The actual movement of ground in an earthquake is seldom the direct cause of death or injury.

Having made a generalization, the writer must now support it:

> Most casualties result from falling objects and debris because the shocks can shake, damage, or demolish buildings and other structures. Earthquakes may also trigger landslides and generate huge ocean waves (seismic sea waves), each of which can cause great property damage and considerable loss of life. Earthquake-related injuries are commonly caused by: (1) partial building collapse, such as toppling chimneys, falling brick

from wall facings and roof parapets, collapsing walls, falling ceiling plaster, light fixtures, and pictures; (2) flying glass from broken windows (this danger may be greater from windows in high-rise structures); (3) overturned bookcases, fixtures, and other furniture and appliances; (4) fires from broken chimneys, broken gaslines, and similar causes (this danger may be aggravated by a lack of water caused by broken mains); (5) fallen powerlines; and (6) drastic human actions resulting from panic.[3]

There are two common ways to use examples. One way is to give one or more extended, well-developed examples. This method is illustrated in the paragraph about earthquake damage. The other way is to give a series of short examples that you do not develop in detail, as in the following paragraph:

> I use the term culture to refer to the "system of knowledge" that is shared by a large group of people. The "borders" between countries usually, but not always, coincide with political boundaries between countries. To illustrate, we can speak of the culture of the United States, the Japanese culture, and the Mexican culture. In some countries, however, there is more than one culture. Consider Canada as an example. There is the Anglophone (i.e., English-speaking) culture derived from England and there is the Francophone culture derived from France.[4]

Like most everything else in writing, the use of examples calls for judgment on your part. Too few examples, and your writing will lack interest and credibility. Too many examples, and your key generalizations will be lost in excessive detail.

ANALOGY

Analogies are comparisons—they compare the unfamiliar to the familiar in order to help readers better understand the unfamiliar. You should frequently use short, simple analogies, particularly when you are writing for lay people. For example, many lay people have difficulty comprehending the immense power released by nuclear reactions. A completely technical explanation of $E = mc^2$ probably would not help them very much. But suppose you tell them that if one pound of matter—a package of butter, for instance—could be converted directly to energy in a nuclear reaction, it would produce enough electrical power to supply the entire United States for 35 hours (that is, over 11 billion kilowatt hours). Such a statement reduces $E = mc^2$t o an understandable idea.

Scientists recognize the need for analogy when they are called upon to explain difficult concepts. A scientist working with microelectronic integrated circuits—that is, microchips—when asked to explain how small the circuits are, said, "Your grope for analogies. If you wanted to draw a map of the entire United States that showed every city block and town square, it would obviously be a *very* big map. But with the feature sizes we're working with to create microcircuits right now, I could draw that entire map on a sheet of paper not much larger than a postage stamp."[5]

A writer looking for a way to explain the immense age of the universe relative to humankind put it this way:

> Some 12 to 20 billion years ago, astronomers think a "primeval atom" exploded with a big bang sending the entire universe flying out at incredible speeds. Eventually matter cooled and condensed into galaxies and stars. Eons after life began to develop on Earth, humans appeared. If all events in the history of the universe until now were squeezed into 24 hours, Earth wouldn't form until late afternoon. Humans would have existed for only two seconds.[6]

Besides being practical, analogies can liven up your writing. Here is a writer having fun with some far-fetched analogies that, nevertheless, help the reader grasp the enormousness of the quantities he is discussing:

> If all the Coca-Cola ever produced were dumped over Niagara Falls in place of water, the falls would flow at a normal rate for 16 hours and 49 minutes . . . Two ships the size of the Queen Elizabeth could be floated in the ocean of Hawaiian Punch Americans consume annually.[7]

Analogies can be presented visually, and in technical writing they frequently are. Figure 9-2 is a graphic that uses the familiar—water pressure and flow—to explain the unfamiliar—*voltage* and *current.*

Throughout your writing, use analogy freely. It's one of your best bridges to the uninformed reader.

CLASSIFICATION AND DIVISION

Classification and division, like chronological and topical arrangement, are useful devices for bringing order to any complex body of material. You may understand classification and division more readily if we explain them in terms of the *abstraction ladder.* We borrow this device from the semanticists—people who make a scientific study of words. We construct the ladder in Figure 9-3 by beginning with a very abstract word on top and working down the ladder to end with a specific term.

While looking at Figure 9-3, keep one important distinction in mind: Even "John Smith's kitchen table" is not the table itself. As soon as we have used a word for an object, the abstraction process has begun. Beneath the word is the table *we see*; and beneath that is the table *itself*, consisting of paint, wood, and hardware that consist of molecules that consist of atoms and space.

In classification, you move *up* the abstraction ladder, seeking higher abstractions under which to group many separate items. In division, you move *down* the abstraction ladder, breaking down higher abstractions into the separate items contained within them. We will illustrate classification first.

Suppose for the moment that you are a dietitian. You are given a long list of foods found in a typical American home and asked to comment on the value of each. You are to give such information as calorie count, carbohydrate count, mineral content, fat content, vitamin content, and so forth. The list is as follows: onions, apples, steak, string beans, oranges, cheese, lamb chops, milk, corn flakes, lemons, bread, butter, hamburger, cupcakes, and carrots.

If you try to comment on each item in turn as it appears on the list, you will write a chaotic essay. You will repeat yourself far too often. Many of the things you say about milk will be the same things you say about cheese. To avoid this repetition and chaos you need to classify the list, to move up the abstraction ladder seeking groups like the following:

Food

Vegetables	*Cereal*	*Meat*
Onions	Corn flakes	Steak
String beans	Bread	Lamb chops
Carrots	Cupcakes	Hamburger
Fruit	*Dairy*	
Apples	Milk	
Oranges	Cheese	
Lemons	Butter	

By following this procedure, you can use the similarities and dissimilarities of the different foods to aid your organization, rather than having them disrupt it.

In division, you move down the abstraction ladder. Suppose your problem now is the reverse of the former one. You are a dietitian, and someone asks you to list examples of foods that a healthy diet should contain. In this case you start with the abstraction, *food.* You decide to divide this abstraction into smaller groups such as vegetables, fruit, meat, cereal, and dairy. You then sub-divide these groups into typical examples such as cheese, milk, and butter for dairy. Obviously, the outline you could construct here might look precisely like the one already shown. But in classification, we arrived at the outline from the bottom up; in division, from the top down. Figure 9-4 shows the Food Guide Pyramid, an excellent example of classification and division in action.

Very definite rules apply in using classification and division.

1. **Keep all headings equal**. In the food classification example, you would not have the headings Meat, Dairy, Fruit, Cereal, and Green Vegetables, because Green Vegetables does not take in a whole class of food as the other headings do. Under the heading of Vegetables, however, you could have subheadings of Green Vegetables and Yellow Vegetables.
2. **Apply one rule of classification or division at a time**. In the example, the classification is done by food types. You would not in the same classification include headings *equal* to the food types for such subjects as Mineral Content and Vitamin Content. You could, however, include these as subheadings under the food types.
3. **Make each division or classification large enough to include a significant number of items**. In the example, you could have many equal major headings such as Green Vegetables, Yellow Vegetables, Beef Products, Lamb Products, Cheese Products, and so forth. In doing so, however, you would have over-classified or overdivided your subject. Some of the classifications would include only one item.
4. **Avoid overlapping classifications and divisions as much as possible**. In our example, if you had chosen a classification that included Fruits and Desserts, you would have created a problem for yourself. The listed fruits would have to go in both categories. You cannot always avoid overlap, but keep it to a minimum.

As you choose your classification and division strategies, keep your situational analysis in mind. In a brochure about controlling termites, the authors chose to classify them according to their habitat:

> Based on ecological considerations, three types of termites occur in the United States: (1) drywood, (2) dampwood, and (3) subterranean. Drywood termites build their nests in sound dry wood above ground. Dampwood species initially locate their nests in moist, decaying wood but can later extend tunnels into drier parts of wood. Subterranean termites are more dependent on an external moisture source, and they typically dwell in the soil and work through it to reach wood above ground.[8]

The authors chose to classify termites in this way because, as they put it, “this information provides a foundation for control methods based on the habits and behavior of the termites.” Obviously, termites can be classified in many ways. Classifying by habitat seemed the best way to these authors in view of the brochure’s purpose and the needs of the audience.

DEFINITION

Everyone in a trade or a profession uses a specialized vocabulary that suits that occupation. Plumbers know the difference between a *globe valve* and a *gate valve*. Electrical engineers talk easily about *gamma rays* and *microelectronics*.

Statisticians understand the mysteries of *chi-squared tests* and *one-way analyses of variance*. In fact, learning a new vocabulary is a major part of learning any trade or profession. Unfortunately, as you grow accustomed to using your specialized vocabulary, you may forget that others don't share your knowledge—your language may be incomprehensible to them. So, the first principle in understanding definition is to realize that you will have to do it frequently. You should define any term you think is not in your reader's normal vocabulary. The less expert your audience is, the more you will have to define. And sometimes, when you use a new specialized term or use an old term in a new way, you will even need to define for your fellow specialists.

Definitions range in length from a single word to long essays or even books. Sometimes, but not usually, a synonym inserted into your sentence will do, as in this example:

> The oil sump—*that is, the oil reservoir*—is located in the lower portion of the engine crankcase.

Synonym definition serves only when a common interchangeable word exists for some bit of technical vocabulary you wish to use.

Sentence Definitions

Most often you will want to use at least a one-sentence definition containing the elements of a logical definition:

> term = genus or class + differentia

Although you may not have heard of the elements of a logical definition, you have been giving and hearing definitions cast in the logical pattern most of your life. In the *logical definition*, you state that something is a member of some genus or class and then specify the differences that distinguish this thing from other members of the class. For instance:

Term	=	*Genus or Class*	+	*Differentia*
An ohmeter	is	an indicating instrument		that directly measures the resistance of an electrical circuit.
A legume	is	a fruit		formed from a single carpel, splitting along the dorsal and the ventral sutures, and usually containing a row of seeds borne

on the inner side of
the ventral suture.

The second of these two definitions, particularly, points out a pitfall you must avoid. This definition of a legume would satisfy only someone who was already fairly expert in botany. Real lay people would be no further ahead than before, because the terms *carpel* and *dorsal and ventral sutures* are not familiar to them. When writing for nonexperts, you may wish to settle for a definition less precise but more understandable:

> A legume is a fruit, such as a pea pod, formed of an easily split pod that contains a row of seeds.

Here you have stayed with plain language and given an easily recognized example. Both of these definitions of a legume are good. The one you would choose depends on your audience.

Extended Definitions

To make sure you are understood, you will often want to extend a definition beyond a single sentence. The most common techniques for extending a definition are description, example, and analogy. However, any of the arrangement techniques, such as chronology, topical order, classification, and division may be used. The following definition, from *Chambers*, a respected technical dictionary, goes beyond the logical definition to give a description:

> *anemometer*. An instrument for measuring the velocity of the wind. A common type consists of four hemispherical cups carried at the ends of four radial arms pivoted so as to be capable of rotation in a horizontal plane, the speed of rotation being indicated on a dial calibrated to read wind velocity directly.

Our lay definition of legume gave an example: “such as a pea pod.” Often analogy is valuable, as demonstrated by this comparison, from the same source.

> A voltmeter is an indicating instrument for measuring electrical potential. It may be compared to a pressure gauge used in a pipe to measure water pressure.

The following definition of a hurricane is a good example of an extended definition intended for an intelligent lay audience. In it, the writer makes extensive use of both process and mechanism descriptions. Notice, also, that the writer begins by defining other terms needed in understanding hurricanes:

Defines related terms

A hurricane is defined as a rotating wind system that whirls counterclockwise in the northern hemisphere, forms over tropical water, and has sustained wind speeds of at least 74 miles/hour (119 km/hr). This whirling mass of energy is formed when circumstances involving heat and pressure nourish and nudge the winds over a large area of ocean to wrap themselves around an atmospheric low. Tropical cyclone is the term for all wind circulations rotating around an atmospheric low over tropical waters. A tropical storm is defined as a cyclone with winds from 39 to 73 mph, and a tropical depression is a cyclone with winds less than 39 mph.

Describes process

It is presently thought that many tropical cyclones originate over Africa in the region just south of the Sahara. They start as an instability in a narrow east-to-west jet stream that forms in that area between June and September as a result of the great temperature contrast between the hot desert and the cooler, more humid region to the south. Studies show that the disturbances generated over Africa have long lifetimes, and many of them cross the Atlantic. In the 20th century an average of 10 tropical cyclones each year whirl out across the Atlantic; six of these become hurricanes. The hurricane season is set as being June 1 through November 30. An “early” hurricane occurs in the 3 months before the season, and a “late” hurricane takes place in the 3 months after the season.

Describes mechanism

Hurricanes are well-organized. The 10-mile-thick inner spinning ring of towering clouds and rapid upper motion is defined as the hurricane’s eyewall; it is here that the condensation and rainfall are intense and winds are most violent. Harbored within the eyewall is the calm eye of the hurricane—usually 10–20 miles across—protected from the inflowing winds and often free of clouds. Here, surface pressure drops to a minimum, and winds subside to less than 15 mph. Out beyond the eyewall, the hurricane forms into characteristic spiral rain bands, which are alternate bands of rain-filled clouds. In the typical hurricane, the entire spiral storm system is at least 1,000 miles across, with hurricane-force winds of 100 miles in diameter and gale-force winds of 400 miles in diameter. A typical hurricane liberates about 100 billion kilowatts of heat from the condensation of moisture, but only about 3% of the thermal energy is transferred into mechanical energy in the form of wind. Sustained wind speeds up to 200 mph have been measured, but winds of about 130 mph are more typical. It is estimated that an average hurricane produces 200 billion tons of water a day as rain.[9]

As this writer has done, extend your definition as far as is needed to ensure the level of reader understanding desired.

Placement of Definitions

You have several options for placement of definitions within your reports: (1) within the text itself, (2) in footnotes or endnotes, (3) in a glossary at the beginning or end of the paper, and (4) in an appendix. Which method you use depends on the audience and the length of the definition.

Within the Text If the definition is short—a sentence or two—or if you feel most of your audience needs the definition, place it in the text with the word defined, as in this example:

> Besides direct electric and magnetic induction, another source of power-frequency exposure is contact currents. Contact currents are the currents that flow into the body when physical contact is made between the body and a conducting object carrying an induced voltage. Examples of contact current situations include contacts with vehicles parked under transmission lines and contacts with the metal parts of appliances, such as the handle of a refrigerator.[10]

When you are using key terms that must be understood before the reader can grasp your subject, define them in your introduction.

In Footnotes and Endnotes If your definition is longer than a sentence or two and your audience is a mixed one—part expert and part lay—you may want to put your definition in a footnote at the bottom of the page or in an endnote at the end of your report. A lengthy definition placed in the text could disturb the expert who does not need it.

In a Glossary If you have many short definitions to give and if you have reason to believe that most members of your audience will not read your report straight through, place your definitions in a glossary (see Figure 9-5 and pages 617–618, 620). Glossaries do have a disadvantage: Your readers may be disturbed by the need to flip around in your paper to find the definition they need. When you use a glossary, be sure to draw your readers' attention to it, both in the table of contents and early in the discussion.

In an Appendix If you need one or more lengthy extended definitions (say, more than two hundred words each) for some but not all members of your audience, place them in an appendix (see pages 634–635). At the point in your text where readers may need the definitions, be sure to tell readers where they are.

DESCRIPTION

In technical writing you will chiefly have to describe two things: mechanisms and processes. The two are closely related. That is, many mechanisms are performing a process of some sort—think of the engine in an automobile. In describing the mechanism, you necessarily describe the process it performs. Conversely, many processes use one or more mechanisms in performing the process.

Often, whether a description is labeled a mechanism or process description is a matter of purpose and emphasis. For example, the graphic in Figure 9-6 has as its purpose the description of the flat-plate collector and places its emphasis on the collector. The graphic in Figure 9-7, while it shows the mechanism, emphasizes the process the mechanism performs. Whether you are writing a mechanism or a process description, as always in technical writing, your goal should be to satisfy your purpose and the needs of your audience.

After explaining the use of visual language in description, we deal with the two types of description.

Visual Language

As Figures 9-6 and 9-7 illustrate, graphics play an important role in many mechanism and process descriptions. But, visual language plays its part also. The following brief description shows how a combination of analogy and a few words indicating shape can help a reader accurately visualize a DNA molecule:

> DNA is a deceptively simple molecule, consisting of a series of subunits, called bases, linked together to form a double helix that can be visualized as an immensely long, corkscrew-shaped ladder. Each rung in the ladder is made up of two bases fitted together, and the ends of the rung are attached to chains of sugar-phosphates that are like the upright rails of a ladder.[11]

We visualize things in essentially five ways—by shape, size, color, texture, and position—and we have access to a wide range of terms to describe all five. In addition, comparison of the unfamiliar to the familiar through analogy is a powerful visualization tool.

Shape You can describe the shape of things with terms such as *cubical, cylindrical, circular, convex, concave, square, trapezoidal*, or *rectangular*. You can use simple analogies such as *C-shaped, L-shaped, Y-shaped, cigar-shaped, cork-screw*, or *spar-shaped*. You can describe things as *threadlike* or *pencil-like* or as *saw-toothed* or *football-shaped*.

Size You can give physical dimensions for size, but you can also compare objects to coins, paper clips, books, and football fields.

Color You can use familiar colors such as red and yellow and also, with some care, such descriptive terms as *pastel, luminous, dark, drab, and brilliant.*

Texture You have many words and comparisons at your disposal for texture, such as *pebbly, embossed, pitted, coarse, fleshy, honeycombed, glazed, sandpaper-like, mirrorlike,* and *waxen.*

Position You have *opposite, parallel, corresponding, identical, in front, behind, above, below, right, left, north, south,* and so forth to indicate position.

Analogy The use of analogy will aid your audience in visualizing the thing described. In the following example, a simple comparison to a balloon (which we have set in boldface) helps the reader visualize the swelling of a volcano before eruption:

> As magma enters the shallow summit reservoir, the volcano undergoes swelling or *inflation* **(a process similar to the stretching of a balloon being filled with air).** This swelling in turn causes changes in the shape of the volcano's surface. During inflation, the slope or *tilt* of the volcano increases, and reference points (benchmarks) on the volcano are uplifted relative to a stable point and move further apart from one another. For Hawaiian volcanoes, pre-eruption inflation generally is slow and gradual, lasting for weeks to years. However, once eruption begins, the shrinking or *deflation* typically occurs rapidly as pressure on the magma reservoir is relieved—**a process not unlike deflating a balloon.** During deflation, changes in tilt and in vertical horizontal distances between benchmarks are opposite to those during inflation.[12]

Mechanism Description

The physical description of some mechanism is perhaps the most common kind of technical description. It is a commonplace procedure with little mystery attached to it.

For example, the description of a plumber's snake on page 174 demonstrates most of the techniques of good technical description. It does all the following:

- Describes the overall appearance of the plumber's snake and names the material it is made of—steel.
- Divides the mechanism into its component parts—cable, boring head, and crank.
- Describes the appearance of the parts, gives their functions, and explains how they work together.
- Points out an important implication, a *so-what,* of one of the descriptive facts: "It's about ten inches long, *so you can get both hands on it.*"

- Gives only information important in this description. For example, because it is of no consequence in this description, you are not told the color of the mechanism.
- Uses figurative language—such as springlike and football-shaped—and comparisons to familiar objects—such as pencils, snakes, and drills—to clarify and shorten the description.

Planning Despite certain elements that most mechanism descriptions have in common, there is no formula for writing them. You must use your judgment, weighing such matters as purpose and audience. As you plan your mechanism description, you'll need to answer questions like these

- **What is the purpose of the description?**
- **Why will the intended reader read the description?**
- **What are the purpose and function of the mechanism?**
- **How can the mechanism be divided?**
- **What are the purpose and function of the parts?**
- **How do the parts work together?**
- **How can the parts be divided? Is it necessary to do so?**
- **What are the purpose and function of the subparts?**
- **Which of the following are important for understanding the mechanism and its parts and subparts:**

  Construction?
  Materials?
  Appearance?
  Size?
  Shape?
  Color?
  Texture?
  Position?

- **Are there any so-whats that you need to express explicitly for the reader?**
- **Would the use of graphics aid the reader?**
- **Would analogies clarify the description for the reader?**

The answers to those questions will largely determine how you arrange your description and the details you elect to provide your readers.

Examples of Mechanism Descriptions In Figure 9-8, the annotations draw your attention to the various features of a mechanism description, as exemplified in the descriptive overview of the Hubble Space Telescope. Figure 9-9 is one of several graphics that accompany the telescope's description. As Figure 9-9 demonstrates, such graphics are frequently labeled and are shown cutaway, to display the interior of the mechanism described.

Many of the principles of mechanism description have nonmechanical applications. For example, we don't usually think of skin as a mechanism, but the same rational principles we have been discussing are found in the passage in Figure 9-10 about skin. The subject is divided, objective physical details are described, function is discussed, so-whats are given, and a graphic is provided.

Process Description

Process description is probably the chief use of chronological order in technical writing. By process we mean a sequence of events that progresses from a beginning to an end and results in a change or a product. The process may be humanly controlled—such as the manufacture of an automobile—or it may be natural—the metamorphosis of a caterpillar to a butterfly, for example.

Process descriptions are written in one of two ways:

- **For the doer**—to provide instructions for performing the process.
- **For the interested observer**—to provide an understanding of the process.

A cake recipe provides a good example of instructions for performing a process. You are told when to add the milk to the flour, when to reserve the whites of the eggs for later use. You are instructed to grease the pan *before* you pour the batter in, and so forth. Writing good instructions is an important application of technical writing, and we have devoted all of Chapter 18 to it. In this chapter we focus on the second type of process description—providing an understanding of the process.

Verb Tense, Mood, and Voice In writing process description, it's important to make the correct choice between present and past tense and to decide which voice and mood to use.

Processes that are ongoing are usually described in the present tense, as if each step were unfolding before the reader's eyes (we have set the verbs in boldface):

> Blood from the body **enters** the upper chamber, atrium, on the right side of the heart and **flows** from there into the lower chamber, the ventricle. The ventricle **pumps** the blood under low pressure into the lungs where it **releases** carbon dioxide and **picks** up oxygen.

Completed processes that have already occurred in the past are usually described in the past tense. In empirical research reports, for example, the researcher describes the procedures that were followed in past tense (verbs in boldface):

During the excavation delay we **accomplished** two tasks. First, we **installed** a temporary intake structure and **tested** the system's efficiency. Second, we **designed, built,** and **installed** a new turbine and generator.

In writing instructions, you will commonly use the active voice and the imperative mood:

> **Clean** the threads on the new section of pipe. **Add** pipe thread compound to the outside threads.

In following your instructions, the reader, after all, is the doer. With its implied *you,* the imperative voice directly addresses the reader. But in a process description written for understanding, which will be read by a reader who is not the doer, the use of imperative mood would be inappropriate and even misleading.

In writing a process description for understanding, therefore, you will ordinarily use the indicative mood in both active and passive voice:

Active voice: The size of the cover opening **controls** the rate of evaporation.

Passive voice: The rate of evaporation **is controlled** by the size of the cover opening.

In active voice, the subject does the action. In passive voice, the subject receives the action. Use of the passive emphasizes the receiver of the action while de-emphasizing, or removing completely, the doer of the action. (Incidentally, as the preceding examples illustrate, neither doer nor receiver has to be a human being or even an animate object.) When the doer is unimportant or not known, you should choose passive voice. Conversely, when the doer is known and important, you should choose the active voice. Because the active is often the simpler, more direct statement of an idea, choose passive voice only when it's clearly indicated. We have more to say on this subject on pages 92–93.

Examples of Process Description As with all technical writing, you can write process descriptions for varied audiences. In the following excerpt, the writer describes how a star like our sun derives energy from fusion, until eventually it depletes its sources and destroys itself. The intended audience is educated lay persons. The writer uses present tense throughout and, predominantly, the active voice.

Overview of process

In their hot, high-pressure and high-density interiors, stars produce energy through the fusion of low-mass atomic nuclei to high-mass nuclei. In normal stars like the Sun, hydrogen nuclei are joined together to make helium, in a process that liberates large amounts of energy.

Description of process

A star like the Sun can persist in its normal state, deriving energy from the fusion of hydrogen to helium, for some 10 billion years. Upon the inevitable depletion of its internal, hydrogen-based energy source, a star proceeds through more advanced evolutionary stages in which it converts successively more massive nuclear species into yet higher mass nuclei, to satisfy its needs for energy and prevent collapse under the influence of its strong self-gravity. After converting hydrogen to helium, it proceeds to convert the helium to carbon and oxygen, then to silicon-like nuclei, and so on, until, in the more massive stars, the nuclear fusion products approach the mass of iron nuclei. Beyond this point, no further energy can be extracted by building nuclei of increasing mass. Atomic nuclei with masses near that of iron are the most stable of nuclei; conversion of these nuclei to other species, through either nuclear fusion or nuclear fission, requires not the extraction of energy but the injection of energy.

Having depleted all its nuclear energy sources, a star begins to cool and can no longer resist the pull of its own gravity. In the more massive stars, we believe that this process leads to a sudden catastrophic collapse. The gravitational collapse of the star's interior is thought to release a large amount of energy which, flowing from the star, blows the star's outer layers away into space, to disperse and mix with the interstellar matter. At the same time, the exploding material in the ensuing supernova explosion is compressed and heated to the point that fast nuclear reactions occur, resulting in a buildup of very massive atomic nuclei, which are dispersed with the star's outer layers into the preexisting interstellar matter.[13]

In writing process descriptions to provide understanding, you'll find that extensive detail is not always necessary or even desirable. As in mechanism description, the amount of detail you give relates to the technical level and technical interests of your readers. When *Time* magazine, for example, publishes an article about open-heart surgery, its readers do not expect complete details on how such an operation is performed. Rather, they expect their curiosity to be satisfied in a general way. The author of the description of a star's fusion process used a level of detail he felt would satisfy his lay audience.

The words and graphic in Figure 9-11 describe the process by which a dry steam power plant operates. The intended readers are business owners who might be considering installing a new power plant. The language is simple, and the level of detail is meant to satisfy the needs of a lay audience.

Figure 9-12 shows a process description written for an executive audience. It deals with shipworms, marine organisms that attack wood immersed in salt water. As with the description written for a lay audience, the writer has chosen her level of detail carefully. As you read it, notice that no attempt is made to give the full information about shipworms that an entomologist might desire. We don't learn, for example, how shipworms reproduce, nor do we even learn very clearly what they look like. For the intended readers of the letter, such information is not needed. They do need to know what is presented—the process by which shipworms lodge on the wood and how they bore into it. The readers do need to know that the damage done by shipworms is largely invisible from the exterior of the wood and, finally, that they must take action and what that action has to be.

Empirical research reports written for experts use process description to describe the *methods* used by the researcher. Writers of such reports must include enough detail about their methods to allow their fellow experts to duplicate the research. Because of that requirement, the level of detail in an expert report is normally much higher than that in a lay or executive report. The writer, having an expert audience, uses technical language freely. The following excerpt is the method section from a report of research that tested whether students taught to revise globally would revise better than those who were not. (To *revise globally* means to deal with such things as purpose, organization, and audience, as opposed to dealing with only surface things such as spelling and grammar.)

> The study was conducted in two writing classes during the ninth week of a sixteen-week semester. Half of the students in each class were randomly assigned to the treatment group; the other half served as the control group. The mean SAT verbal score for the control group (532.2) was slightly higher than that for the treatment group (514.4); however, a t-test revealed that the difference between these means was not significant.
>
> After giving brief instructions about the nature of the study, an experimenter (not the instructor for the course) asked the students in the control group to go with another experimenter to a nearby room to complete the experiment. The experimenters read the same brief instructions to both the treatment and control groups. These task instructions [not included in this quoted excerpt] informed students that they would have 30 minutes to revise a short text about the operation of a water treatment plant so that it could be used as a handout for high school students who tour the plant. The instructions specifically cued students to revise so that the handout would be "clear, organized, easy to read, and free of errors." The instructions also directed students to mark deletions,

additions, changes, and movements of text in standard ways such that a typist could easily retype their revised texts.

After reading the instructions and asking for questions, the experimenters reminded the students that they had 30 minutes to complete their revisions and instructed them to begin. The students were informed when they had 15 minutes and 5 minutes remaining. For each of the treatment and control groups, the procedure was completed within the 50-minute class period.

Procedures for the two groups were identical except that an experimenter presented eight additional minutes of instruction to the treatment group. The eight minutes taken for the special instruction of the experimental groups was approximately equal to the time it took to change rooms for the control groups.

The purpose of this instruction was to cue students to revise globally by illustrating how an expert writer and a novice writer revised a similar text. The experimenter illustrated differences between the revision activities of the expert and the novice writers using overhead transparencies. First, he explained the differences in basic approach and procedure—the expert writer read through the entire text to identify major problems and then focused on improving the whole text. In contrast, the novice writer began making changes immediately and proceeded to search through the text for local errors.

After this overview, the experimenter illustrated differences in the amount and types of changes that the two writers made using transparencies of the two writers' actual revisions of the sample text. The transparencies illustrated that the expert writer not only made more revisions but made different kinds of revisions. The effect was rather dramatic: while the novice writer limited himself to eliminating spelling, wordiness, and grammar errors, the expert writer also addressed global issues, adding an initial purpose statement, selecting and deleting information for the specified audience, reorganizing the text, and providing explicit cues to the new overall organization.[14]

Given the premises on which this book is based, we are pleased to report that the students taught to revise globally revised more successfully than those who were not. For more information about writing method sections in empirical research reports, see pages 494–495.

Planning As with writing mechanism descriptions, there are no easy formulas to follow in writing process descriptions. You must exercise a good deal of judgment in the matter. As in all writing, you must decide what your audience needs to know to satisfy its purpose and yours. However, the following questions should provide guidance to aid you in exercising your judgment:

- What is the purpose of the description?
- Why will the reader read the description?
- What is the reader's level of experience and knowledge regarding the process?
- What is the purpose of the process
- Who or what performs the process?
- What are the major steps of the process?
- Can the major steps be broken down into substeps?
- Are there graphics and analogies that would help the reader?

PLANNING AND REVISION CHECKLISTS

You will find the planning and revision checklists that follow Chapter 2, Composing, and Chapter 4, Writing for Your Readers, valuable in planning and revising any presentation of technical information. The following checklists specifically apply to organizational strategies. As well as aiding in planning and revision, they summarize the key points in this chapter.

CHRONOLOGICAL ARRANGEMENT

Planning

- Do you have a reason to narrate a series of events? Historical overview? Background information? Drama and human interest for a lay audience? Forecast of future events?
- What are the key events in the series?
- In what order do the key events occur?
- Do you know or can you find out an accurate timing of the events?
- How much detail does your audience need or want?
- Will graphics help?

Revision

- Is your sequence of events in proper order?
- Are all your time references accurate?
- Have you provided sufficient guidance within your narrative so that your readers always know where they are in the sequence?
- Is your level of detail appropriate to your purpose and the purpose and needs of your audience?
- Did you use graphics?

TOPICAL ARRANGEMENT

Planning

What is your major topic?
What is your purpose?
What is your audience's interest in your topic? How do their interest and purpose relate to your purpose?
Given your purpose and your audience's purpose, how can you limit your topic?
What subtopics are appropriate to your purpose and your audience's purpose?
Can you divide your subtopics further?

Revision

- Do your topics and subtopics meet your purpose and your audience's purpose and interests?
- Did you limit your subject sufficiently so that you can provide specific facts and examples?
- Do you have headings? Do your headings accurately reflect how your reader will approach your subject matter? Are your headings phrased as questions? If not, would it help your readers if they were?

EXEMPLIFICATION

Planning

- Do your generalizations need the support of examples?
- Do you have or can you get examples that will lend interest and credibility to your document?

Revision

- Have you left any generalizations unsupported? If so, have you missed a chance to interest and convince your readers?
- Have you provided sufficient examples to give interest and credibility to your material?

ANALOGY

Planning

- What is your audience's level of understanding of your subject matter?
- Would the use of analogy provide your readers with a better understanding of your subject matter?
- Are there things familiar to your readers that you can compare to the unfamiliar concept—for example, water pressure to voltage?
- Will graphics help?

Revision

- Have you provided analogies wherever they will help reader understanding?
- Do your analogies really work? Are the things compared truly comparable?
- Did you use graphics?

CLASSIFICATION AND DIVISION

Planning

Where is your subject on the abstraction ladder? Are you moving up the ladder, seeking higher abstractions under which you can group your subject matter (classification)? Are you moving down the ladder, breaking your abstractions down into more specific items (division)?

- What is your purpose in discussing your subject matter?
- What is your audience's purpose and relationship to your subject matter?
- What classification or division will best meet your purpose and your audience's needs?
- Will graphics help?

Revision

- Are all the parts of your classification equal?
- Have you applied one rule of classification and division at a time?
- Is each classification or division large enough to include a significant number of items?
- Have you avoided overlapping classifications and divisions?
- Does your classification or division meet your purpose and your audience's needs?
- Did you use graphics?

DEFINITION

Planning

- Do your readers share the vocabulary you are using in your report? Or do you need to make a list of the words you need to define?
- Do any of the words on your list have readily available synonyms known to your readers?
- Which words will require sentence definitions? Which words are so important to your purpose that they need extended definitions?

- How will you extend your definition? Description? Example? Analogy? Chronology? Topical order? Classification? Division? Graphics? Are there words within your definition that you need to define?
- Does everyone in your audience need your definitions? How long are your definitions? How many definitions do you have?
- Where can you best put your definitions? Within the text? In footnotes? In a glossary? In an appendix?
- Will graphics help?

Revision

- In your sentence definitions, have you put your term into its class accurately? Have you specified enough differences so that your readers can distinguish your term from other terms in the same class?
- Will your readers understand all the terms you have used in your definitions?
- Have you used analogy and graphics to help your readers? If not should you?
- Does the placement of your definitions suit the needs of your audience and the nature of the definitions?
- Did you use graphics?

MECHANISM DESCRIPTION

Planning

- What is the purpose of the description?
- Why will the intended reader read the description?
- What are the purpose and function of the mechanism?
- How can the mechanism be divided?
- What are the purpose and function of the parts?
- How do the parts work together?
- How can the parts be divided? Is it necessary to do so?
- What are the purpose and function of the subparts?
- Which of the following are important for understanding the mechanism and its parts and subparts: Construction? Materials? Appearance? Size? Shape? Color? Texture? Position?
- Are there any so-whats that you need to express explicitly for the reader?
- Will analogies clarify the description for the reader?
- Will graphics help?

Revision

- Does your description fulfill your purpose?
- Does the level of detail in your description suit the needs and interests of your readers?
- Have you made the function of the mechanism clear?

- Have you divided the mechanism sufficiently?
- Do your descriptive language and analogies clarify the description?
- Have you clarify stated your so-whats?
- Did you use graphics? If so, are they sufficiently annotated?

PROCESS DESCRIPTION

Planning

- What is the purpose of the description?
- Why will the reader read the description?
- What is the reader's level of experience and knowledge regarding the process?
- What is the purpose of the process?
- Who or what performs the process?
- What are the major steps of the process?
- Do the major steps break down into sub-steps?
- Are there graphics and analogies?

Revision

- Does your description fulfill your purpose?
- Does your description suit the needs and interests of your readers?
- Have you chosen the correct tense—either past or present?
- Have you chosen either active or passive voice appropriately?
- Are the major steps of the process clear?
- Have you provided enough graphics? Are your graphics sufficiently annotated?

EXERCISES

1. Write a memo to an executive. The purpose of the memo is to inform the executive about the subject matter of the memo. Base the arrangement of the memo on one of the techniques described in this chapter. With your memo include a short explanation of why you chose the arrangement technique you did. Your explanation must show how your purpose and your reader's purpose and interests led to your choice. For instruction on the format of memos, see Letter and Memorandum Format, Appendix B.
2. Write a chronological narrative of several paragraphs that is intended to serve as a historical overview. Choose as a subject for your narrative some significant event in your professional field. Accompany your narrative with a description of your audience and an explanation of how their purpose and yours led you to the level of detail you use in your narrative.

3. Write an analogy several paragraphs long that will make some complicated concept in your discipline comprehensible to a fourth-grade student.
4. Write an extended definition of some term in your academic discipline. Use a graphic if it will aid the reader. In a paragraph separate from your definition, explain to your instructor your purpose and audience.
5. Write a description of some mechanism in your field. If you have no mechanisms in your field, choose three common household tools—such as a can opener, vegetable scraper, screwdriver, carpenter's level, or saw—and write a one-paragraph description of each. Include at least one graphic as a part of each description. In a paragraph separate from your description explain to your instructor your purpose and audience.
6. Write two versions of a process description intended to provide an understanding of a process. The first version is for a lay audience whose interest will be chiefly curiosity. The second version is for either an expert or an executive audience that has a professional need for the knowledge. The process might be humanly controlled—for instance, buying and selling stocks, writing computer programs, fighting forest fires, giving cobalt treatments, or creating legislation. It could be the manufacture of some product—paint, plywood, aspirin, digital watches, maple syrup, fertilizer, extruded plastic. Or you might choose to write about a natural process—thunderstorm development, capillary action, digestion, tree growth, electron flow, hiccuping, the rising of bread dough. In a separate paragraph accompanying each version, explain to your instructor how your situational analysis guided your strategy.

FIGURE 9-1 • Population Graph

Source: U.S. Department of Commerce, *How We're Changing* (Washington, DC: Bureau of the Census, 1997), 1.

FIGURE 9-2 • Visual Analogies

Source: U.S. Department of Energy, *Emf in the Workplace* (Washington, DC: DOE, 1996), 6.

FIGURE 9-3 • Abstraction Ladder

FIGURE 9-4 • The Food Guide Pyramid: An Example of Classification

Source: U.S. Department of Agriculture, *Making Healthy Food Choices* (Washington, DC: GPO, 1993), 2.

FIGURE 9-5 • Definitions in a Glossary

Source: U.S. Department of Energy, Homemade Electricity: *An Introductory to Small-Scale Wind, Hydro, and Photovoltaic Systems* (Washington, DC: GPO, n.d.), 57.

FIGURE 9-6 • Mechanism Description

Source: U.S. Department of Energy, *Solar Water Heating* (Washington, DC: DOE, 1996), 2.

FIGURE 9-7 • Process Description

Source: U.S. Department of Energy, *Geothermal Energy . . . Power from the Depths* (Washington, DC: DOE, 1997), 5.

FIGURE 9-8 • Mechanism Description of the Hubble Space Telescope
Source: National Aeronautics and Space Administration, *Exploring the Universe with the Hubble Space Telescope* (Washington, DC: GPO, n.d.), 57.

FIGURE 9-9 • Graphic for the Hubble Space Telescope

Source: National Aeronautics and Space Administration, *Exploring the Universe with the Hubble Space Telescope* (Washington, DC: GPO, n.d.), 58.

FIGURE 9-10 • Skin Described as a Mechanism
Source: U.S. Department of Labor, *First Aid Book* (Washington, DC: GPO, 1993), 9.

FIGURE 9-11 • Process Description
Source: U.S. Department of Energy, Geothermal Energy . . . *Power from the Depths* (Washington, DC: DOE, 1997), 4.

FIGURE 9-12 • Executive Process Description