SUGGESTIONS AS TO EXPRESSION

UNITY, COHERENCE, AND EMPHASIS

A scientific report is an exposition of facts, inferences, conclusions, and, often, arguments and criticisms. The report should be clear enough that the reader cannot mistake its meaning, simple enough to be easily understood by the intended readership, and concise enough to avoid padding and needless repetition. Good exposition has unity, coherence, and emphasis. Unity comes from oneness and completeness in thought: A sentence may be simple, compound, or complex, but every word, phrase, or clause should help develop that one thought. Coherence means that words are understandably put together. Emphasis relates to proper stress.

Unity asks that you as a writer of scientific reports direct every sentence, paragraph, and chapter toward the stated subject of your report. Avoid paragraphs that are mere collections of sentences; ideally, each paragraph should have one central thought, and each sentence should lead toward that thought. Topic sentences are valuable aids to unity, both for the reader and for the writer. Topic sentences inform the reader that a new thought follows, and they help the writer adhere to that single thought. Besides using topic sentences, you can heighten interest and enhance comprehension without sacrificing unity by skillfully introducing variety into sentence length and phrasing.

Coherence requires that all parts of your report be logically arranged: Words, phrases, and clauses should lead the reader forward through sentences into paragraphs and through paragraphs into logical groupings under suitable topic headings and chapters. You can also gain coherence by ending statements with transitional words, phrases, or sentences that summarize what has been said and point toward what is to come. You can relate sentences or paragraphs to one another by repeating significant words or phrases used before. If a discussion is long, a brief transition paragraph will help you maintain coherence.

Emphasis can be gained through literary devices such as changes in voice, variety in sentence length and structure, and careful choice of words. Make the beginning and ending of a paragraph not so long or so complicated as to lose unity or so short as to lose coherence.

COMMON GRAMMATICAL PROBLEMS

Because many excellent books on grammar are available in libraries and book stores, STA focuses mainly on grammatical problems that commonly have appeared in Survey manuscripts. Some problems recur over and over. Careful attention to grammar saves the time of authors, reviewers, and editors alike, but careless attention to the basic principles of grammar takes time from everyone.

PROBLEMS WITH SENTENCE STRUCTURE

Two types of problems are common in structuring complete sentences: (1) Ending too soon—a sentence fragment—before a complete thought has been conveyed and (2) ending too late—a run-on sentence—after more than one idea has been expressed without the appropriate connectives of grammar and punctuation.

Sentence Fragments

A complete sentence must have at least one independent clause—that is, a group of words that contains a subject and a verb, stands by itself, and makes sense. "The sandstone is interbedded with shale" is an independent clause; ended with a period, it also is a sentence. If a word such as "although" is added at the beginning, the sentence is no longer independent: "Although the sandstone is interbedded with shale" is a sentence fragment that needs further qualification: "Although the sandstone is interbedded with shale, the shale is only a minor constituent of the formation." The "although" clause has become dependent; its meaning is incomplete until it is followed by a second, independent clause. Sentence fragments usually result from the addition of a qualifying word or words at the beginning of the clause; for example, "in which," "when," "to" plus a verb, or "if." Few Survey authors, of course, would compose a sentence fragment, but such fragments often appear inadvertently in manuscript revisions. To recognize one, ask yourself if the sentence element contains a subject, a verb, and a thought that can stand alone. If not, you have a sentence fragment.

Run-On Sentences

At the opposite extreme from sentence fragments, and more common, are run-on sentences. These take two forms, comma splices and fused sentences. In the comma splice, two independent clauses are joined by a comma: "Another interesting study was by Stephanic (1981), his primary objective was to compare the geochemistry of the two types of deposits." Two independent clauses cannot be joined by a mere comma. A coordinating conjunction (and, but, or, for, nor, so, yet, still) must be added immediately after the comma, or the comma must be replaced by a semicolon or by a period and a capital letter. The comma-splice sentence in the preceding example becomes a fused run-on sentence simply by omitting the comma and running the ideas together. Correct the error by inserting a coordinating conjunction to compound the sentence, or replace the pronoun "his" by "whose" to make the second clause dependent on the first.

Lack of Agreement Between Sentence Elements

In grammar, agreement involves singular or plural forms of two or more words that function together. Lack of agreement comes in two forms: (1) noun subjects that disagree with their verbs and (2) pronouns that disagree with their antecedents. Both forms diminish the quality of the writing.

Subject/Verb Disagreements

Subject/verb disagreements flourish in complicated sentences. Few people would write "Mechanical problems *appears* to be a major reason for the poor data," because the singular verb "appears" next to the plural subject "problems" does violence to the ear. Intervening phrases between subject and verb, however, can trick the ear by placing distance between the two sentence elements. Thus, one author wrote, "Mechanical problems with the inclinometer *appears* to be a major reason for the poor data." The prepositional phrase, "with the inclinometer," and the singular form of the word "inclinometer" tricked the author into composing the disagreement.

A second type of subject-verb disagreement involves compound singular subjects—the so-called 1+1 agreement problem. "The composition of each sample was examined carefully" would nearly always be written correctly, but if a second singular subject is added, the likelihood of error increases greatly, even for experienced writers: "The composition and texture of each sample *was* [were] examined carefully." Because each noun is singular, the writer took them to be one subject and was misled into using a singular verb. Remembering that 1+1=2 may reinforce your perception of the need for a plural verb.

Plural/Singular Verbs and Singular/Plural Predicate Nouns

This awkward problem of verb/noun agreement generally involves "is" or "are" as the principal verb, but it is easily remedied by (1) subordinating "is" or "are" to another verb, (2) substituting a stronger verb, or (3) changing the number (singular or plural) of one of the elements.

Delete words in italic; add those in brackets:

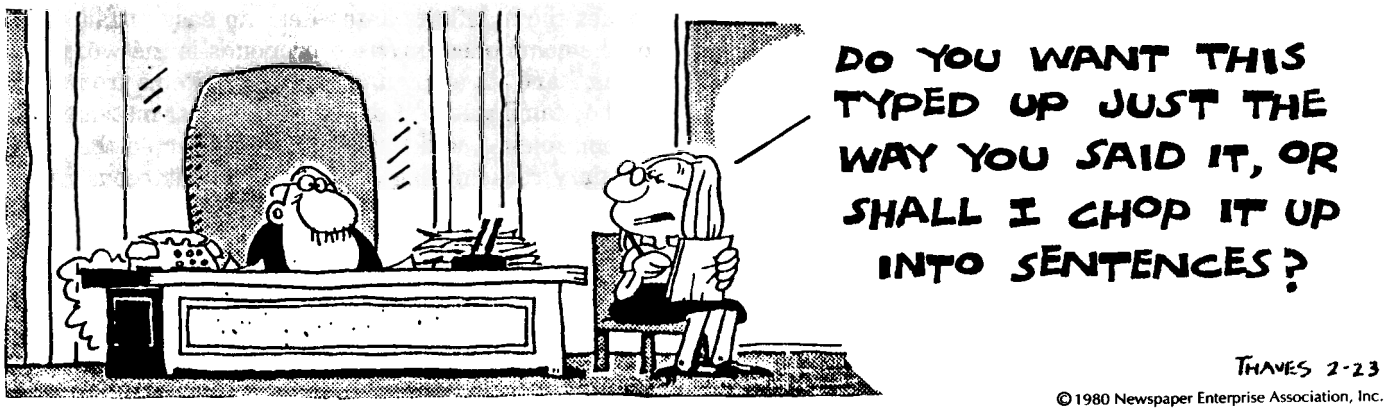
> This matrix is [made up] chiefly [of] microphenocrysts of plagioclase and hornblende. ("Consists" would be better than "is made up.")

> Eolian strata of the Weber *are* [compose] the chief petroleum reservoir.

> The red beds of the Catskill Formation are *a* North American counterpart[s] of the Old Red Sandstone.

> In some populated areas the uraniferous waters or the deposits themselves may *be* [present] a significant natural environmental hazard. (Or, delete "a" and pluralize "hazard" to make the verb and noun agree.)

> The Wasatch Mountains are a narrow upfaulted range. (Rewrite as, "The Wasatch Mountains are narrow and upfaulted," or substitute a transitive verb: "The Wasatch Mountains form a narrow, upfaulted range.")



The Dillon Mesa Tuff is crystal-poor rhyolite containing fine-grained phenocrysts that locally underlie the outflow Sapinero Mesa Tuff. (The "that" clause wrongly modifies "phenocrysts." Rewrite as "The Dillon Mesa Tuff, a crystal-poor rhyolite containing fine-grained phenocrysts, locally underlies the outflow Sapinero Mesa Tuff.")

Much of its extent is defined by a zone of faults and a well-marked fault scarp, which has been described in detail by Gilbert. (Inasmuch as both "zone of faults" and "well-defined fault scarp" are objects of the first preposition "by," the reader naturally connects the "which" clause to both of them. Just delete "which has been" and the preceding comma to clear up the difficulty.)

Pronoun Disagreements

Pronouns are words that substitute for nouns; antecedents are those nouns. Pronouns that disagree with their antecedents appear in many manuscripts. The following sentence illustrates the problem: "Large-scale pyroclastic eruptions began about 49 m.y. ago; this included the activity that is represented by ash-flow tuffs at Surrey Ridge and in Long Valley." "Eruptions" is the antecedent of the pronoun "this." Because "eruptions" is plural, its substitute pronoun must be the plural form "these." Even the pronoun "these," used by itself as above, has a vague connotation; a clearer, more forceful phrasing would repeat "eruptions" in the clause "these eruptions included * * *."

Problems With Collectives and Their Verbs

Certain nouns and pronouns called "collectives" may take either singular or plural verbs as predicates, depending on the meaning being conveyed. If the noun or pronoun is viewed collectively as a unit, its verb should be singular; if viewed as separate items, the verb should be plural. The following sentences are correct:

The number of men employed was greater in 1985.

A large number of the men were injured. ("Many men * * *" would be better.)

He thinks that 30 cents is a high price.

Three dimes were placed on the table.

About 3,000 tons was produced in 1934. ("About 3,000 tons" means a quantity weighing, in all, about 3,000 tons; it does not mean about 3,000 neat parcels each containing exactly a ton.)

At this place, 9 meters of sandstone is exposed.

A series of studies was begun. (Emphasis on "series.")

The United States protects its natural resources. (Although the term "United States" is treated as a plural in the Constitution, it is generally used elsewhere in the singular.)

"None" is singular when it means "no one," "no person," or "nobody." It is plural when it means "no persons" or "no things." "No one" may be substituted for "none" in some sentences to express the singular.

None of the mines were open.

None of the ore contains gold.

None were injured.

No one was injured. (Emphatic: Not one was injured.)

"Each" and "every" are usually singular in usage.

Each man will stand his post.

Every species is represented.

Eliminating Indefinite Antecedents

The term "indefinite antecedent" refers to a phrasing in which the antecedent of the pronoun is ambiguous. In some such sentences the pronoun may vaguely represent two or more different nouns: "Bill's father left home when he was 6 years old." Consider the following example: "Close to the faults, however, the folds are tighter, the fold limbs are steeply dipping, and *they* display bedding-plane schistosity." Whether "they" refers to "folds" or "fold limbs" is unclear to anyone but the author, and even if an analysis of the context could clarify the meaning, the reader's train of thought has already been derailed. Change to, "Close to the faults, however, the folds are tighter, they display bedding-plane schistosity, and their limbs dip steeply." (See p. 165 regarding the use of the verb "display.")

Your familiarity as author with the subject matter makes the indefinite antecedent an easy pitfall. One of the commonest misused pronouns is the word "this," and its ambiguity in writing stems from author familiarity: "Low-grade regional metamorphism, folding, and thrust faulting affected the pre-Tertiary rocks during Jurassic and Cretaceous time. *This* ended with regional intrusion of granodioritic stocks and batholiths in the eastern part of the study area. To the north, *this* resulted in northeast-trending folds." The antecedent of "this" in these sentences is unclear. Although the sequence of events may have been clear to the author, the unsuspecting reader must try to puzzle out what the author meant; most

readers will just shrug and move on. Whenever the word "this" appears in a manuscript, ask yourself, "This what?" If the answer is unclear, you as author or reviewer should add the appropriate noun, or recast the sentence.

"Some" is another word to watch. If "some" is intended as a pronoun but has no clear antecedent, the reader may take it to be an adjective modifying the word that follows, and the result can be ambiguous.

> Since no one wants a high-level nuclear waste dump, some doubt that a compromise can be reached.

The above statement can be read as a sentence fragment, with "some" serving as an adjective modifying "doubt." To clear up the ambiguity, the writer should subordinate "some" to a noun such as "people." Then the sentence would make sense: "* * * some people doubt that * * *." (Also, "Because" would be a better starter word than "Since.")

Modifiers

Sentences should be written with an eye to the best placement of modifying words and phrases. The subject, predicate, and object shape the framework of the sentence; the modifiers—adjectives, adverbs, participles, and descriptive phrases and clauses—add detail and meaning. In using modifiers, carefully choose the best words available to express your meanings and carefully put them in the most appropriate places. For clarity, put them as close as possible to the words they modify, and remember that the most emphatic positions in a sentence are at the beginning and end.

In the following sentence, the modifying phrases are right after the nouns they modify: "Removal of salt by extrusion, solution, or lateral flowage partly destroyed these folds, either by causing collapse along faults or by causing general subsidence." Note that the emphasis is at the beginning on "removal of salt." The phrase "by extrusion, solution, or lateral flowage" has a position of lesser importance. Placing "general subsidence" at the end gives it emphasis also.

Writers are often exhorted to use "exact" words to express their meanings, but few words really have "exact" meanings. Even some of the commonest words need a full column of 6-point type just to explain their dictionary definitions; to have exact meanings, words must be used skillfully in relation to one another. To choose appropriate modifying words and phrases, you need access to a good dictionary, to relevant glossaries and lexicons, and to any of the many good word-use books available in the library or marketplace.

Misplaced Modifiers

Misplaced modifiers sometimes provide unintended comic relief. A newspaper caption explained that a nanny-in-training was "feeding and diapering a baby with educational toys." A list of unusual explanations given to a life insurance company by accident claimants included "I had been driving my car for 40 years when I fell asleep at the wheel and had the accident," and "I was on my way to the doctor's with rear end trouble when my universal joint gave way causing me to have an accident." Laugh, but do not cast the first stone. Geoscience writing, of course, hardly ever contains misplaced phrases, but when it does, the result is more often pathetic than laughable: "The samples were preserved for analysis in a paraffin-sealed flask." "Remnants correlated with this pediment are plentiful in the southern part of the San Juan Basin, according to Parker, lying 90–120 m below the Scottsville erosion surface and 30–60 m above modern drainage." "The howling of coyotes is often heard by field personnel, as these animals frequently stray into the area." "Because of its huge size, oceanographic information is inadequate in many places."

Errors of modification are common in everyday oral and written language. Ask yourself if phrases are really next to what you intend them to modify and if they do in fact modify the appropriate subject. Pay particular attention to beginnings and endings of sentences, where misplaced (and dangling) modifiers are most likely to be. The proper placement of phrases within the context of a sentence must be a conscious decision. Modifiers belong next to the words they modify. Consider the following sentence:

Misplaced modifier. Example 1:

> We also present a plausible model for the origin of the ore deposits at the Sun Valley mine, Pitkin County, Colo., which until now has lacked a satisfactory explanation.

Because the phrase beginning with "which" is placed immediately after "Colorado," this sentence must be taken to say that either the Sun Valley mine, or Colorado, lacked a satisfactory explanation until now. "Which" clauses are often appended to sentences as added inspiration when the creative juices are flowing, but they sometimes end up in the wrong place. The intended meaning could be clarified in several ways. Two possibilities follow:

> **Suggested alternative 1:** We also present the first plausible model for the origin of the ore deposits at the Sun Valley mine, Pitkin County, Colo.

Suggested alternative 2: We also present a plausible model for the origin of the ore deposits at the Sun Valley mine, Pitkin County, Colo. No one had previously studied the origin of the deposits.

Notice that in the second alternative we gained additional information, with little increase in length over the original version.

Misplaced modifier. Example 2:

Because they are highly sensitive to changes of temperature and salinity, paleontologists use them as indicators of the environment that was present when they died.

Recast the above sentence yourself to straighten out the antecedents and put the paleontologists in their proper place. Then, try this one from "The New Yorker": "At the Battle of Antietam a careless Confederate officer used a piece of paper containing General Lee's orders to wrap his cigars."

Dangling Modifiers

Dangling modifiers differ from misplaced modifiers, not in their placement in the sentence but in having no antecedent to modify. They have no real grammatical relationship to the sentence, despite the intentions of their authors. Two examples illustrate the problem:

Dangling modifier. Example 1:

By comparing the fence diagram with the resistivity log profiles in figure 5, it is evident that injected freshwater is most efficiently transmitted through the highly permeable zones.

If you write an "-ing" phrase like this one, ask yourself who is doing the comparing. According to the phrasing in example 1, "it" is making the comparison, but "it" (an indefinite pronoun) is incapable of comparison, so the initial phrase dangles. This sentence can be revised either to eliminate the need for a subject of the modifying phrase or to add the appropriate subject.

Suggested alternative 1: A comparison of the fence diagram with the resistivity log profiles in figure 5 shows that injected freshwater is transmitted most efficiently through the highly permeable zones.

Suggested alternative 2: By comparing the fence diagram with the resistivity log profiles in figure 5, we learned that injected freshwater is transmitted most efficiently through the highly permeable zones.

Dangling modifier. Example 2:

As a field investigator working in the Desert Southwest, your paraphernalia should include two pairs of stout leather boots.

("As a field investigator" is an unintended modifier of the subject, "paraphernalia.")

Suggested alternative: As a field investigator working in the Desert Southwest, you should include two pairs of stout leather boots in your paraphernalia.

Here is a parallel to example 2: "As a first impression, the Sparks fault appears to have moved more than once." And one more: "As a baboon who grew up wild in the jungle, I realized that Wiki has special nutritional needs."

Even careful writers are sometimes trapped by dangling modifiers, especially by participles. A few more examples and their remedies may be helpful; correct the errors by inserting the missing words modified or by restructuring the sentences. Delete the words in italic; add those in brackets.

On closer inspection, chattermarks were observed. (Write, "Closer inspection showed chattermarks.")

Going seaward the boulders became smaller. (Just delete "Going" and change "became" to "were."

The [roughly tabular] western part of the ore body *has a roughly tabular shape dipping* [dips] southeast.

Judging from the dip of the tuff [indicates that] a small hill has been buried here.

None of the old openings are accessible, but *judging from* material on the dumps [indicates that] the ore was massive magnetite.

Going downward the till *becomes* [is] less oxidized [at depth].

Crossing to the other side, the peak came into full view. (The peak didn't cross to the other side, the viewer did. Try, "From the other side, the peak is in full view.")

And one from a morning paper:

On his way home, Bill was mugged, robbed, and left for dead. Going to work the next morning, he was found by a lady lying in a snowbank.

Other Misplaced Words and Phrases

Try to keep related words and phrases together. Watch out for misplaced adverbs and adverbial phrases, especially "only," "principally," "mainly," "chiefly," "alone," "also," and "too." In the following sentences, delete the words in italic and add the words in brackets:

Their presence can *only* be determined [only] by tests.

The sediments were [derived] principally *derived* from quartzite. (Sentence is strengthened by not splitting the verb.)

In the following statement it is not clear which part of the sentence "when the time came" modifies:

> I told him when the time came I would do it. (Write, "When the time came, I told him I would do it," or "I told him I would do it when the time came," according to the meaning intended.)

The sentence, "They suspended operations as the weather became colder and moved south," says that the weather moved south. Write, "As the weather became colder, they suspended operations and moved south," or "they suspended operations and moved south as the weather became colder."

Prepositional phrases also may be misplaced, as in the following examples:

> *Under such conditions* it is easy to see that the commercial development of these deposits [under such conditions] * * *.

> *In Indiana* writers have classified the rocks [in Indiana] as Utica or Eden.

> *On level 2* it is reported that considerable realgar and orpiment were found [on level 2].

> Fossils [from Indiana] were described *from Indiana.*

> *From the ice* water overloaded with glacial debris discharged westward [from the ice]. (Inserting a comma after "ice" is not a good remedy for poor construction.)

Adjectival expressions are misplaced occasionally or are misused for adverbs as well as misplaced.

> *A careful sample of* this rock was [carefully sampled] *taken* for chemical analysis.

> The granite was intruded during the *great* period of [great] structural deformation.

> Leaves [little] room for *little* doubt.

> The *luxuriant* gray green of the [luxuriant] sagebrush.

> *Tilted* edges of [tilted] sandstone strata.

> The *most prevalent* region of [most prevalent] cloudbursts.

> A [dark] coarsely porphyritic rock of *dark* granular texture. (It is the rock, not the texture, that is dark.)

> Two altered thin vitreous tuff beds. (Change to read "two thin beds of altered vitreous tuff.")

The sentence "There is a band of coarsely crystalline limestone carrying bunches of garnet-pyrite rock from place to place" presents an absurd picture. Better write, "A layer of coarsely crystalline limestone contains sporadic [or scattered] bunches of garnet-pyrite rock." Note that "layer" replaces "band," which refers simply to the visible edge of a layer.

The statement "Care should be taken to see whether such wells are contaminated by frequent analysis" slanders the analyst. Change to, "Analyze the water frequently to see if such wells are contaminated."

In general a phrase that applies equally to two or more items should follow the first item, not the last. Don't keep the reader in suspense:

> * * * mountainous in the western part [of the quadrangle] and level in the eastern part *of the quadrangle.*

> The thickness ranges from 215 meters at the east side [of the area] to perhaps 500 meters at the west side *of the area.*

> The upper coal bed is as thick [as the lower bed], if not thicker *than the lower.*

Dangling Non Sequiturs

Dangling non sequiturs are phrases out of context but meant to be modifiers; most of them are participles. They have no logical relationship to what they are attached:

> Formerly mined in southern Greenland, cryolite occurs in limited quantity near Pikes Peak, El Paso County, Colorado.

> Much of it is perfectly transparent, the oval grains being a half a centimeter in diameter.

> Douglas-fir grows between altitudes of 2,000–2,400 meters, the individuals averaging 40–50 centimeters in diameter.

> Born in Schenectady, she graduated with honors from Boston University.

> The discharge of the spring is about 8 gallons a minute, its temperature being 90°F.

> Home of the Air Force Academy, Colorado Springs received 17 centimeters of rain in less than 5 hours.

Troublesome Participles

In many sentences a participle can be replaced by a restrictive relative clause to gain emphasis. Delete words in italic:

> A gravel-floored plain *sloping* [that slopes] gently toward the southeast * * *.

> All thick coal beds *cropping out* [that crop out] in this field * * *.

Other improvements involving participles are indicated as follows. Delete words in italic:

> They are therefore regarded as *being* of the same geologic age.

> The basal formation of the group here *occurs resting* [rests] upon the Tejon Formation.

These dikes *were found cutting* [cut both] the granitic rocks and *were noted cutting* the aplite dikes.

Remnants of quartzite *occur perched along* [cap] the crest of the ridge.

The cliff *rises facing* [faces] the river.

Uncoordinated Sentence Elements

Clauses within sentences are normally joined by conjunctions or by various forms of punctuation. Independent clauses are joined by coordinating conjunctions (*and, but, for, or*), which are words that connect equal or coordinate elements. A dependent clause linked to an independent clause should be joined by a subordinating conjunction (such as *after, although, because, unless, when,* and *whereas*). A clause that amplifies or restricts the meaning of another clause should be introduced by an adverbial conjunction (for example, *consequently, however, nevertheless, therefore,* and *thus*). Selecting the appropriate conjunction depends on the intended meaning. A coordinating conjunction should be used only between clauses of equal importance; if one clause is more important, the other should be introduced by a subordinating conjunction. If two clauses contain equally important information but are not simple equivalents, one of the clauses should begin with an adverbial conjunction. The following examples should help clarify these distinctions:

Faulty coordination: The formation exhibits characteristics suggestive of a fluvial environment, and it is red.

The color of the formation in this example is not coordinate with the depositional environment. Eliminate the second clause by incorporating the information into the first clause or by changing the second clause into a parenthetical phrase. (Also, the verb "exhibits" is a bit overblown for characteristics that merely suggest.)

Suggested alternative: The formation, which is red, has characteristics that suggest fluvial deposition.

The revised sentence contains the same information, but its emphasis is stronger.

Misused conjunctions may confuse the intention of the sentence. In the next example, the idea that the two clauses present equivalent pieces of information is incorrect:

Faulty coordination: Zircon is the only original rock constituent that remains stable throughout the cycle of alunite alteration, and biotite and Fe-oxide minerals are pseudomorphed by TiO_2.

These two clauses present noncoordinate ideas; the implied contrast between the two pieces of information would be expressed better by substituting the adverbial conjunction "whereas" for "and" or by just dropping the "and" and starting a new sentence with "biotite."

Incomplete Comparisons

If a sentence attempts to compare two incomparable things, the resulting grammatical problem is called an incomplete comparison. The problem is common because the true nature of the comparison seems obvious to the writer. Consider the following sentence:

Faulty comparison: The producing wells in this part of the basin are similar to the Williston Basin.

The writer's intention of comparing wells in one basin with wells in another basin has been ineptly compressed.

Suggested alternative: Producing wells in this part of the basin are similar to those (*or* * * * are similar to wells * * in the Williston Basin.

Incomplete comparisons are also illustrated by the following sentences: "The average dip of the Lyons Sandstone is less than the Pierre Shale." (One dip can be compared with another, but not with a formation.) "No density measurements were made of the south slide; however, prefailure density should have been about the same as the north slide." (Density cannot be compared to a landslide.) In making any comparison, be sure that the structure of the sentence leads to a comparison of like things.

Problems With Poorly Chosen Adverbs, Prepositions, and Infinitives

Adverbs

An adverb is a word that modifies a verb, an adjective, or another adverb. Many of them end with "ly" (nearly, hardly, largely, poorly, usually). Adverbs are easily misused, particularly the common adverb "where." "Where" should relate to the idea of place, but it is often used incorrectly for "when." Some writers use "where" for "on which," "in which," or "for which."

Faulty choice of "where": Where a number of ponds in a landslide seem to have been formed at about the same time, such a date might represent a time of significant slide movement.

Here the word "where" was inaccurately intended to connote time; change it to "when."

Suggested alternative: When several ponds on a landslide apparently formed at about the same time, the date of their formation might have been a time of significant slide movement. (Better yet, change "when" to "if.")

Prepositions

Prepositions, like adverbs, make for fuzzy writing if used carelessly. Commonly confused prepositions include "with," "of," "for," "from," and "in." "With," misused as a conjunction, troubles many writers who have little difficulty with most other prepositions. In the following example "with" inaccurately connects "environment" to "movements":

> Deposition of the upper San Rafael Group in northwest New Mexico took place in a quiescent environment *with* only broad regional movements.
>
> **Possible alternative:** Deposition of the upper San Rafael Group in northwest New Mexico took place in a quiescent environment during a time of broad regional movements.

For a better rewrite, get rid of "deposition", "took place," "a time," and the prepositions "of" and "in." Recast as follows:

> The upper San Rafael Group accumulated quietly in northwest New Mexico during broad regional movements.

"With" is also often taken to mean "and" or "but" plus "having" or "using." In the following sentence, "with" wrongly takes the place of the conjunction "and":

> The faults have been indurated and tilted, with some slight folding. Change to: The rocks have been indurated, tilted, and slightly folded.

In the following sentence, "with" is used improperly to qualify the water's clarity: "The water is very clear *with* a faint bluish tinge." Change to: "The water is very clear but has a faint bluish tinge." ("But has" suggests a limitation on clarity not conveyed by "with.")

"With" may also trick you into wordiness and faulty logic:

> The top of the mountain is flat *with* a smooth descent to the west. (The top cannot descend.) Change to: The flat-topped mountain slopes smoothly west.

Further indiscretions with "with":

Change this	**To this**
The mechanic advised the man with the broken cylinder head to report it to the company's regional office.	The mechanic advised the man to report the broken cylinder head to the company's regional office.
The surface of the bedrock is fairly even with depressions representing temporary channels of the shifting creek.	The surface of the bedrock is fairly even but contains depressions * * *.
A fine-grained rock with blotches of bright pink color * * *	A fine-grained rock blotched with bright pink * * *.
The conglomerate pebbles are well rounded with a very loose cement.	The conglomerate pebbles are well rounded and loosely cemented.
He discusses the geology of the county with descriptions of 19 mining districts.	He discusses the geology of the county and of 19 mining districts within it.

You should be aware that "without" may be as misused as "with." If you find "with" or "without" in your writing, doublecheck to make sure you should not be using a conjunction instead.

Prepositions Doubled Up

The use of a preposition following a verb to express an idea that can be conveyed by some other verb alone may lead to the undesirable doubling of prepositions. Examples of undesirable doubling and tripling of prepositions follow:

> The conditions *met with* [observed, confronted] in the field * * *
>
> A large production is not *to be looked for* [expected] from these deposits.
>
> A thickness of *from* 1 to 2 meters * * *.
>
> An estimate of the cost of *operation of* [operating] the filter * * *. (In most such phrases, a noun ending in "tion," and the "of" following it, should be replaced by a gerund as in the preceding example.)
>
> Following the discovery of the character of this deposit * * *. (Write, "After the character of this deposit was discovered * * *.")
>
> Each of the veins has been drifted on for from 15 to 20 meters. (Write, "Drifts have been run 15 to 20 meters along each vein.")

Infinitives

Writers trying to express ideas succinctly occasionally misuse infinitives ("to" plus a verb): "A Grand Junction man was killed this morning to raise the traffic toll for the year to 273." Newspaper journalists face the intense pressure of daily deadlines, but Survey writers lack such excuses:

> He hiked all day only to learn that he was on the wrong ridge. (Write, "He hiked all day before learning that * * *.")

An eruption of Mount St. Helens *occurred* this morning *to blanket all of* [blanketed] the northwestern United States with ash. (Note that "occurred" and "all of" in the previous sentence are superfluous.)

And a heading dredged up by Robert L. Bates of "Geotimes":

Portrait of First President to Hang at Association Headquarters.

EFFECTIVE PUNCTUATION

Try to imagine a written communication without punctuation. Punctuation clarifies communication by conveying to the reader the stops and stress points intended by the writer. A good writer uses punctuation for the same purpose that a good speaker uses gestures, facial expressions, voice tone, and inflections. Points of law have been decided on the placement of a comma.

Frank C. Calkins, a long-time Survey geologist who had a penchant for improving the writing of others, once expressed the relationship of punctuation to cadence as the musiclike quality that gives writing balance and flow. The cadence a musician creates through the use of eighth, quarter, half, and whole rests is analogous to a writer's artful use of commas, semicolons, colons, periods, dashes, and parentheses. The cadence of the sentence controls accent and timing, which together influence the reader's understanding. Effective punctuation clarifies writing; ineffective punctuation clouds it.

Punctuation is purely functional; it clarifies writing by (1) grouping related words, (2) separating unrelated words, (3) enclosing parenthetical words, and (4) emphasizing important words. The Survey's attitude toward punctuation is based on the principle that if punctuation does not clarify the text it should be omitted and that the sole aim of punctuation marks should be to clarify the author's thoughts (U.S. GPO Style Manual, 1984, p. 117). If a sentence cannot be so punctuated as to make the author's thoughts clear, the sentence probably needs to be rephrased.

THE COMMA

Commas mark brief pauses in the flow of ideas, like quarter rests in music. Needless commas break the flow and rhythm of the sentence, but commas missing where needed cause ambiguity or misunderstanding.

Some guidelines:

1. After any introductory phrase or clause, a comma is needed if its absence forces the reader to back up and reread the sentence to understand the intended meaning:

Change this	**To this**
During periods of intense rain water from the claypit flows through this ranch.	During periods of intense rain, water from the claypit flows through this ranch.
Where data are inaccurate or insufficient results deviate from what is expected.	Where data are inaccurate or insufficient, results deviate from what is expected.
After cooling the sample is reweighed and ground to 80 mesh.	After cooling, the sample is reweighed and ground to 80 mesh.

2. An introductory participial phrase should be set off by a comma:

   Spreading toward natural and manmade depressions, the sediments settled in stream valleys, drainage ditches, borrow pits, and lakes.

   Deflected by natural obstructions, the lava stream turned eastward.

3. Commas are required between the parallel words, phrases, or clauses of a series:

   The deposit consists of clay, sand, and gravel.

   The upper coal is 53 cm thick, the parting 30 cm, and the lower coal 46 cm.

   Some writers mistakenly assume that the comma before the final "and" is unneeded because the "and" signals the end of the series, but this notion can cause trouble, especially in technical writing, as follows:

   The complex consists of three conformable, well-layered units of gabbro, diorite and granodiorite and granophyre.

   Without another comma this sentence lacks clarity. The units could be (1) gabbro, (2) diorite, and (3) granodiorite and granophyre, or they could be (1) gabbro, (2) diorite and granodiorite, and (3) granophyre. A comma placed before the proper "and" removes the ambiguity.

   If members of a series contain commas, a semicolon between the members may be needed for clarity:

   The order of deposition was quartz and pyrite; massive galena, sphalerite, and pyrite; brown carbonates and quartz; and small amounts of all those named, together with fluorite, barite, calcite, and kaolin.

4. Commas are needed between two or more adjectives of equal rank (parallel, or coordinate, adjectives) that precede the word(s) modified. (If "and" can be inserted between the adjectives or

if their order can be reversed with no change in meaning, the adjectives are parallel and should be separated by a comma.)

Parallel	Nonparallel
hard, impermeable subsoil	hard clay subsoil
a brief, interesting account	a brief typewritten account
short, swift streams	short tributary streams
long, tedious spell of dry weather	long dry spell
freezing, driving rains	heavy spring rains
perceptible, strong ground motion	strong lateral ground motion
silty, clayey sand	yellowish-gray clayey sand

5. Parenthetical words, phrases, and clauses are usually set off by commas.

Parentheses or dashes may be used to indicate stronger, longer, or more abrupt breaks in thought. Parentheses within parentheses should be avoided.

Identical punctuation marks are needed on both sides of the parenthetical expression, unless the expression is at the end of the sentence: two commas, for instance, or two dashes—not a single comma or a comma and a dash.

Change this	To this
Several individual flows, each thicker than 25 meters have been traced for more than 160 kilometers.	Several individual flows, each thicker than 25 meters, have been traced for more than 160 kilometers.
The President, in his energy message to the Congress recommended that this program go forward.	The President, in his energy message to the Congress, recommended that this program go forward.

Expressions introduced by "together with," "as well as," and "in addition to" are parenthetical and should be set off by commas.

Commas are needed between more than two items of run-in numbered or lettered series:

> Damage resulted from (1) vibration, (2) ground cracking, (3) subsidence, and (4) sea waves.

6. The independent clauses of a compound sentence may or may not need separation by commas, or semicolons, depending on their length and complexity:

> **Without:** Where the drainage went is problematical but it almost certainly turned west.
>
> **With:** A south-flowing course toward the White River looks plausible on a planimetric map, but geomorphic evidence is against it.

But: The coordinate conjunctions "for" and "as" need a preceding comma to avoid being read as prepositions. If "because" is used instead of "for" or "as," the comma may not be needed.

Change this	To this
The arching of the deck probably pulled the piling upward for the connections between the stringers and the piles were strong.	The arching of the deck probably pulled the piling upward, for the connections between the stringers and the piles were strong. Or: The arching of the deck probably pulled the piling upward because the connections * * *.

7. No punctuation is needed after items in a vertical list, whether numbered or unnumbered, unless the items are complete sentences or clauses:

> During our trip we saw many interesting sights:
> Washington Monument
> Statue of Liberty
> Mount Vernon
> Natural Bridge
> Lee's birthplace
> Shenandoah Valley

But:

$$P = \tfrac{1}{2}\gamma H^2 Kp$$

where
P is force per horizontal foot of bulkhead,
γ the unit weight,
H the height along the bulkhead,
and
Kp the passive pressure coefficient.

8. A comma is needed between an adjective and an adverb modifying another adjective or a participle:

> Standard, nationally recognized units of measure * * *.

9. A secondary clause beginning with "so," "then," or "yet" may need separating punctuation, and a comma may suffice.

> Field relations indicate divergent geomorphic histories for the two formations, yet over broad areas they are nearly coextensive.

10. Survey style specifies the following uses or omissions of commas in relation to dates, names, places, and numbers:

> Wilmington, Del., was the site of the convention.
>
> July 4, 1776, was the date.
>
> July 1776 was the time.

The river flooded in June and July 1975.

The river flooded between March 6 and April 15, 1975.

The address of the U.S. Geological Survey's National Center is 12201 Sunrise Valley Drive, Reston, VA 22092.

Water-Supply Paper 2022, page 2632 (this usage applies to all serial numbers); *but,*

2,632 pages, 92,485 kilometers

Henry Smith, Jr., chairman; John Smith II

11. An unneeded or a misplaced comma is as confusing as an omitted one. Commas should not separate a subject from its verb, a verb from its object, a preposition from its object, or an adjective from its noun. (A parenthetical expression is not considered to be a grammatical separation.) The comma in the following sentence separates a subject and its verb:

    A national program aimed at reducing hazards to life and property and at minimizing disruption of governmental and private activities, is spelled out in a newly published report. (Either insert a comma after "program" or delete the comma after "activities.")

    Compound predicates and compound complementary infinitives, each consisting of no more than two elements, generally need no commas. The commas in the following sentences should be omitted:

    The Center staff also provides assistance to users, and conducts training courses in remote sensing.

    The final statement was filed with the Council of Environmental Quality, and was made available to the public in June.

    Scientific personnel are available to answer queries, and to explain how the Survey conducts mapping investigations.

12. A comma may be used to prevent a misreading or to add emphasis. This rule provides the flexibility authors may need to occasionally sidestep the previous rules, as below:

    The movements of the shorelines were affected by sedimentation and subsidence, and were preserved as transgressive/regressive cycles.

    Dependent clauses are not normally preceded by commas, but because the preceding sentence contains an "and" before and after "subsidence," the comma after "subsidence" aids readability. In effect, the second clause then becomes a parenthetical add-on at the end of the sentence. This rationale does not mean that the rules should be violated on whim, but it does suggest that the rules may be bent to enhance clarity.

The Semicolon

Returning to Calkins' musical analogy, you can equate the semicolon with the half rest; it demands a longer pause than the comma. Use it, therefore, when you want a more significant stop than a comma, or when the comma is already serving a lower level function. Rules for the use of semicolons thus dovetail with rules for the use of commas. The first rule applies to punctuating a series:

1. Use a semicolon to separate items in a series if individual items already contain commas:

    Much of the unit is red, pink, or gray; medium to coarse grained; and equigranular or slightly porphyritic.

    The first items of the series, "red, pink, or gray" are separated by commas. If you also used a comma to separate "gray" from "medium," the relationship between those elements would be confusing. Note also that once the need for the semicolon is dictated by internal commas, you must use semicolons in parallel fashion throughout the series—even if no other elements contain commas. If the sentence becomes unwieldy, it might be grasped more easily if written as follows: "Much of the unit is (1) red, pink, or gray, (2) medium to coarse grained, and (3) equigranular or slightly porphyritic."

2. Use a semicolon to separate two independent clauses not joined by a coordinate conjunction:

    Only tungsten and tin are sufficiently concentrated to be potential resources; other elements shown in figures 4–6 are possible "pathfinder" elements for exploring other prospects.

    In the above construction, the semicolon links two closely related but complete thoughts. The closer the link, the better it is to keep the ideas within the same sentence structure—joined, that is, by a semicolon instead of a period. A comma-splice run-on sentence, which is a mild illiteracy, would result if a comma were used in this construction.

3. Use a semicolon to separate two independent clauses joined by a coordinate conjunction if either of the clauses contains at least two commas. As in a series, the commas are already serving one function (here, marking pauses within a clause);

the semicolon, therefore, must serve a function normally assigned to the comma:

> In some populated areas, such as the Lake Tahoe Basin or the Colorado Front Range, the uraniferous waters or the deposits themselves may be significant natural environmental hazards; and further study is needed to determine the severity of the problem.

The nonrestrictive phrase starting with "such as," set off by the required pair of commas, dictates the need for the semicolon before the conjunction "and." The same rule would apply if the two commas were in the second clause. If you are uncomfortable with this use of the semicolon—and many writers are—you may avoid it by simply eliminating the coordinate conjunction "and" (rule 2) or by putting a period after "hazards" and beginning a new sentence with "further."

4. Use a semicolon before adverbial conjunctions that begin a second or subsequent clauses.

   These are the more common adverbial conjuctions:

accordingly	moreover
besides	nevertheless
consequently	still
furthermore	therefore
hence	thus
however	

> In-place rock was sampled whenever possible; however, most plugs were taken from cores or from boulders around quarries or construction-site borrow pits.

Note that "however" is preceded by a semicolon and followed by a comma; this punctuation is standard treatment for adverbial conjunctions. If a comma were used to splice this sentence together, a run-on sentence would result. The clue to avoiding the problem is in recognizing adverbial conjunctions. Rather than joining two clauses in a coordinate fashion, the adverbial conjunction both links and modifies.

Because "however" is used widely as an adverbial conjunction in technical reports, its use as a standard adverb also needs mention. So used, it is treated like any other nonrestrictive element:

> In-place rock was sampled whenever possible; most plugs, however, were taken from cores or from boulders around quarries or construction-site borrow pits.

In these two examples, the key difference in the use of "however" is its function in the sentence: As an adverbial conjunction, it introduces a new clause; as an adverb, it qualifies a statement being made within a clause. The second example reads more smoothly than the first, because "however" follows rather than precedes the subject it qualifies, "most plugs." The sentence would be even smoother, though less arresting, if "but" were used instead of "however," as a simple coordinating conjunction:

> In-place rock was sampled *whenever* [wherever] possible, but most plugs were taken from cores or from boulders around quarries * * *. (Note the substitution of "wherever," signifying place, for "whenever," signifying time.)

5. Words and phrases such as "for example," "that is," and "namely," which introduce an enumeration or explanation, are preceded by a semicolon and followed by a comma:

> Simple physical and mathematical modeling is useful in investigating the general characteristics of a broad class of geothermal systems; for example, vapor-dominated or hot-water systems.

This construction is least disruptive at the end of a sentence. If the context requires that it be embedded within the sentence, setting it off in dashes or parentheses is better than the punctuation just described.

The Period

Periods are used after letters or numbers denoting items in vertical series, after abbreviations unless otherwise specified, in decimals, and after the captions of text illustrations, but not after titles or subtitles. Write: SW¼ sec. 13, T. 2 S., R. 23 E.; N. 40° W., 35° SE. The period provides a more emphatic stop than either the comma or the semicolon. It indicates that an idea is complete. Any writer who recognizes a complete statement uses the period quite naturally, but if its proper use is in doubt, see discussion of "Sentence Fragments" and "Run-On Sentences."

The Exclamation Point

The exclamation point is rarely used in technical writing (and practically never in Survey reports). Its use there tends to irritate the reader and suggests a certain immaturity on the part of the writer. Technical subject matter, moreover, does not lend itself to such emphasis, and even if it did, the use of the exclamation point is a bit histrionic for the objectives and style of technical writing. Emphasis is better gained through effective rhetoric. In a popular publication directed to a nontechnical readership, its use

might rarely be justified, but its effectiveness is related to its not being overdone. An exclamation point must convey great emotion, anguish, force, excitement, or stress; for example, "Please be careful!" "No, not now!" "Help!" "Yes, yes!" and "The volcano is erupting!" Even to convey heightened emotion, the slight understatement of a period may express the poignancy more effectively: "When one experiences a storm like this and sees the consequences, exaggeration is difficult—and pointless." If the words themselves suffice to show the tone, the exclamation point is not called for (Fowler, 1965, p. 590).

The Colon

The colon is a handy punctuation mark because it tells the reader that a statement just read will be amplified immediately after the colon. This function, discussed in rule 1 below, is the most common use of the colon.

1. The colon is used after an introductory statement that conveys the idea that something is to follow.

   > The following is a list of observations summarizing the laboratory results:
   >
   > I regard the two surfaces as one, displaced by faulting, for the following reasons:

   In the above examples a period would be an acceptable substitute, but the colon makes the connection more precise and more emphatic: The reader is thereby prepared for the "list of observations" and the "following reasons."

   If the statement that precedes the colon is incomplete, the colon is generally inappropriate: Either the statement must be finished, or the colon must not be used. Rare exceptions seldom appear in technical reports, but here is an example: "Gold and silver: That's what won the West!"

   But do avoid the following trap: "Factors controlling distribution of stromatolites are: total quantity of sediment, rate of sediment movement, and wave action." Here the colon is unneeded and incorrect because the clause before the colon is an incomplete thought.

2. A colon can be used to separate two independent clauses, the second of which amplifies the first. In this usage, a colon functions in the same way as a dash—it is no more correct than a semicolon or a period, but it more precisely defines the connection between the two independent clauses. The first word following the colon is not capitalized if the matter following it is merely a supplementary remark made to clarify the meaning, as follows:

   > Contact relations within the complex indicate that the granodiorite was the last intrusive phase: it cuts the diorite and tonalite.

   Here the colon clearly signals that what follows will prove that the granodiorite was the last intrusive rock. Although the colon is not required, it is informative. If the statement following the colon is a grammatically complete sentence that can stand alone, many American writers will capitalize the first word.

3. A colon is used after the introduction to a long quotation. Long quotations have minimal use in technical writing, but when one is repeated, the colon is appropriate.

The Dash

The dash is an emphatic and versatile punctuation mark, but it should be used with restraint. Overuse dilutes its effectiveness and even antagonizes some readers—there are those who love it and those who do not—but when not overdone, its use can be very effective.

The dash and the colon are often used interchangeably—some writers use the dash when, in fact, the colon is more apt. The dash, however, does have three major uses. The first is most common in technical writing:

1. A pair of dashes is used to emphasize a nonrestrictive phrase or clause. In this construction, paired dashes replace the paired commas that would be standard usage. Keep in mind that the information enclosed by the dashes will receive particular attention from the reader. The following example shows how these dashes might be used:

   > Another attribute of the Mowry Shale—a diagnostic one, and an unmistakable clue to the identity of the formation—is the presence of countless well-preserved fish scales found with little effort on nearly every outcrop.

   Use of dashes allows two major ideas to be conveyed in the above sentence—both what the attribute is and the writer's perception of its significance. The result is a sentence that is strong and effective.

   In other examples, the dash is justified by the context of the sentence. If several commas are

used in more than one function, the dash may prevent misreading:

Change this	To this
There are shore deposits, gravel, sand, and clay, but marine sediments underlie them.	There are shore deposits—gravel, sand, and clay—but marine sediments underlie them.

On first reading, "shore deposits" appears to be the first of a series of four items; the reader must reread the sentence to recognize that the final three items are a subset of the first. Although "gravel, sand, and clay" do not require emphasis in this sentence, this construction both emphasizes and clarifies the relationship between the ideas. Parentheses could have been used, but they would have deemphasized the enclosed matter.

2. The dash is used before a word that sums up a preceding series. This use of the dash parallels the second use of the colon: It is an artful punctuation. A minor rearrangement of the sentence would eliminate its need, but the dash effectively conveys the appropriate emphasis:

   > The close association with chemogenic units and rocks indicative of pauses in active volcanism, the simple mineral assemblage, and the rhyolite doming in some localities—all suggest that the stratiform sulfides developed through fumarolic activity.

   If you eliminate "all," the dash will have to go too. The present construction, however, allows the reader to pause and absorb the material preceding the dash before reading on to its significance.

3. A dash is used to indicate an afterthought or an abrupt change in thought. This use requires caution. It rarely is acceptable in technical writing but it can be very effective:

   > Then, when downcutting resumed, the soft fill was removed preferentially and buried promontories such as Kings Point were exhumed—an ancient Tertiary landscape faithfully, if incompletely, restored.

   Consideration of readership is important when you construct and punctuate sentences. Artful uses of the dash and the colon can appeal to those readers who appreciate both what you say and how you say it.

Parentheses

Parentheses (which always come in pairs) are used to enclose disconnected elements. Their function parallels that of paired commas and paired dashes, but parentheses deemphasize the enclosed matter; dashes have the opposite effect—they emphasize. Commas, being neutral, merely separate.

In Survey writing (and in most other technical reports) parentheses are used chiefly to set off bibliographic citations and references to figures and tables. They also set off (1) numbers or (a) letters identifying items of a run-in series.

The Hyphen

The hyphen is widely used in technical writing, but it can be ambiguous and confusing. Principles outlined below may help avert problems:

In Syllable Breaks

Word breaks at the ends of lines of type should be made only between syllables, and any good contemporary dictionary will show where the syllable breaks are. Syllable breaks are ignored in some computer-set type, and though the resulting errors may be amusing, they are always distractive and should always be corrected in galley or page proof.

In Unit Modifiers

A unit modifier is made from two or more words that together qualify the meaning of a noun; for example, "zero-frequency limit," "pale-green shale," and "water-oil flow." If the words must work in tandem to be meaningful, use a hyphen. If each word individually modifies the noun, omit the hyphen. The following basic rules apply:

1. Words functioning as unit modifiers (that precede the noun modified) are generally hyphenated.

   a 6- to 10-m-thick unit
   five-spot homogeneous system
   five- and nine-point finite-difference grids
   chimney- and halo-like anomalies (better to say "chimneylike" and "halolike" anomalies)
   log-interpreted lithology
   oil-bearing shale
   cliff-forming sandstone
   fine-grained, thin-bedded sandstone
   blue-green algae
   dark-gray shale

   Omission of the hyphen can change the meaning (p. 146).

2. The same words used as compound predicate adjectives (following the verb) are not hyphenated.

   The shale is oil bearing.

   The sandstone is fine grained and thin bedded.

3. Do hyphenate unit modifiers that follow the noun in inverted sentences (often used in map explanations and measured sections).

   Sandstone, fine-grained and thin-bedded
   Shale, oil-bearing

4. A two-word unit modifier is not hyphenated if the first word is an adverb ending in "ly," but adverbs that might be mistaken for adjectives should be followed by a hyphen.

   Finely crystalline limestone
   Widely spaced joints
   Very clean outcrop
   Well-defined aquifer
   Poorly defined surface

   The hyphen is not used if the first word of a three-word unit modifier is an adverb that modifies the second word, or if the first two words are adverbs.

   Very fine grained sandstone
   Very well defined surface
   Unusually well preserved specimen

6. Common adverbs that cannot be mistaken for adjectives need not be hyphenated.

   Too much turbidity
   Almost empty pool

7. If the words of the unit modifier commonly go together, hyphenation is unnecessary. Ask yourself if you are improving the readability of your sentence by adding hyphens.

   High school student
   Rare earth element
   Mother Lode Belt
   Solid waste disposal

8. The intent of hyphenation in unit modifiers is to aid readability; a hyphen is unnecessary if the meaning is clear without it.

Rules may seem arbitrary, but they are based on clarity and readability. Rules 7 and 8 are deliberately vague, because the decision to use a hyphen is sometimes a matter of judgment. Additional rules 9–13 from the U.S. GPO Style Manual (1984, p. 75–79) apply to many Survey manuscripts:

9. Do not use a hyphen in a unit modifier consisting of a foreign phrase.

   in situ sample
   ex officio member
   per diem allowance
   prima facie evidence

   But, "They did not believe in-vitro fertilization was feasible" needs a hyphen to avoid temporary misreading.

10. Use a hyphen or hyphens to prevent mispronunciation, to ensure a definite accent on each element of the compound, or to avoid ambiguity.

    un-ionized (as distinguished from unionized)
    non-quartz-bearing rock
    non-civil-service position

11. Use a hyphen between the elements of compound numbers from twenty-one to ninety-nine and in adjective compounds having numerical first elements.

    twenty-one
    2-meter rattlesnake
    two-sided question
    thirty- (30-) day period

12. Do not use a hyphen in scientific terms used as unit modifiers if no hyphen appears in their original form. (For hyphenating petrologic terms, see "Petrologic Terminology," p. 98)

    carbon dioxide content
    methyl bromide solution
    equivalent uranium content
    quartz monzonite stock
    but, iron-oxide-stained zone

13. Use as one word compass directions consisting of two points, but use a hyphen after the first point when three points are combined

    northeast
    north-northeast

14. Use a hyphen between numerical values when "from * * * to" is not used. (Substitute an en dash for the hyphen in typeset copy.)

from 3 to 6 m
3–6 m

Slash or Virgule

Any ambiguity that interrupts the reader's train of thought diminishes comprehension. Hyphens may cause ambiguity, because they are used to join words as well as to separate them. If a hyphen causes ambiguity, a slash may add clarity. Consider the "Green-Snake divide": Here the hyphen seems to punctuate a unit modifier, "Green Snake," but the intention is to indicate the divide between the Green and Snake Rivers. "Green/Snake divide" would be clearer. Confusion is compounded if three or more words are involved: "Sunbeam-Sand Wash Basin area" seems to say that "Sunbeam-Sand" is a unit modifier of "Wash Basin." In "dry oak-hickory savannah," the expression is obscure unless a slash replaces the hyphen. Another example further illustrates the point: "a slump-debris-flow complex." Because "debris-flow" as a unit modifier of "complex" requires a hyphen, an additional hyphen after "slump" obscures the meaning, but a slash clarifies it: "a slump/debris-flow complex." Rephrasing with prepositions may add clarity but also adds words and tends to be cumbersome, especially if used repeatedly in the same or in succeeding paragraphs: "a complex of slumps and debris-flows."

Use a slash to substitute for "per" (m/km, ft^3/s, gal/min).

The Apostrophe

1. **In the possessive case**

   The apostrophe is used chiefly to form possessives, indicate contractions, and create certain plurals. The possessive case of a singular or plural noun ending in "s" or with an "s" sound is formed by adding an apostrophe only: boss', bosses', Reynolds', Reynoldses', Ph.D.s', and Cos.'. To show possession in compound nouns, add an "s" to the last word only: secretary-treasurer's position, David Brown III's report.

   Remember that the apostrophe is omitted from the possessive pronouns its, yours, theirs, ours, and hers.

   The possessive form is added to the last element of a series to show joint possession—Tyler, Moore, and York's experiment—but to each element to show separate possession—author's, technical reviewer's, or editor's opinion. The singular possessive case is used in such general terms as fuller's earth and miner's inch.

2. **In contractions**

   Contractions are rarely used in formal technical writing, but the contraction "it's" and the possessive "its" are commonly confused in Survey manuscripts.

3. **In plurals**

   Despite a trend in contemporary writing toward eliminating the apostrophe from certain plurals, STA follows the U.S. GPO Style Manual (1984, p. 118, rule 8.11) in its use of coined plurals of letters, figures, and symbols, such as 1920's, Btu's, a's, 7's, T's, and 2×4's. On the other hand, adding apostrophes to the plurals of common or proper nouns not in the possessive case is a clumsy error: assorted opal's; elephant's on the move; dined with the Smith's.

Brackets

One primary function of brackets is to indicate information added to the work of another writer. This information is generally added in either of two places: in quotations or in references. Occasionally a quotation will be introduced by a pronoun that does not provide a clear referent for the reader. Brackets can be used to add the referent, as in the following example:

> The Federal Government should, as a matter of policy, actively and vigorously seek to take maximum feasible advantage of the opportunities provided by this [information resources management] technological revolution.

In references, brackets are used to indicate additional information that is not available on the title page of the publication. This information might be the actual date of publication as compared to the imprint date, an English translation of a foreign language title, or an indication that a particular cited article is an abstract.

The Survey also uses brackets to enclose headnotes in tables and measured sections.

Points of Ellipsis

Ellipsis is the omission of words necessary for complete grammatical construction but unnecessary for comprehension in the context of a sentence. Ellipsis (pl. ellipses) is also used in the omission of material from quotations. The Survey advocates a series of three asterisks separated by spaces (in preference to a series of three periods) to indicate points of ellipsis (* * *). Asterisks avoid the confusion that period

ellipses cause at the end of a sentence. Four periods in a row could mean that the ellipsis either precedes or follows the end of the sentence, but when three asterisks and a period are used, the end of the sentence is obvious. Few people outside the Federal Government use asterisks, but their meaning in context is self-evident.

Quotation Marks

In Survey style, quotation marks are used to enclose (1) direct quotations, (2) titles of publications named in text, (3) words spoken of as words, (4) letters spoken of as letters, (5) words used ironically or out of context, and (6) misnomers. At the ends of quotes, the comma and the final period are placed inside quotation marks. Other punctuation marks are placed inside the quotation marks only if they are part of the matter quoted.

If the quoted matter consists of more than one paragraph, you should place quotation marks at the beginning of each paragraph and at the end of the quotation. The editor may remove the quotes and mark the copy for type different from the rest of the text. You may omit nonpertinent parts of quoted matter, but the omission should be indicated by ellipsis marks (* * *), and the result should be a complete sentence.

Omission of a complete paragraph should be indicated by a line of seven asterisks separated by spaces across the page or column.

Matter following "entitled," "the word," "the term," "marked," "designated," "classified," "named," and "signed" is usually enclosed in quotation marks. Matter following "known as" and "so-called" is usually not enclosed in quotation marks. For example:

> The term "silt" refers to unconsolidated rock particles finer than sand and coarser than clay. The so-called bottom load refers to the larger particles that move on or near the bed of the stream.

Further examples of appropriate use of quotation marks are given in the U.S. GPO Style Manual (1984, p. 131):

> After the word "treaty," insert a comma.
> Of what does the item "miscellaneous debts" consist?
> The document will be marked "Exhibit 21"; *but* The document may be made exhibit 2.
> The check was endorsed "John Adamson."
> It was signed "John."
> Beryllium is known as glucinium in some European countries.
> The so-called investigating body met * * *.

Quotation marks should not be used in lieu of apology—to say, in effect, that a particular word probably isn't the best available, but that time was not available to find one more suitable. Nor should quotes be used with condescension—to indicate that you know the word isn't quite right, but fear the reader may not know unless tipped off.

Style

> Try to preserve an author's style if he is an author and has a style.
>
> *Wolcott Gibbs*

Style is more easily recognized than defined. You may recognize it in people, places, and things without knowing why. Some have style; some have not. Style in writing is the way thoughts are put into words, the form of expression as distinguished from the content. As a technical writer, you may never achieve style in a literary sense, but your goal should be to write clearly enough to be understood and smoothly enough to avoid stylistic quirks. Technical writing should be dispassionate and unobtrusive. If your readers are overly conscious of how you express yourself, your message will fall short. Being clearly understood is the best test of good technical writing style.

Style is hard to categorize because it is more judgmental than grammatical. Writing can be grammatically flawless but without style, and a writer may relish a phrasing that a reader finds offensive. Good style should have a certain grace and elegance that the reader senses subconsciously. The basic elements of style can be learned, and understanding them helps authors and editors alike uphold the quality of Survey writing.

Emphasis

To express thoughts effectively, you may need to emphasize different parts of a sentence. Some common ways are given below.

Position

Important ideas should have important positions—positions that command attention. Unimportant ideas should be subordinated. The most emphatic positions in the sentence are the beginning and the end, especially the end. Readers naturally stress the words immediately preceding and following punctuation marks. The only objection to ending a sentence with a preposition is that an unimportant or weak word is placed in a position of emphasis. A sentence ended with a preposition, however, may be better than an unnatural or awkward sentence phrased to avoid such an ending.

Order

Deviation from the usual order attracts attention. In some sentences emphasis can be changed by just transposing a word or phrase:

> Gold mining has been the leading industry of the region for many years. (Emphasis on gold mining.)
>
> For many years gold mining has been the leading industry of the region. (Emphasis on many years.)
>
> The leading industry of the region has long been gold mining. (Emphasis on leading industry.)
>
> In this region gold mining has long been the leading industry. (Emphasis on region.)

Voice

The active and passive voices are discussed further on page 142. Two points, however, relate directly to the subject of emphasis: (1) The passive voice, on the whole, is less emphatic than the active, and (2) whatever emphasis the passive voice has is imparted to the object acted upon rather than to the agent of the action. "The sandstone is cut obliquely by the fault" (passive voice) emphasizes the sandstone and is not as strong overall as "The fault obliquely cuts the sandstone" (active voice).

Specific Terms

Specific and concrete terms are more emphatic than general and abstract terms.

Italic

Italic type is used chiefly to differentiate or highlight certain words or phrases. In manuscript, it is indicated by underlining. In scientific writing, italic should not be used for emphasis; composition should be so phrased that emphasis requires no typographic assistance. Similarly, boldface type should not be used for mere emphasis either.

The following are examples of what is printed in italic:

- *See* and *see also*, in indexes and glossaries
- *In* and *of* in certain reference citations
- Sideheads in text
- Names of vessels, aircraft, and spacecraft
- Letter symbols in mathematical equations
- Most letter symbols used in physics.

Letters used for subordinating figure numbers for maps and other illustrations, or in text to refer to such numbers, are set in italic without periods and are capitalized if so shown in copy—for example "(fig. 1*A*)."

Scientific names of genera, species, and subspecies or varieties of organisms are ordinarily italicized, but in italic matter they are set in roman: *Productus*, *Inoceramus fragilis*, *Ostrea congesta* Conrad, *Bulimina elongata subulata*. If italic is unavailable on the office printer, such names may be printed in a suitable typeface different from that used in the text, following recommendations of the International Code of Zoological Nomenclature (Stoll and others, 1964, p. 143; Ride and others, 1985). Underlining, for example, is more commonly available on word processors than italic and is equally appropriate for camera-ready copy. One typeface should be used throughout. Names of families and higher groups are ordinarily printed in roman: Brachiopoda, Mollusca, Foraminifera.

Chemical symbols and foreign words are printed in roman, even in italic matter.

Variety in Sentence Length and Type

Monotonous sentence structure reduces the effectiveness of a report. You can achieve variety in sentence length or form by interspersing simple, complex, and compound sentences, by changing the word order, by using meaningful connectives, and by avoiding excessive use of participial phrases.

Some authorities advocate short, snappy sentences, but too little variety in length—either short or long—yields flaccid prose. Too many short, choppy sentences tend to irritate the reader, but one long sentence after another befogs the reader's mind. Good writing needs a mixture of sentence lengths to provide cadence, add emphasis, and heighten interest. The longer the sentence, the greater the risk of convolution, but regardless of length, the train of thought is broken if the reader is forced to analyze the sentence structure to unravel its meaning. Long sentences of themselves need not be hard to read. The late Survey grammarian-geologist Frank Calkins once pointed out that a sentence may be long without being involved, or involved without being long, but an involved sentence always seems longer than it really is. One short sentence in a series of longer ones will catch extra stress. So will the converse. By varying sentence lengths, therefore, you can effectively control emphasis. To check for appropriate length, read the words aloud, listening for their clarity, flow, and cadence. Whispering the words to yourself is almost as effective. A reminder: The most emphatic places in a sentence are at the beginning and the end, where the eye lingers longest. The important words belong there.

Four Types of Sentences

To enhance style, sentences should vary in form as well as length. Regardless of length, every sentence

can be classified into one of four types: simple, compound, complex, or compound-complex.

Simple. A simple sentence contains one independent clause consisting of at least one subject and one verb: "The ground shook." Simple sentences thus can be spare in form, but they can also have associated objects and linkages: "The ground appeared to be stable." (Here the phrase "appeared to be" links the subject to "stable.") Simple sentences can also be quite involved: "The striking contrast between the simplicity and symmetry of spheres and the apparent chaos of the universe has attracted men to spherical bodies since the dawn of abstract perception." Short sentences likely are simple sentences, but simple sentences are not necessarily short.

Compound. A compound sentence consists of two or more simple sentences joined by a coordinating conjunction (and, but, for, or, yet, so) or a semicolon. When a reviewer suggests a need to coordinate ideas, the compound sentence is a possible approach. Like the simple sentence, a compound sentence can be rather simple or rather complicated in form. A simple example: "The northeastern margin of the batholith steepens with depth, and in the lowest exposed parts it is nearly vertical." A more complicated example: "The two coal dumps near Engleside are shown on the map because the steep angle of repose poses [ugh] a threat of landslide, and they contribute smoke, suspended solids, and odor to the atmosphere, as well as suspended and dissolved minerals to the streams and ground water." This sentence needs help. Each clause introduces multiple thoughts ineptly strung together.

Complex. Complex sentences convey ideas that have unequal relationships—one independent clause linked to one or more dependent clauses. Certain ideas are thus subordinated to others that the writer regards as more essential. If the expressed idea is uncomplicated, the dependent clause can be short: "The basal unit is the Anza Formation, which is a coarse conglomerate about 350 m thick." The author chose to emphasize the idea that the basal unit is the Anza Formation. Greater stress could be added by placing "Formation" last: "The basal unit, which is a coarse conglomerate about 350 m thick, is the Anza Formation."

Complex sentences often contain fairly involved ideas, sometimes to their detriment: "Because the ship selected for the program, the *Glomar Conception*, lacked dynamic positioning capability, its anchoring capacity determined the maximum water depth in which drilling could take place." Inserting "the *Glomar Conception*" into the middle of the first clause broke the rhythm of the sentence. Two separate sentences, one simple and one complex, would be better: "The ship selected for the program was the *Glomar Conception*. Because it lacked dynamic positioning capability, its anchoring capacity determined the maximum water depth in which drilling could take place." Complex sentences communicate involved ideas and provide variety in style, but their construction needs care.

Compound-complex. The compound-complex sentence is potentially the longest and most complicated sentence type, and it therefore contains pitfalls for both the writer and the reader. Combining the two previous sentence types, it consists of two or more independent clauses, and one or more dependent clauses. Although such a sentence can be unmanageable, and sometimes is, it can also be clear and bright: "As the mass arched through the air, it quickly chilled on the outside, and a hardened skin formed around the still-hot plastic core." The following sentence, at the other extreme, is neither clear nor bright: "These feldspars differ from the saussurite pseudomorphs occurring in some of the rocks transitional to the quartz diorites, although even these saussuritic feldspars are probably due to hydrous solutions, inasmuch as zoisite is a hydrous silicate, and they suggest, if they do not demand, dynamic processes for their formation." A danger of the compound-complex form thus is that the sentence may be so dense with poorly expressed ideas that the reader cannot easily interpret the message. Note that "occurring" is superfluous in the above example and should have been left out.

Active Versus Passive Voice

Voice refers to the relationship between a transitive verb and the subject of the sentence either as actor or as recipient of the action. If the subject is the actor, the voice is active: "Jane measured the section." If the subject is the recipient, the voice is passive: "The section was measured by Jane." Note that the passive form requires an auxiliary verb (was), which adds an extra word to the sentence, and a preposition (by), which adds another. Saving a few words here and there makes little difference to the preparation cost of the report, but it can greatly improve the style and readability. The following sentence gains both style and readability by a change of voice: "*As a result of* determining the hydrological units, *a clearer* [clarified our] understanding of stratigraphy *was achieved.*

In another simple example, "I did the experiment," the voice again is active. The pronoun subject "I" is the actor who did the experimenting. In the passive voice, "The experiment was done by me," the noun subject, "experiment," received the action of the

verb, and the actor was relegated to a flabby prepositional phrase tacked onto the end of the sentence. If the whole discussion centers around the experiment, however, it would be silly not to make "experiment" the subject of the sentence, even in the passive voice. To do otherwise would jar the reader. The passive voice requires more words to say the same thing, but it is less personal than the active voice and is more anonymous and hence is less committal: "These rocks are thought to be overturned" doesn't say who thinks so; it lets the writer off the hook. It also is more modest than "I think these rocks are overturned," and it is less assertive than, simply, "These rocks are overturned," but it also is less forthright and less forceful. Good technical writing should have a blending of voices, but the active should predominate. In any event, the subject matter of a report needs emphasis, not its author.

Passive Voice and Personal Pronouns, First and Third Person

Some writers conscientiously use the passive voice or the third person to avoid using the pronouns "I" or "we" (first person) on the grounds that such usage is somehow boastful. The first person is more straightforward than the third, and avoiding an appropriate "I" risks a stodgy, overly formal style. Referring to yourself as "the author," 'the writer," or "the senior author" smacks of false humility. "The author" or "the writer," moreover, can be ambiguous or even misleading if another author has just been mentioned: "Gillespie's report mentioned several occurrences of chalcopyrite, but their exact locations were unknown to the writer."

On the other hand, some authors overuse the first person in a way that seems arrogant or self-congratulatory. Survey editors try to be openminded about authors' preferences; use either person, first or third, but do not use them both in the same report. If you find yourself struggling to avoid the first person, use it, but if it appears on every page, or more than once or twice on a single page, rephrasing may be appropriate.

Enhancing Clarity

That, Which, Who, Whom, and Whose in Restrictive and Nonrestrictive Clauses

> THAT, *relative pronoun*. . . The two kinds of relative clause, to one of which *that* and to the other of which *which* is appropriate, are the defining and the nondefining; and if writers would agree to regard *that* as the defining relative pronoun, and *which* as the nondefining, there would be much gain both in lucidity and in ease.
>
> *H. W. Fowler*

Some misunderstanding and argument cloud the distinctions in the use of the relative pronouns "that" and "which." As a relative pronoun, "that" is used only to introduce restrictive (distinguishing or defining) clauses: "Oviparous animals are those that lay eggs." The essence of the sentence is lost if the "that" clause is deleted. "Which" is used to introduce nonrestrictive (informing or parenthetical) clauses: "Oviparous animals, which include birds and most reptiles, are those that lay eggs." Delete the "which" clause and the sentence still makes sense. Many good writers use "which" to introduce restrictive clauses, but in so doing they lose an element of precision and style in their writing. In the following jingle, substitute "which" for "that" and note the loss of style; it becomes just a bit prissy.

> This is the house that Jack built.
> This is the cow with the crumpled horn
> That tossed the dog
> That worried the cat
> That killed the rat
> That ate the malt
> That lay in the house that Jack built.

Similarly, "These are the times that try men's souls" is a powerful statement; substitute "which" for "that" and feel the loss of strength.

Some otherwise great writers have been inveterate whichers, but STA urges Survey writers to observe the distinctions anyway, not just to help preserve the purity of the language but to maintain the clarity of their writing.

Some authors are elegant variationists. They throw in an occasional "which" just for the sake of euphony, or they alternate between "that" and "which" in a litany of inelegance. Try it with "The house that Jack built."

In some constructions, either "that" or "which" is appropriate, depending on the intent of the writer:

> **Restrictive.** "The peak that is capped with quartzite is the highest in the range." (Here the capping of quartzite distinguishes the highest peak from lesser ones capped with something else.)
>
> **Nonrestrictive.** "The peak, which is capped with quartzite, is the highest in the range." (Here the capping of quartzite is merely added information, incidental to the statement of fact.)

In both examples, the whole issue can be sidestepped without a loss of good grammar by just omitting "that is" or "which is': "The peak capped with quartzite is the highest in the range." The sense of the clause is restrictive unless "capped with quartzite" is set off by commas.

In another example that could be either restrictive or nonrestrictive, "Periodically, much of Browns Park was flooded by lake waters that deposited blankets of sand and clay," the author wanted to emphasize the fact that the lake waters were depositing sand and clay. They were not just any old lake waters.

The pronouns "who" and "whom" are acceptable substitutes for "that" or "which" but only as applied to persons, not to animals, for which they are unidiomatic:

> This is the maiden all forlorn *that* [who] milked the cow with the crumpled horn.

"Whose," however, is an idiomatic substitute for persons, animals, and inanimate objects, and its use can enhance clarity:

> This is the dog *the mistress of which* [whose mistress] milked the cow.

> The peak *of which the* [whose] summit is quartzite * * *.

The use of "which" in a restrictive clause occasionally adds something to a sentence, at least if an emotional or a melodramatic effect is desired: "It is for us the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced." Frank Calkins called this construction the "running which," and it isn't preceded by a comma, but such an effect is seldom sought in scientific works. More often, "which" is used simply out of habit, or because the writer is unaware of the distinction. "Which" used in a restrictive sense is not a cardinal sin, but the precision of the sentence is diminished if the distinction is not observed.

Parenthetical Expressions

Parenthetical expressions are nonrestrictive interjections and hence are not essential to the grammatical completeness of a sentence. They can range from single words or short verbless phrases to long independent clauses or complete sentences set off by commas, dashes, brackets, or parentheses. They offer flexibility, therefore, in conveying information and in varying your writing style, but for the same reasons, they can easily confuse the reader. If they are lengthy, or are carelessly placed, they force the reader to backtrack to pick up the essential thread of the sentence: "Five flatcars carrying U.S. Mail, as well as the toe of the landslide, came to rest in the Weber River."

For easy reading, put parenthetical expressions at logical breaks in the sentence—before, between, or after independent clauses, not in the middle of them. Place them after prepositional phrases or after participial phrases. Avoid interjections (unless unusual impact is desired) in the middle of a clause, where they will jar the reader. Sentences read more smoothly if such breaks are at logical breathing places. Additional information is sometimes better presented in a separate sentence rather than in a parenthetical expression.

Parallel Construction

Parallel construction is one of the author's strongest tools for writing clearly and forcefully. Sentence elements that are parallel or coordinate in meaning should also be parallel or coordinate in style.

The following sentence elements signal the need for parallel construction:

1. Coordinate conjunctions ("and," "but," "or," sometimes "for," "nor," "yet"). A shift in verb tense, voice, or mood, after a coordinate conjunction, violates the principle of parallelism and may also create other difficulties:

Change this:	**To this:**
Tours of the facility will begin following the ceremony on Friday and continuing through Saturday.	Tours of the facility will begin on Friday following the ceremony and will continue through Saturday.
Limestone in massive beds and thin layers of sandstone	Limestone in massive beds; sandstone in thin beds

2. Correlative conjunctions ("both * * * and"; "either * * * or"; "if * * * then"; "neither * * * nor"; "not only * * * but also"). If a verb follows one, a verb should follow the other; if a prepositional phrase follows one, a prepositional phrase should follow the other. Repair of faulty parallelism may require only transposition or addition of a word or two.

> Mr. Small *both* talked [both] longer and more rapidly than I had expected.

> To the northeast, the sandstone bed *both* became [both] thicker and coarser grained. ("Both" adds little to either of the above sentences and could be omitted.)

> *Either* the water was [either] too turbulent or too shallow for such bottom-dwelling species.

> *Either* you will [either] report on time or be penalized for your absence.

> This nation *not only* has achieved great things [not only] in science but also in the arts.

> The program *not only* aimed at development of techniques that [not only] would be useful in the present emergency but also would improve the efficiency of normal operations.

3. "And which," "and who," "and that," "but which," "but who," and "but that" need a preceding "which," "who," or "that."

Change this	To this
This district, the largest and which contains the principal mine, is in the western part of the county.	This district, which is the largest and which contains the principal mine, is in the western part of the county.

4. Items in a list, in a reading column of a table, and in a description of a process should be in parallel format.

Change this	To this
a. Laboratory equipment should be assembled.	a. Assemble laboratory equipment.
b. Then arrange samples in proper sequence.	b. Arrange samples in proper sequence.
c. Tests are run.	c. Run tests.
d. We recommend that results then be recorded.	d. Record results.

5. Items in a series.

Change this	To this
The content of CRIB was based on user response, individual discussions, and by certain requirements of the GYPSY program.	The content of CRIB was based on user response, individual discussions, and certain requirements of the GYPSY program. Or: * * * on user response, on individual discussions, and on certain requirements of the GYPSY program.
The Department of the Interior had 15 Skylab experiments in which its scientists were principal investigators, co-investigators on 4 other experiments, including one experiment with the Italian Geological Survey.	Scientists of the Department of the Interior were principal investigators on 15 Skylab experiments and were co-investigators on 4 other experiments, including one with the Italian Geological Survey.

6. Expressions of comparison and contrast.

Change this	To this
The instruments on Skylab were more complex than the ERTS payload.	The instruments on Skylab were more complex than those on ERTS.

Faulty parallelism. Florida deposits were discovered in 1888, in Tennessee in 1894, and in the Western United States in 1906.

If you don't believe the previous sentence has faulty parallelism, substitute "phosphate" for "Florida" to see the flaw.

Suggested alternative. Deposits were discovered in Florida in 1888, in Tennessee in 1894, and in the Western United States in 1906.

Parallelism is flawed if a series includes items that do not really belong. Consider the following example:

Faulty parallelism. Abstracts are selected on the basis of geologic significance, amount of new information, broad interest, and in the case of section meetings there must be relevance to the section's geographic coverage.

The first three elements of the preceding sentence express parallelism through a series of noun phrases, but the "and" introduces an unrelated independent clause. The three items preceding "and" relate to something other than section meetings, and they rightly belong in a parallel series, but the final item does not. The problem can be remedied as follows:

Suggested alternative. Abstracts for the national meeting are selected for geologic significance, new information, and broad interest; abstracts for section meetings must additionally be relevant to the section's geographic coverage.

The use of the word "additionally" in the previous sentence conveys the idea that abstracts for section meetings must meet the criteria for abstracts for the national meeting as well.

More examples of faulty parallelism. The following sentences are clumsy or misleading because they fail to observe parallelism. Words in italic should be deleted; words in brackets should be added. Read each sentence first with the italic, then as corrected.

The average growing season *according to the Ennis record* is 98 days [at Ennis] and longer at the other stations.

The district has a moderate climate, in winter not very cold and *not excessively hot* in summer [not excessively hot].

The veins pinch out in one direction and *in the other* pass under the glacier [in the other].

These leaves range in length from 6 to 9.5 cm and [in width] from 4 to 7.5 cm *in width.*

The boundary between the belts is fairly distinct in [some] places and *in places* indefinite [in others].

The biotite replaced albite and quartz extensively and *sparingly replaced* hornblende [sparingly].

The layers of shale are much thinner than the *chert* layers [of chert].

Estimating the potential value of power sites and [the] storage *capacities* [capacity] of reservoir sites * * *. ("Storage capacity" is an abstract term like "potential value.")

The replacement of pyrite by chalcocite would result in an increase in volume; the replacement of chalcocite by pyrite would *occur with a slight volume decrease* [result in a slight decrease].

A change in form of a phrase or clause may be taken by some readers to indicate a difference in idea, but in the immediately preceding example the only difference is between "increase" and "slight decrease." The two clauses are parallel and should be expressed in the same form. Also, the phrasing would be stronger if "would result in" were changed to "would cause"—a change from intransitive mode to transitive.

For clarity, sentences that contain coordinate information should be written in parallel form also:

The Madison Limestone forms sheer cliffs. The underlying Lodore Shale forms rubbly slopes.

Excessively Long Unit Modifiers

Authors should avoid clumsy unit modifiers intended to save space but more likely to confuse the reader. Read, for example, the following: "It is shown by this simple study that advances must be made in both earthquake-prediction capability, and in ground-motion and structural-response-estimation technology, for the costs associated with long-term design and planning decisions to be significantly reduced." Aside from all the other stylistic problems in this sentence, the overuse of the unit modifier diminishes clarity and hampers the comprehension of the reader. Few readers are likely to grasp the meaning of this sentence without regressing more than once.

The following clever phrases gleaned chiefly from the columns of Robert L. Bates can be clarified simply by recasting with prepositional phrases or by inserting appropriate hyphens.

Multidisciplinary Sinkhole Conference
(Change to: Multidisciplinary Conference on Sinkholes)
Heavy crude trained personnel
(Change to: Personnel trained in [refining?] heavy crude)
Endangered Mammalian Dictionary
(Change to: Dictionary of Endangered Mammals)
Caribbean Plate Steering Group
(This example is too precious to alter)
Regional Climate Coordinating Office
(This example is too ambiguous to remedy without additional information)
Underwater Mining Institute
Abnormal Subsurface Pore Pressure Symposium
Abandoned Mine Reclamation Project
Small horsepower salesman
First carnivorous dinosaur eggs
Closed loop Earth coupled heat pump
High Altitude Health Conference
Low rank coal study
Underground Operators Conference
Boring Late Cambrian organisms
Horizontal boring machine operator

Avoid using nouns as adjectives, especially in unit modifiers:

Ocean Disposal Symposium
Copper acetate ammonia solution method
The natural gas production report

Split Infinitives

The split infinitive, in which "to" is separated from its verb by an adverb (or by several other words), is generally awkward and unnecessary. It is justified, however, if (1) placing the adverb before the "to" or after the verb causes a more cumbersome construction or (2) the result otherwise is ambiguous:

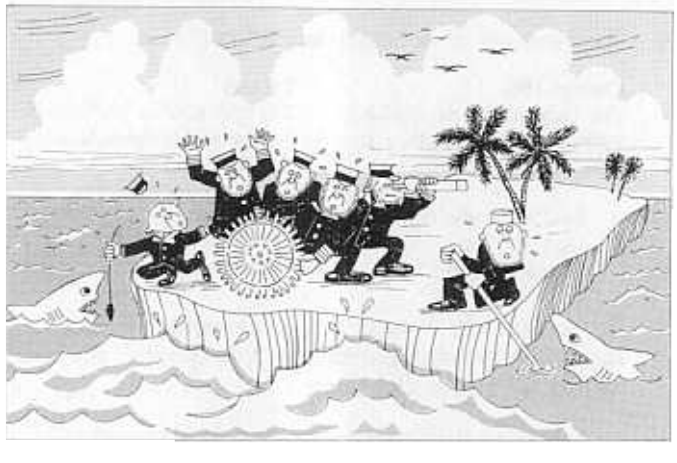
"Our intent is to further strengthen the embankment" is much better than the ambiguous revision, "Our intent is further to strengthen the embankment." (Further intent, or further strengthen?)

Don't hesitate to split an infinitive to avoid ambiguity or to improve the flow of a sentence, but infinitives in many manuscripts are split without reason, and most such sentences thus lose emphasis:

To slowly accumulate (to accumulate slowly, *and* to have slowly accumulated)

To violently erupt (to erupt violently, *but not* violently to erupt)

It was difficult to locally distinguish one tuff from another. (Locally, it was difficult to distinguish * * *.)



"Caribbean Plate Steering Group."

Terminal Prepositions

Some writers studiously avoid placing prepositions at the ends of sentences to the extent that their phrasing becomes stilted and unidiomatic. Most terminal prepositions can be avoided gracefully by recasting, but recasting an already adequate sentence may be more trouble than most writers are willing to put up with. Fowler (1965, p. 473–475), in fact, devoted nearly a page and a half defending terminal prepositions and cited many examples of their appropriate use. The chief objection to ending a sentence with a preposition is that a place of emphasis in the sentence is lost to a weak or unimportant word.

Repetition and Synonyms

Appropriate word choice is essential to clarity. If a word has two (or more) possible meanings (many have), avoid using it for both in the same paragraph or in nearby paragraphs. Avoid homonyms. A short word is better than a long one if it has the same nuance, and repeating a short, familiar word is less distracting to the reader than repeating a long or uncommon one. Substituting a synonym may be appropriate, but the writer should not resort to elegant variation just to avoid repetition; unless the synonymy is obvious the reader may be diverted from the main thought. In technical writing, precise terms should be repeated for clarity and emphasis. If one term is substituted for another, the reader is temporarily distracted, as in the following example: "Andesine and augite, the essential minerals, are usually found in the proportion of 3 of the plagioclase to 1 of the pyroxene." The reader is forced to equate andesine with plagioclase and augite with pyroxene. Revise the sentence to avoid the substitution: "The proportion of the essential minerals is usually 3 andesine to 1 augite."

Acronyms

Acronyms are troublesome for most readers and should be avoided. If an acronym is widely understood (radar, sonar, NATO, NASA) its use may be acceptable, but some reports are loaded with obscure acronyms that few readers can keep straight. Saving space is insufficient justification for a loss of clarity. Well-known acronyms or abbreviations are appropriate in Survey reports for often-repeated names of organizations and the like but not for geographic names or geologic terms. The Survey, for example, disapproves of UWTB for Utah-Wyoming Thrust Belt or QFS for quartzo-feldspathic schist.

Ten Steps Toward Clarity

1. Be concise.
   Delete needless words.
2. Choose the right word carefully.
   Favor the short word over the long.
3. Do not needlessly repeat words, phrases, or ideas.
   Do repeat what is needed for clarity.
4. Favor the active voice over the passive.
5. Be specific.
   Use concrete terms; avoid abstract nouns (shun "tion").
6. Avoid dangling modifiers.
   Place modifiers as near as possible to what they modify.
7. Take care in the placement of parenthetical phrases.
8. Avoid shifts in subject, number, tense, voice, or viewpoint.
9. Express parallel thoughts through parallel construction.
10. Arrange thoughts logically.
    Work from the simple to the more complex.

Conciseness

Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph should contain no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecssary parts.

William Strunk

Insecurity about subject matter sometimes leads to wordiness, but a flood of words will not hide technical inadequacies. Know your subject before you start to write, then get to the point. George Otis Smith, fourth Director of the U.S. Geological Survey, was a champion of plain language. In 1921, he addressed the following plea:

This brings me to a third reason for our use of highly technical language; we too often try to overdress our thoughts. Just as there is a somewhat prevalent notion that clothes make the man, so we subconsciously believe that words make the idea. We follow the precept, "To be scientific, use scientific terms," and in so doing we deceive ourselves. I do not wish to be unduly autobiographic in this analysis, but to show my true sympathy for those whose practices I denounce, I confess that I, too, have had the unhappy experience of stripping the technical words from what looked like a good-sized geological deduction only to find that the naked idea was rather small and not my own. It is also a common experience to make the sad discovery that a piece of involved and obscure writing is simply the product of roundabout reasoning or twisted thinking. Our own words fool us, and unconsciously we cover up with long words or tangled rhetoric our lack of plain thinking.

The attitudes of a society are reflected in its writing styles, and our fast-paced society has little time for stylistic niceties. The following statement met standards of style in 1921, but most readers today would find it boring, if not foolish: "So keen were his observational powers in the geological direction that he was finally inveigled into deserting the purely scientific realm which he had so auspiciously entered in Brazil, Iowa, Illinois, and Kansas, and on the Hayden surveys in Idaho, Wyoming, Colorado, and New Mexico, and into expending his superior powers on the more remunerative economic aspects." Simpler language would be more appropriate today: "He was a highly talented, widely traveled research geologist, but the promise of financial gain lured him from research into industry." Ideas should not be overly compressed, but to convey ideas clearly and directly, the writer should scrupulously eliminate unnecessary words.

Expletives

In grammar, expletives are filler words or phrases such as "There are" and "It is" that substitute for the real subject of a sentence or for the object of the verb. Expletives put the real subject into a subordinate place in the sentence, generally add words needlessly, and hence generally weaken the vigor and clarity of your writing. They can project an informality, however, that sometimes is desired.

Gunning's Fog Index

Several years ago Gunning (1968) devised a "fog index" as a test of readability and as a way to see where your own writing stands against the writing of others. Slightly modified here, the fog index is simply a factoring of sentence length and word length, ignoring intangibles such as grammar and rhetoric. It shows how sentence length and word length directly affect comprehension—the longer the sentence and its words, the harder they are to read. An index of 8 equals an 8th grade reading level; 12 equals 12th grade or high-school senior level. Try it out, using several sentences or paragraphs taken at random from your own report.

First, measure the average length of sentences in the passage by dividing the number of words in the passage by the number of sentences. Independent clauses—joined by "and," "but," some other conjunction, or a semicolon—should be counted as separate sentences.

Next, find the percentage of "hard words" by counting the number of words per 100 containing three or more syllables. Unusual acronyms and abbreviations should be counted as hard words. Don't count capitalized nouns, and don't count verb forms that have three syllables merely because they end with suffixes "ed" or "es" (such as "disgusted" or "sentences"). Use your own judgment about hyphenated words.

Finally, get the fog index by just adding the average number of words per sentence to the percentage of hard words and multiplying by 0.4 as follows:

$$F = 0.4 \times (l + h)$$

where

F is the fog index,
l is the average length of sentences, and
h is the percentage of hard words.

An index of 13 or more means that your copy exceeds the danger line of reading difficulty for most readers in the general public. Copy with a fog index of 13 or more runs the risk of being ignored or misunderstood by many people. Popular reports should range near 12. (The first two paragraphs of this section have an index of 12.) Table 6 below compares Gunning's fog index with various reading levels.

Table 6. The fog index by reading level

Fog index	Reading level: By grade	Reading level: By magazine
17	College graduate	
16	College senior	Most technical reports in this range but no popular magazines
15	College junior	
14	College sophmore	
13	College freshman	
Danger line for most readers		
12	High-school senior	"Atlantic Monthly"
11		"Time" and "Newsweek"
10		"Reader's Digest"
9	High-school freshman	Popular magazines off the rack
8	8th grade	
7	7th grade	"True Confessions"
6	6th grade	Comics

Many passages in technical journals exceed 20. Some abstracts reach 30, and at that level are hard reading, even for the professional peers of their authors. The following excerpt from a Survey Professional Paper has a fog index of about 14 and is fairly easy going. Polysyllables are italicized.

The Phosphoria Formation *accumulated* in a large shelving *embayment* bordered by lands of low relief that *contributed* little *detritus* to the sea. Cold, phosphate-rich waters upwelled into this basin from the ocean *reservoir* to the south or southwest. *Phosphorite* was deposited from these *ascending* waters, *probably* in depths of 1,000 to 200 meters, as their pH increased along with increase in *temperature* and decrease in partial pressure of CO_2. *Carbonates* were *precipitated* from these waters when they reached more shallow depths, at a somewhat higher pH. The phosphate-rich water nurtured a *luxuriant* growth of *phytoplankton*, as well as

higher forms of plant and animal life, some remains of which were *concentrated* with fine-grained *materials* in deeper waters away from shore. Part of the phosphate and probably some of the fine-grained silica in the *formation* were *concentrated* by these *organisms*.

Even if you are writing for a scholarly journal you will do well to pay attention to sentence lengths and polysyllables. If your intended readership is nontechnical (a "popular report"), try to judge its reading level in terms of table 6.

Coherence in the Report

Topic Sentences

Coherence is essential at every level of a report, from the sentence to the paragraph, to the chapter, to the entirety. If the message is to reach the reader, ideas must follow a logical order that excludes extraneous thoughts. Transitional devices such as topic sentences help supply coherence by linking sentences and paragraphs together. These in turn are the building blocks of a coherent report.

A unified paragraph contains a clearly defined topic sentence and the necessary supporting detail. (Note that the previous sentence is a topic sentence; it clues in the reader as to what will follow and at the same time puts a restriction on the subject matter.) If a topic sentence is too general, the paragraph will lack direction. If it is too specific, the paragraph will lack room to develop. Too many paragraphs in Survey reports have no topic sentence at all; they just string out the facts with little apparent connection—they are just aggregates of marginally related sentences.

Most topic sentences are at the beginning of paragraphs, and that is where they belong, but some are placed at the end, where they serve either as summary statements or as transitions to the next paragraph. At the beginning a topic sentence should at least hint at what will follow, so the reader can anticipate the supporting details. This arrangement introduces the reader to the topic of each paragraph. A chapter may have a topic sentence also, or a topic paragraph. But if the paragraph starts out with specifics and ends with a summation—the deductive or who-done-it approach—the reader may fail to see the linkage or may have to regress and reread to see it.

Paragraph Organization

Besides having a topic sentence that defines the subject matter, each paragraph should be internally organized. Four major patterns are possible: (1) decreasing importance, (2) increasing importance, (3) time, and (4) place. A paragraph organized in terms of decreasing importance begins with the topic sentence, followed by a description of the evidence ranked from most to least significant. Conversely, the pattern of increasing importance builds the evidence to support the concluding topic sentence or summation.

Much geologic writing is organized by time or place, such as studies focused on geologic time and studies that are site specific. The content of a paragraph cannot always be organized so easily, but the writer should aim for a coherent structure and a logical order.

Paragraph Length

Authors should cultivate a feeling for paragraph length. Many paragraphs are too long, commonly because of weak topic sentences. Paragraphs should be logical units of thought and should not be broken simply because of length, but if a paragraph extends over more than one manuscript page, its stated subject should be critically reexamined; the reader may be better served by a forceful introductory paragraph (a topic paragraph) and several subsequent paragraphs developing specific aspects of the subject. Several short paragraphs are easier to assimilate than a long one. Besides, readers need occasional breaks to collect their thoughts and catch their breath. The readers' comprehension is enhanced even more by a careful interweaving of long and short paragraphs joined by appropriate transitional devices to provide coherence.

One-sentence paragraphs are suspect. If such a sentence-paragraph logically follows the paragraph that precedes it, you should see if it is more effective as part of that paragraph, or as part of the one that follows. One-sentence paragraphs are used occasionally to emphasize an idea or to serve as a transition between two otherwise unrelated paragraphs, and in rare instances such emphasis is justified, but before using a one-sentence paragraph as a transition, you should rethink the organizational structure.

Transitions and Coherence

Coherence is improved through the use of (1) transitional devices, (2) parallel constructions, and (3) key words. Transitions are designed to link ideas through the careful use of words, phrases, and sentences. Some overzealous reviewers eliminate what they perceive as extraneous verbiage by deleting transitions that are needed for coherence. Transitions cannot solve every problem of coherence, but they can help the writer make logical connections between ideas whose relation is not otherwise apparent to the reader. Some useful transitional words are listed at the top of the next page.

Addition: additionally, again, also, and, besides, equally important, finally, further, furthermore, in addition, last, moreover, next.
Comparison: also, in comparison, in like manner, likewise, similarly, too.
Concession: admittedly, although, granted, of course, to be sure, true, given that.
Conclusion: finally, in any event, in conclusion, to conclude.
Contrast: but, however, nevertheless, notwithstanding, on the contrary, on the other hand, still, whereas, yet.
Emphasis: as has been stated, as I have said, chiefly, indeed, in fact, in other words, in particular, most important, note that.
Example: as an illustration, for example, for instance, specifically, such as, that is.
Place: adjacent, behind, beyond, by, elsewhere, here, in the background, near, on the other side, opposite, there.
Result: accordingly, as a result, consequently, hence, therefore, thus, so.
Summary: in brief, in other words, in short, in summary, to sum up.
Time: afterward, at length, after [some period of time], before, during, immediately, in the meantime, later, meanwhile, soon, until.

Parallel constructions (p. 144) add coherence within a sentence or a paragraph by tightly relating coordinate ideas. Related words, phrases, and clauses need similar vocabulary, structure, and logic.

Key words repeated from one sentence to the next or from the end of one paragraph to the beginning of the next help connect related ideas. Synonyms do not serve that purpose, and if they are used as word substitutes, take care to avoid derailing the reader; make sure their connection is clear. The personal pronouns *I*, *you*, *he*, *she*, *it*, *we*, and *they* are effective substitutes for nouns, but they rarely function well as key words. The demonstrative adjectives *this*, *that*, *these*, and *those* can point back to particular nouns if their antecedents are unmistakable.

Coined Verbs

Most verbs in *-ize* are inelegant. Sir Alan Herbert has compared them to lavatory fittings, useful in their proper place but not to be multiplied beyond what is necessary for practical purposes.

H. W. Fowler

English is a dynamic language, and change has always been inherent in its growth. Not all change, however, improves the language. Some writers, especially in the media, the military, and the bureaucracy, introduce new word forms whether they are needed or not, often out of sloth, and the resulting proliferation seldom enhances either the richness of the language or its clarity. "Destruct" is a pitiable example from the space program. "Input" and "access," both as verbs, are two of many contributions from computer language where perhaps they should remain. So, also the verb "keyboard." Many long-standing nouns used in Survey reports are unacceptable as verbs, and although some may gain acceptance through long use, the Survey is not an appropriate agent for their nurture. Many will vanish unassisted from the idiom. Some such verbs are formed by affixing "ize" to the noun or adjective—words such as "prioritize" (ugh). Thousands of standard words (crystallize, itemize, digitize), as well as some abominations (finalize), have thus entered the language. "Finalize" became fashionable in the 1960's, over spirited opposition from wordsmiths. Survey authors can hardly judge what current coinages deserve to survive. Rather, authors should heed the advice of "The American Heritage Dictionary" (Second College Edition), regarding the suffix "-ize": "New coinages of this sort should be used with great caution until they have passed the tests of utility, permanence, and acceptance by good writers."

Recently coined words ending in "ize" are not alone among offensive verbs; new creations appear often in the earth sciences. "Young," for example, is a good adjective but an unacceptable verb, and to write that something "youngs to the east" will offend most readers. One author described rocks that "had been boudinaged" during regional deformation. Similarly, "contact metamorphism" is a recognized geologic process, but its acceptability as a noun does not justify its use as a verb: "The magma contact-metamorphosed the igneous rock." The favorite abomination of one Survey editor is "complexify" but, except right here, it is not likely to see print in a Survey publication.

Simply using nouns as verbs can obfuscate clarity also. For example, the headline "CHINA PROTESTS FUEL REFORM DEBATE" has two possible unrelated meanings. The unsuspecting reader is sure to take "PROTESTS" to be the verb and read the sentence accordingly, but the intended verb is "FUEL," which is likely to be taken as a noun. "PROTESTS," meant to be a plural noun, is the intended subject, whereas the apparent subject, "CHINA," is meant to be a proper adjective modifying the noun "PROTESTS." Now reread the sentence and catch its real meaning.

Authors should also avoid usages that distort the true meanings of words and that thereby rob the

language of its clarity and acuity. Students of plate tectonics have seized "collide" and "collision" to signify processes that bear little relationship to the true meaning of the words. We, alas, are probably stuck with continental "collisions," but such portrayals can only cause confusion in the minds of laymen. Disneyesque depictions aside, truer if less colorful meanings would be conveyed by "join," "merge," "converge," "contact," "abut," "press against," "occlude," or "override."

Abstract Nouns in the Subject of the Sentence

Abstract nouns are less offensive than newly coined "ize" verbs, but they are more pervasive, and their widespread use is among the commonest and most crippling stylistic faults in technical writing. In particular, turning active verbs into abstract nouns ending in "tion" puts the wrong word into the subject nominative and compels the writer to find a substitute verb—nearly always a weak one. Survey grammarian Frank Calkins used to admonish young writers to "shun tion."

As a writer you should consider whether an abstract or a concrete noun makes a better subject and should decide which choice strengthens the verb. In the following examples, the writers have converted strong, active verbs into abstract nouns for their subjects and have been forced to substitute weak, inappropriate verbs for their predicates, such as "occurred," "accomplished," "transpired," or "performed." Delete the words in italic and add those in brackets:

The *mapping of the* area was *accomplished* [mapped] by Smith and Jones.

The principal production [Most of the ore] was mined from the Nevada property. (You cannot mine "production.")

The *exploration of the* region was *carried out* [explored] by Smith.

During this epoch *aggradation of* the lowlands may have *transpired* [been aggraded].

Thus *a sudden inundation of* the desert would [suddenly] be *accomplished* [inundated].

Capitalization of the initial letters of formal geologic names [have been capitalized] *was adopted* by the Survey *in* [since] 1961.

Modifications may be made to existing formal names [may be modified] if evidence is *presented in a* published *report.*

The *movement of the* ore solutions here must have *been* [moved] very slow[ly].

The *formation of the* ore deposits *occurred* [were formed] just after the igneous intrusions. (Or better yet: The ore was deposited just after the igneous rocks were intruded.)

Confirmation of these reports cannot be *obtained* [confirmed].

The *selection, equipment, and maintenance of* stream-gaging stations are *performed* [selected, equipped, and maintained] according to standard methods.

The principal use of sheet mica is *in the manufacture of* [used principally in making] electrical apparatus.

Examination of the prospect could not be *made* [examined].

Slippage may *occur in association* [be associated] with volcanic activity. (Better yet: Slippage may result from volcanic activity.)

Because many mid-Paleozoic complexes are undeformed, *it has been possible to obtain a reasonably good understanding of* their tectonic setting [is reasonably well understood.]

Computation of the fractal dimension would be *done* [computed] in the Branch of Geophysics.

Internal deformation of the Moine rocks *was accomplished* [were deformed] primarily by northwest-directed ductile thrusting.

Other lines of evidence for the weakness of fracture zones come from geologic studies. (Change to: Geologic studies yield other evidence for * * *.)

In the sentence "Barite and intense silicification usually always accompany the ore" the compound subject links together a mineral, which perhaps accompanied the ore, and a process, which ended long ago. Change "intense silicification" to "intensely silicified rock." Whatever idea the writer had in mind by "usually always," the expression is objectionable, and the conditions would be better described by deleting "always."

Forgetting Your Subject

Some writers seem to forget their subject before they finish the sentence.

Its flow is large and is reported to be excellent for drinking. (The flow [of the spring] is so many gallons a minute; it is the water, not the flow, that is excellent.)

The "rimrock," which surrounds Billings, Park City, and the intermediate area, is the popular designation for this scarp. (A "designation" cannot surround an area. There is more than one way to correct this sentence; it might be rewritten "This scarp, which surrounds * * *, is popularly called the rimrock.")

The average thickness of the shale partings is about 1 millimeter but is extremely variable. (How could an average be variable? Write "The thickness * * * averages about 1 millimeter but is extremely variable.")

Muscovite is possibly unstable in the presence of hornblende and occurs as biotite, plagioclase, and quartz. (Wow!)

Although the rock has been greatly altered by weathering, the decomposition is believed [to be] rather superficial and is regarded as affording entirely adequate foundations. (Decomposition seems hardly an "adequate" foundation for a dam.)

The principal granite district of this group of States is at Salida, Chaffee County, and is sold for monumental stone. (The granite, not the district, is sold.)

The French deposits have been largely Government owned and have been sold through the German-French cartel. (It is the potash mined from the deposits that has been sold, not the deposits.)

Cattle, poisoned by selenium-rich foliage, prompted scientists of the Department of Agriculture to investigate * * *.

Modified Subject Misapplied

A phrase that qualifies or relates to the subject applies until a new subject is introduced, but in many sentences such a phrase is inadvertently applied to an unrelated part of the sentence.

For full development the tree seems to require considerable water and probably deserves its reputation as an indicator of underground water. (The phrase "for full development" does not apply to the second clause and should be transposed after "considerable water.")

The individual grains in the coarser limestone are as much as a millimeter in diameter and average 0.02 millimeter in the finer grained beds. (Write "The individual grains * * * are as much as a millimeter in diameter, but those in the finer grained beds average 0.02 millimeter.")

Its generally dark color is somewhat somber for building stone but makes a very substantial structure. (The dark color does not affect its durability. Put a comma after "building stone" and insert "the rock" after "but.")

During the summer a pool of water forms on the ice and gradually freezes again during the winter. (Change to read: A pool of water forms on the ice during the summer and gradually refreezes during the winter.)

No lead and manganese were reported in these analyses and were evidently negligible. (One can assume that "no lead and manganese" would be negligible. Write "Lead and manganese were not reported in these analyses.")

Very little sulfide is present in the main ore shoot, but it is abundant along the margins. (It is sulfide, not "very little sulfide," that is abundant. Write "Sulfide is scarce in the main ore shoot but is abundant along the margins.")

Undesirable Change in Construction

Many compound or complex sentences switch ineptly from the active voice to the passive in midsentence. For clarity, continuity, and parallelism the voices of verbs should be the same:

Surface water percolates downward until [it reaches] the zone of saturation *is reached.*

These vugs carry no gold and [do not affect] the tenor of the vein *has not been affected by them.*

The workings were closed and *examination of them* could not be *made* [examined].

The rocks show both bedding and cleavage, but *the amount of* [not much] metamorphism *has not gone far.* (Also, delete the comma.)

Undesirable Alliteration

Alliteration, the repetition of initial word sounds, may have a positive impact on the reader but is more likely to draw attention from the substance of the message to the style. A few egregious examples:

Larger and longer lived lakes
Famous fossil-fish formation
Crustal movements that crushed and crumpled
Further fissuring, faulting, and fracturing
Well-waterworn polygonous pebbles
Low-lying lands that lie
Shattered and scattered through the shale
Saturated silts sliding slowly seaward
Somewhat similar series of sediments

Loose Versus Tight Language

Loose language is appropriate in some contexts, but the greater precision of tight wording is better for technical reports. A few examples:

Loose	Tight
a number of	several, a few
accountable for	the cause of
essentially	principally, mostly
evidenced	showed, indicated
grows	becomes
improve	increase
in case of	if
in the vicinity of, in the neighborhood of	about, near, nearly
majority	most
open, close	begin, end
over, under	more than, less than
provided, provided that	if
ranges up to	is as much as
various	many, several

Meaningless Redundancies

Commonly heard redundancies are sometimes used unthinkingly, as follows:

actual measurement	join together
advance planning	metric unit of measure
age dating	low-lying depression
bisect into two parts	originally of * * * origin
completely absent	preliminary preparations
completely surrounded	refer back
down dropped	relative proportion
downward direction	repeated repetition
dropped down	Rio Grande River
erroneous misconception	rise up, sink down
feeling of euphoria	Sierra Nevada Mountains
first began	surrounded on all sides
first initiated	throughout the entire
green in color	underground cavern

Perhaps you can add more examples from your own list.

Prepositions in Idiomatic Expressions

Idiomatic expressions are word groupings that are unique to a language or culture. Some cannot be explained logically, but they are part of conventional usage. A few common prepositional idioms are listed below:

Compare: x **with** y (similar things), x **to** y (different things)
Conform: **to** practice, **to** a design; conformable **to**, in conformity **with**
Contrast (verb): x **with** y
Contrast (noun): **between** x and y; x placed in contrast **with** y
Correspond: **to** (things), **with** (persons)
Differ: An object differs **from** another object, a person differs **with** something or someone ("I beg to differ with you.")
Different: **from** (not **than**)
Independent: **of** (not **from**)
Overlain: **by** (not **with**)

Foreign Words

Foreign words are unlikely to add anything to a scientific report that is not better expressed and understood in English. Many readers, perhaps most, cannot translate or define "viz," "i.e.," "e.g.," and "et al." "In place" is generally better than "in situ." "Etc." is meaningless in most constructions and is improper in the following examples:

> Deposits of this type occur in several mines—for example, the Telegraph, Commercial, [and] Old Jordan, *etc.*

> The solution contained mineralizers, such as fluorine, [and] boron, *etc.* (Delete the comma after "fluorine.")

> The glacial features that give variety to the surface, such as moraines, kames, [and] eskers, *etc.*, are described.

On the other hand, a few foreign words that have no appropriate English equivalents have been adopted as technical terms—words such as arête, bajada, boudinage, couloir, felsenmeer, inselberg, lahar, moulin, and roche moutonnée.

Vogue Words and Trite Phrases

Vogue expressions intended to enliven reports or add sophistication may have the opposite effect. Through overuse they lose effectiveness; even worse, they may foster subconscious antagonisms, or by leaping from the page, may distract the reader's attention from the thoughts that the author hoped to convey. Though some vogue words may endure, the writer of scientific reports is hardly the proper judge of idiomatic trends. Trite words and phrases, such as "timeframe," "viable," "point in time," "might well be," "window of opportunity," and "impact" (in some connotations as a verb), will pass out of use, and we can rejoice in their passing, but we must be on guard against new ones springing forth. "Model" has become a prevalent substitute for "conjecture" or "postulate"—the working hypothesis of times past is the working model of today. "Metastable," from

physical chemistry, has been adopted by geomorphologists. "Powerful tool" had a spate of fashion among earth scientists in the 1980's. If you suspect that a word is trite, it surely is.

Stilted and Showy Language

Some authors seem to believe that writing is enhanced by obscure phrasing and that the best means to that end is stilted and showy language, what George Otis Smith called "the wordy sins of scientists." These authors never "go" anywhere; they invariably "proceed." Rather than "start" new projects, they "initiate" them. They "encounter" fossils, "inaugurate" new programs, and "conduct" field trips. The engineer who remarked that "Repairs are a very manually intensive effort," meant that they must be done by hand. The mapper who wrote that "Contact relationships are poorly constrained due to talus-block slopes" meant that the contacts are covered with talus.

Bernard H. Lane, in his revised and enlarged STA 4, noted that authors only occasionally recognize these faults in their own writing. (Faults are easier to see in the writing of others.) One writer changed "hydropneumatothermal contact action" to "hot solutions" in his own manuscript and thereby deprived his reviewer of the vicarious pleasure.

Pedantic phrases in some technical reports seem designed to flaunt learning or to hide shortcomings by overwhelming the reader. Other sincere but misguided attempts at precision are likely to be seen as priggish distractions. If a choice can be made between a polysyllabic Latin derivative and a simple Anglo-Saxon word, between a long word and a short one, the latter is almost always more effective. Use the big word if it is precisely and uniquely right, but try to save your reader's train of thought and a needless trip to the dictionary. Use "palynomorphs" if you must, but if you are talking about pollen grains, say "pollen grains." In the words of one sage, eschew obfuscation. Economy in words serves two purposes: It enhances readability, and it cuts printing costs. If a word must be repeated, a short word diverts the reader's attention less than a long one.

Here are a few stilted words, with suggested alternatives. As George Otis Smith once said, "It takes years for some geologists to break the fetters of this scholastic habit."

abstruse phrases	vague words
allochthon	upper plate
appellation	name
approximate	about
arenaceous	sandy
argillaceous	shaly
autochthon	lower plate
conduct	lead, do
congeliturbation	frost action
display	show
employ	use
exhibit	show
ignimbrite	welded tuff
inaugurate, initiate	start, begin
interdigitate	interfinger
limited	small, few
numerous	many
palynomorph	pollen grain
pelite	clay, shale
peruse	read
plication	fold
psammite	sandstone
psephite	conglomerate
riparian border	riverbank
secure, obtain	get
terrestrial gastropod	land snail
transect	cut across
verge	bend, turn, move

Care With Metaphors and Similes

Samuel Goldwyn, late master of the neatly turned phrase, once said that anyone who makes atom bombs is fooling with dynamite. He also said that people who visit psychiatrists should have their heads examined. Metaphors and similes used sparingly may add meaning and color to some scientific reports, but they must be used with care: "carpeted with grass," yes, "carpeted with boulders," no; and like fine old scotch, they should not be mixed.

Pathetic Fallacy

Ascribing human traits or feelings to inanimate objects—what Ruskin called the "pathetic fallacy"—is inappropriate in scientific reports. Mountains neither enjoy uplift nor suffer degradation, tides are never restless, and skies are never angry, at least not in reports of the USGS.

Sexist Pronouns

Variations of the pronoun "he" are unacceptable to many people when referred collectively to both masculine and feminine genders and should be avoided in that context in Survey reports. The noun "geologist," for example, has no implied gender—it may be either masculine or feminine—but "he" is inherently masculine, despite the remonstrations of some grammarians. "He" can be avoided gracefully by careful grammatical construction. Contrived, tricky artifices to cover both genders should be avoided: He/she, she or he, s/he, his/hers, his or hers, him/her and him-or-her sometimes appear in technical reports, but they tend to distract or annoy the reader, especially if used repeatedly. Moreover, by making curt little bows to feminism, they are condescendingly sexist (Johnson, 1983).

Sexist pronouns can be avoided in various ways. In the following examples the bracketed words should be added; the italicized words or letters should be deleted.

1. Use plurals instead of singulars:

   Before beginning to write *the* author[s] should familiarize *himself* [themselves] with the literature.

2. Change the person of the subject and pronoun from third person (he) to second (you); second person may be inappropriate in technical reports, but it often is useful in nontechnical writing:

   Before beginning to write *the author* [you] should familiarize *himself* [yourself] with the literature.

3. Use the imperative mood; the imperative serves the same purpose as second person but more forcefully:

   The author should [Be] familiar*ize himself* with the literature before beginning to write.

4. Change the voice of the verb from active to passive. The passive voice should not be overdone, but its occasional use can have a positive effect on the reader:

Change this	**To this**
An author should not think that because he has studied thin sections of all the rocks of a district it is necessary to publish exhaustive descriptions of them.	An author should not think that because all the rocks of a district have been studied in thin section, exhaustive descriptions must be published.

   The recast version, by switching to the passive voice, has fewer words and the added virtue of parallel construction. It does not specify, however, that the author studied the sections. Some advantages and disadvantages of the passive voice are discussed on page 142.

5. Insert a participle:

   The author may follow the same procedure before *he turns* [turning] the report in for review.

6. Simply omit the offending words where the meaning is clear without them and recast the sentence, substituting applicable articles for pronouns and deleting other unneeded words:

   In this section *are* outlined[s] *the* successive steps *that an author will* normally follow[ed] in planning and writing *his* [a] report, beginning when an investigation is authorized and ending with *his* final review. [Included are] suggestions *are also offered* that *he* may *find* [be] useful at different stages.

   Procedure 6 also has the merit of yielding tighter, crisper writing (34 words instead of 44).

Ellipsis

Ellipsis, the omission of words where the reader is expected to understand the meaning without them, can tighten and freshen style or obscure the meaning. Use ellipsis to avoid distractive repetitions, but be careful to avoid ambiguities or illiteracies.

Many good writers use ellipsis instinctively. In "Much Ado About Nothing," "The fashion wears out more apparel than the man," the Bard's meaning is perfectly clear without repeating "wears out" or adding "does," but in the following sentence, "Fred was more interested in the fossils than his wife [was]," the bracketed verb is needed for clarity.

Conversely, studied avoidance of ellipsis is fairly common in Survey manuscripts, probably in the mistaken belief that clarity is thereby gained. In the sentence, "Graphs present some kinds of data more concisely than *does* any other format," the word "does" adds little more than awkwardness to the sentence. "Does" would be less awkward if it followed "format," but its presence there is not needed for clarity.