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Grammar, Punctuation, and Capitalization

A Handbook for Technical Writers and Editors

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Grammar, Punctuation, and Capitalization

A Handbook for Technical Writers and Editors

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Preface

The four chapters making up this reference publication were originally written as part of an ongoing effort to write a style manual for the Technical Editing Branch of the NASA Langley Research Center. These chapters were written for technical publishing professionals (primarily technical editors) at Langley. At the urging of my branch head, I am making this part of the style manual available to the technical publishing community.

This publication is directed toward professional writers, editors, and proofreaders. Those whose profession lies in other areas (for example, research or management), but who have occasion to write or review others' writing will also find this information useful. By carefully studying the examples and revisions to these examples, you can discern most of the techniques in my editing "bag of tricks"; I hope that you editors will find these of particular interest.

Being a technical editor, I drew nearly all the examples from the documents written by Langley's research staff. I admit that these examples are highly technical and therefore harder to understand, but technical editors and other technical publishing professionals must understand grammar, punctuation, and capitalization in the context in which they work.

In writing these chapters, I came to a realization that has slowly been dawning on me during my 15 years as a technical editor: authorities differ on many rules of grammar, punctuation, and capitalization; these rules are constantly changing (as is our whole language); and these rules (when they can be definitely ascertained) sometimes should be broken! Thus much of writing and editing is a matter of style, or preference. Some of the information in this publication, particularly the chapter on capitalization, is a matter of style. Langley's editorial preferences are being presented when you see the words *we prefer*, "we" being Langley's editorial staff. I do not intend to imply that Langley's style is preferred over any other; however, if you do not have a preferred style, Langley's editorial tradition is a long and respected one.

I wish to acknowledge that editorial tradition and the people who established it and trained me in it. I am also grateful to Alberta L. Cox, NASA Ames Research Center, and to Mary Fran Buehler, Jet Propulsion Laboratory, for reviewing this document.

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Chapter 1. Grammar

1.1. Grammar and Effective Writing

All writing begins with ideas that relate to one another. An author chooses words that express the ideas and chooses an arrangement of the words (syntax) that expresses the relationships between the ideas. Given this arrangement of words into phrases, clauses, and sentences, the author obeys grammar and punctuation rules to form a series of sentences that will impart the ideas.

English rules of grammar originated in antiquity, but over centuries have evolved according to usage and are still changing today. Thus, grammar rules may change and may be inconsistent, but usually have a functional basis. This functional attitude toward grammar, and punctuation, is described in *Effective Revenue Writing 2* (Linton 1962). A rule of grammar or punctuation with a functional basis will not prevent effective statement of ideas, nor will following all the rules ensure effective writing.

Effective writing requires good syntax, that is, an effective arrangement of sentence elements. Obviously, an editor is responsible for ensuring that a consistent and correct set of grammar and punctuation rules have been applied to a report (a process often called copy editing). However, language and substantive edits, as defined by Van Buren and Buehler (1980), involve revision of sometimes perfectly grammatical sentences to improve effectiveness of sentence structure. This chapter discusses grammar, and the next chapter concerns sentence structure with emphasis on methods of revision.

According to *Webster's Ninth New Collegiate Dictionary, grammar* means "the study of the classes of words, their inflections [changes in form to distinguish case, gender, tense, etc.], and functions in a sentence." An abundance of good, detailed grammar, writing, and usage books are available. This chapter is not meant to be a definitive grammar reference. It is intended to address grammatical problems often encountered in technical documents and to indicate preference when grammar authorities do not agree. Please refer to the books cited in the References section and others to complement and clarify the discussions that follow.

1.2. Nouns

Nouns change form to indicate case and number. The number of a noun is usually not a problem (though the number of pronouns and verbs corresponding to the noun may be). The three possible cases are nominative, objective, and possessive. In English, nominative and objective case nouns have the same form.

1.2.1. Possessive Case

At Langley, the preferred rules for forming possessives are as follows (G.P.O. 1984; and Rowland 1962):

- Form the possessive of a singular or plural noun not ending in *s* by adding *'s*.
- Form the possessive of a singular or plural noun ending in *s* by adding an apostrophe only:

Singular	Plural
man's	men's
horse's	horses'
Jones'	Joneses'

- Form the possessive of a compound noun by adding *'s* to the end of the compound:

  sister-in-law's home
  John Doe, Jr.'s report
  patent counsel's decision

- Indicate joint possession by adding *'s* to the last element of a series; indicate individual possession by adding *'s* to each element:

  Wayne and Tom's office (one office)
  editor's, proofreader's, and typist's tasks

Some authorities (for example, Skillin et al. 1974; and Bernstein 1981) partially disagree with the second rule above. They state that the possessive of a singular *proper* noun is formed by adding *'s* even when the noun ends in *s* (for example, Jones's); however, a triple sibilant is always avoided (for example, Jesus').

1.2.2. Possessive of Inanimate Objects

In the past, the possessive case (*'s*) was not acceptable for inanimate nouns. Instead the preposition *of* was preferred, that is, *strength of the laminate* rather than *laminate's strength.*

Exceptions to this rule were inanimate words representing a collection of animate beings (for example, company's profits, university's curriculum) and words expressing measure or time (for example, 2 hours' work). Current practice is to dispense with both the *'s* and the *of* (Skillin et al. 1974):

company profits
university curriculum
laminate strength
2 hours work

In fact, the use of *'s* on an inanimate object is no longer taboo, particularly if the object has some lifelike qualities (Bernstein 1981):

computer program's name
Earth's rotation

Whether an *'s* can properly be added to an inanimate noun seems to be a matter of idiom. We would not say, for example,

systems' analyst
table's top

1.3. Pronouns

All pronouns must have an antecedent (the noun they replace) with which they agree in number, gender, and person. In addition, some pronouns change form to indicate nominative, objective, and possessive case (for example, *he, him, his*).

- An apostrophe is never used to form possessive case pronouns.

1.3.1. Antecedents

Most grammatical errors involving pronouns result from the lack of a clear antecedent. The following sentences suffer from this problem:

> He foresaw aircraft applications and thus emphasized rectilinear motions. *This* causes complicated integral equations for other types of motion.
>
> The boundary condition becomes a source term, *which* permits use of the Green function.
>
> Required surface pressures are obtained in several ways, for example, from blade element theory or experimental measurements. Whatever the technique, *it* is usually available.

In the first two sentences the pronouns *this* and *which* refer to the idea of the previous sentence or clause and do not have a noun antecedent. The *Writer's Guide and Index to English* (Ebbitt and Ebbitt 1978) states that this "broad reference" usage of pronouns is acceptable in "general" writing, but should be avoided in "formal" writing. The danger of broad reference is that the antecedent (whether a noun or a clause) may not be clear. In the second sentence above, *which* appears to refer to *term*. The following revisions would be preferable:

> He foresaw aircraft applications and thus emphasized rectilinear motion. This emphasis causes complicated integral equations for other types of motion.
>
> Because the boundary condition becomes a source term, the Green function can be used.

In the third sentence, *it* is much too distant from its antecedent, *pressures*. Because of this distance, the pronoun does not agree in number with its antecedent.

Bernstein (1981) discusses ambiguous or nonexistent antecedents under "Pronouns" and under particular words, for example, "Each" and "None."

- Grammatical errors involving pronoun antecedents can be avoided very simply: check every pronoun for a clear, appropriate antecedent and then ensure agreement between antecedent and pronoun.

1.3.2. Personal Pronouns

First person pronouns

Tichy and Fourdrinier (1988) attribute the pervasiveness of passive voice in technical writing to evasion of first person pronouns (*I, we*). In the early 1900's, first person pronouns were banished from technical writing to obtain objectivity; however, Tichy and Fourdrinier effectively demonstrate that objectivity is not always attained. Writing authorities no longer forbid, and sometimes encourage, the use of first person pronouns (CBE 1978; AIP 1978; Houp and Pearsall 1984; and Mills and Walter 1978). Thus, *we* in technical documents cannot be condemned, particularly when the opinion of the author (and a research staff) is being expressed:

> We believe that this effect is due to nozzle aspect ratio.

This use of *we*, meaning "I and others," should be distinguished from the editorial *we*, meaning "you readers and I" (Ebbitt and Ebbitt 1982). In technical documents the editorial *we* is often used in mathematical presentations:

> Now we define a recursive relation for the $(k+1)$th iteration:
>
> $$\mathbf{P}_{k+1} = (\mathbf{X}_k^T \mathbf{X}_k)^{-1}$$

Tichy and Fourdrinier (1988) recommend that the antecedent of *we* always be made clear. They also offer advice on when to use first person pronouns and when not to.

Gender

Third person singular pronouns change form to indicate gender (*he, she*). When the pronoun could refer to either sex or when the antecedent's sex is unknown, the masculine pronoun is grammatical. However, in recent years, objections have been raised to this grammatical rule.

- It is preferred practice to avoid the masculine pronoun when the antecedent may be feminine. Often the antecedent can be made plural:

Poor	An editor must have guidelines on which to base *his* revisions.
Better	Editors must have guidelines on which to base their revisions.

Or the wording of the sentence can be changed:

Poor	The listener may not fully perceive the sound because *his* ear has a critical summation time of 1 sec.
Better	The listener may not fully perceive the sound because the human ear has a critical summation time of 1 sec.

1.3.3. Relative Pronouns

Relative pronouns function not only as pronouns but also as conjunctions. The relative pronoun replaces a noun in a dependent clause and connects the clause to the rest of the sentence.

Antecedents of relative pronouns

- *Who* and *whom* refer to persons.
- *Which* refers to things.
- *That* refers to things and in rare instances may refer to persons.
- *Whose,* the only possessive case relative pronoun, may refer to either persons or things according to Bernstein (1981). Other grammar authorities disagree and condemn the use of *whose* to refer to inanimate nouns. We prefer *whose* when *of which* would be awkward:

Awkward	A low-cost process has been developed for making alumina, the limited availability and cost of which have previously inhibited its widespread use.
Better	A low-cost process has been developed for making alumina, whose limited availability and cost have previously inhibited its widespread use.
Awkward	The attenuation is accompanied by an echo the amplitude of which is above the background level and the position of which is related to the depth of the region.
Better	The attenuation is accompanied by an echo whose amplitude is above the background level and whose position is related to the depth of the region.

Which *versus* that

- *Which* is always used in a nonrestrictive relative clause (one that could be omitted without changing the meaning of the basic sentence):

> The most common examples of panel methods are the aerodynamic codes of Hess and Smith (ref. 26), which were originally developed for nonlifting surfaces.

Which may also be used in a restrictive relative clause. Note that proper punctuation of restrictive and nonrestrictive clauses is vital: commas enclose nonrestrictive clauses, but never enclose restrictive clauses (see section 3.5.2).

- *That* is preferred for restrictive (or defining) relative clauses (Bernstein 1981):

  > The most common examples of panel methods are the aerodynamic codes that Hess and Smith (ref. 26) designed for nonlifting bodies.

There are three exceptions to the use of *that* to introduce a restrictive clause:

- *Which* must be used after a preposition (Bernstein 1981):

  > The shading in figure 2 indicates elements in which fibers have failed.

- *Which* is used after the demonstrative *that* (Bernstein 1981):

  > The most commonly used aerodynamic code is that which Hess and Smith (ref. 26) designed for nonlifting bodies.

- *Which* sounds more natural when a clause or phrase intervenes between the relative pronoun and its antecedent (Fowler 1944):

  > Finite bodies can undergo motions (such as spinning) which complicate the equations.

Omission of that

That can sometimes be omitted from restrictive relative clauses, but this omission is not recommended:

Correct	The model they analyzed is the most realistic one studied.
Better	The model that they analyzed is the most realistic one studied.

Who *versus* whom

Who (and its indefinite derivative *whoever*) is the only relative pronoun that changes form to indicate case (*who, whom, whose*). When a relative clause is inverted, we have difficulty determining whether the pronoun is in nominative case (*who*) or in objective case (*whom*). The easiest way to resolve such questions is to change the relative clause to an independent clause by substituting a third person personal pronoun for the relative pronoun. For example, in the questionable sentence

> Information derived from this contract may be transmitted to those *who the Defense Department has cleared to receive classified information.*

change the relative clause to an independent clause:

> The Defense Department has cleared *them* to receive classified information.

The sentence requires a third person pronoun in objective case (them), so the relative pronoun must also be in objective case (...those whom the Defense ...).

1.3.4. Demonstrative Pronouns

Demonstrative pronouns refer to something present or near (*this*, *these*) or to something more remote (*that*, *those*). Technical writing tends to exhibit two types of problems involving demonstrative pronouns: broad reference (see section 2.2.1) and incomplete comparison (see section 2.5.2).

Broad reference

The demonstrative *this* is often used to refer to the idea expressed in the previous sentence, a practice to be avoided in formal writing (Ebbitt and Ebbitt 1982). For example,

> The entire noise prediction methodology for moving bodies becomes autonomous. This means that improved models can be incorporated simultaneously in pressure and noise calculations.
>
> Most loads could be reduced 0.8 percent if voltage was more closely regulated. Nonessential loads such as payloads could take advantage of this, but essential loads could not.

This type of construction is sometimes vague and usually unnecessary. Often the demonstrative pronoun can be deleted:

> The entire noise prediction methodology for moving bodies becomes autonomous. Thus, improved models can be incorporated simultaneously in pressure and noise calculations.

Or the antecedent can be clarified:

> Most loads could be reduced 0.8 percent if voltage was more closely regulated. Nonessential loads such as payloads could take advantage of voltage regulation, but essential loads could not.

Incomplete comparison

Demonstrative pronouns can often be used to complete vague comparisons:

Poor	The errors in this prediction are greater than in table III.
Better	The errors in this prediction are greater than those in table III.

But make sure that the antecedent and meaning are clear:

Unclear	West's results were in better agreement with ours than those of Long et al.
Either	West's results were in better agreement with ours than were those of Long et al.
Or	West's results were in better agreement with ours than with those of Long et al.

See section 2.5 for further discussion of comparisons.

1.4. Verbs

Verbs, the only words that can express action, change form to indicate person, tense, mood, voice, and number.

1.4.1. Tense

Verbs change form to indicate tense, or time that an action or state of being takes place. English has six tenses: present, present perfect, past, past perfect, future, and future perfect. Each of the six tenses has a progressive form indicating a continuing action. (See Text 4 of *Effective Revenue Writing 1,* IRS 1962.) Writing authorities do not specify exactly which tenses should be used in a technical document, but they universally agree that shifts in tense should occur only when the time of the action changes. In other words, the point of view of a report with respect to tense must be consistent.

The relationship between point of view and verb tense can be understood in terms of the four elements of discourse (Buehler 1970):

- Exposition (explains how and why things happen)
- Narration (tells what happened)
- Description (gives a mental image)
- Argumentation (convinces by reasoning)

The elements are quite often mixed. For example, in the Results and Discussion section, behavior of models or specimens (narration) might be discussed along with presentation of results in tables and figures (description) and explanation of results (exposition). Narration is usually in past tense while description and exposition are usually in present tense. Consistency in tense does not mean that all sentences are in the same tense; it means that sentences expressing the same point of view (or element of discourse) are in the same tense. Avoid shifting back and forth between points of view by grouping material with a consistent viewpoint; but when the viewpoint does shift, shift the tense accordingly.

Tenses of independent clauses of report

There are no firm rules concerning tense of various sections in a report. However, if an author is inconsistent in tense, the following guidelines might be helpful to the editor:

- The Summary is usually in past tense.
- Past research (for example, in references) is usually described in past tense.
- Permanent facilities are usually described in present tense.
- Experimental procedures and apparatus for a particular study are usually described in past tense.

- Behavior of models, specimens, etc., during the study is usually expressed in past tense, and results presented in the report's illustrative material are expressed in present tense:

  > Typical fracture profiles are shown in figure 21. These profiles show that fracture mode changed with cyclic exposure. The specimens failed ...
  >
  > As shown in figure 10, the autorotative rolling moment is a nonlinear function of roll rate, so that as spin rate increased, the propelling moments became equal.

- Explanation of why results occurred are in present tense:

  > The data failed to provide any reasonable estimates for C_{n_r}. This failure can be attributed to the small excitation of yawing velocity.

- The Concluding Section is usually in past tense except that conclusions (that is, deductions thought to be universally true independent of the specific conditions of the investigation) should be in present tense.
- The Abstract is usually in present tense.

Sequence of tenses

The logical time relation between the various verbs and verbals in a sentence is expressed by shifts in the tense of these verbs and verbals. Sequence of tenses is a very complicated subject, which is discussed in almost every grammar and writing book. Only the basic guidelines are given here; for a more complete understanding, refer to such reference books.

- When the principal verb is in a present or future tense, subordinate verbs may be in any tense:

  > The data indicate that lift increases with angle of attack up to $\alpha = 35°$.
  >
  > The data indicate that the specimen failed in a noncumulative mode.
  >
  > The data indicate that propellers will have a place as a propulsive device of the future.

- When the principal verb is in a past tense, the subordinate verb must be in a past tense unless the subordinate clause expresses a universal truth or an action that is still continuing:

  > The data indicated that lift increased with angle of attack up to $\alpha = 35°$.
  >
  > Previous studies had indicated that alumina is a suitable fiber for reinforcement.

- The present tense forms of verbals refer to action occurring at the same time as the main verb; the past tense or perfect tense forms of verbals refer

to action occurring before the action of the main verb. This principle is most easily seen for participles:

> Photographs *indicating* nearly laminar flow justified this assumption.
>
> Photographs *taken* during an earlier test justified this assumption.

1.4.2. Mood

The three moods in English are indicative, imperative, and subjunctive. Almost all verbs in technical documents are indicative. Imperative mood is sometimes used in instructions or descriptions of procedures. Subjunctive mood is rarely used and seems to be disappearing from English usage. However, there are two situations when the subjunctive should be used (Bernstein 1981):

- Subjunctive mood is used to indicate a command, suggestion, recommendation, or requirement:

> The console operator instructed that the preflight inspection *be repeated.*
>
> The committee recommends that this research *be continued.*

- Subjunctive mood is used to indicate a condition contrary to fact or highly improbable:

> If the integral *were* not singular, the question could be solved easily.
>
> Up to now, all discontinuous fiber-reinforced composites have low ductility. If their ductility *were improved,* they would be highly attractive materials for aircraft applications.

The subjunctive should be used only when the author wishes to imply strong doubt. Notice the subtle change in attitude when the subjunctive is not used in the above example:

> If their ductility *was improved,* they would be highly attractive materials for aircraft applications.

1.4.3. Voice

The voice of a verb indicates whether the subject is performing the action (active) or receiving the action (passive). Writing authorities overwhelmingly prefer active voice because it is direct, clear, and natural. Overuse of passive voice weakens style and obscures responsibility. This preference for active voice is not a condemnation of passive voice. Tichy and Fourdrinier (1988) list five situations when the passive voice is appropriate:

- When the actor is unimportant, not known, or not to be mentioned
- When the receiver of the action should be emphasized
- When the sentence is abrupt in active voice
- When variety is needed in an active voice passage

- When a weak imperative is needed (for example, "The figures should be corrected quickly")

  The first two items justify much of the passive voice in technical documents. See section 2.2.2 for a discussion of revising passive voice sentences to make them active voice.

1.4.4. Verb Number

A verb must agree in number with its subject. This is a simple and absolute rule. However, verb-noun disagreements (in number) are common grammatical errors, sometimes caused by words intervening between the subject and verb and sometimes caused by difficulty in determining the number of the subject.

- Some nouns have confusing singular or plural forms, for example,

aeronautics, sing.	equipment, sing.
apparatus, sing.	hardware, sing.
apparatuses, pl.	phenomena, pl.
data, pl.[1]	criteria, pl.

Consult the dictionary or a usage book when there is a question concerning the number of a particular noun.

Subjects joined by coordinate conjunctions

- Subjects joined by *and,* whether singular or plural, require a plural verb.
- Singular subjects joined by *or* or *nor* require a singular verb.
- When a singular subject and a plural subject are joined by *or* or *nor,* the verb agrees in number with the subject nearer to it.
- When subjects are joined by *and/or,* the number of the verb depends on the interpretation of *and/or.* Either a singular or plural verb can be justified. Bernstein (1981) considers *and/or* a "monstrosity" and recommends that it be avoided. Often either *and* or *or* alone is sufficient.

Subjects with intervening phrases

Phrases that intervene between the subject and verb do not affect the number of the verb; it always agrees with the subject:

> Damping ratio as well as frequency agrees with the experimental values.
>
> This error plus any other systematic errors appears in the output of the instrument.

[1] Authorities disagree on the number of the noun *data.* Bernstein (1981) takes the traditional view that it is a plural noun, but Tichy and Fourdrinier (1988), Ebbitt and Ebbitt (1982), and IRS (1962) consider it to be a collective noun either singular or plural depending on its meaning. We prefer that *data* be plural in Langley reports.

Collective subjects

A singular collective subject, which names a group of people or things, is treated as singular when the group is considered a unit or as plural when the members of the group are considered individually:

> Langley's research staff is well-known for its achievements in aeronautics.
>
> Langley's research staff do not all publish their results in report form.

- The number of such words as *most, all, some, half, part,* or *percent* is governed by the number of the noun in the phrase that follows, or that could follow, them:

> Most of the measurements contain this error.
>
> Most of the disagreement between the plots is attributed to this error.
>
> Six percent of the chord has laminar flow.
>
> Of the subjects tested, six percent rate all the noises acceptable.

- When a number is used with a plural noun to indicate a single measurement, a singular verb is required:

> Twenty liters of fuel has passed through the combustion system.

When such a subject is thought of as individual parts, a plural verb is appropriate:

> Twenty milliliters of water were added, one at a time, to the solution.

Compound clauses with auxiliary verbs omitted

In compound sentences with passive voice verbs, the auxiliary verbs are sometimes erroneously omitted:

> The wing plate was fabricated from nickel 201, its surface polished, and nickel rods welded to its edge.

- The omission of auxiliary verbs is grammatical unless the subjects change number (Rowland 1962). The above sentence should be

> The wing plate was fabricated from nickel 201, its surface was polished, and nickel rods were welded to its edge.

1.5. Adjectives

Since modifiers make up the bulk of most writing, their placement is very important to sentence structure.

In contrast to adverbs, adjectives are naturally placed near the noun or pronoun that they modify. Single-word adjectives and unit modifiers precede the noun and adjective phrases and clauses follow it. See section 2.2.3 for a discussion of placement of modifiers.

See section 2.5.1 for discussion of the degree (positive, comparative, and superlative) of adjectives.

1.5.1. Articles

***Indefinite articles* a *and* an**

- The indefinite article *a* precedes a word beginning with a sounded consonant, and *an* precedes a word beginning with a vowel sound.
- Whether *a* or *an* should precede an abbreviation or acronym depends not on its initial letter but on how the author expects it to be read (Bernstein 1981). For example, most people read "M.A." as letters rather than as "Masters of Arts," so "an M.A. degree" is appropriate. Likewise, we prefer "an NACA airfoil." However, "NASA" is not usually read as letters, so we prefer "a NASA airfoil."

Articles with coordinate adjectives

Whether or not articles are repeated before coordinate adjectives affects meaning (Rowland 1962).

- If coordinate adjectives each refer to different things or persons, articles are repeated when the modified noun is singular and are not repeated when the modified noun is plural:

Wrong	The transverse and shear strain is calculated for each specimen. (two strains)
Correct	The transverse and the shear strain is calculated for each specimen.
Or	The transverse and shear strains are calculated for each specimen.

- If coordinate adjectives refer to one thing or person, the article is not repeated:

Wrong	A more nonlinear and a lower stress-strain curve resulted from the test. (one curve)
Correct	A more nonlinear and lower stress-strain curve resulted from the test.

Omission of articles

There is a trend in modern writing, particularly journalism, to omit articles. Langley has traditionally preferred this "elliptical style" for symbol lists, figure captions, headings, and titles:

u	ratio of [the] wing mass to [the] mass of air in [a] truncated cylindrical cone enclosing [the] wing

Figure 1. Effect of leak area on pressures, heating rates, and temperatures in [the] cove and at [the] bulkhead.

Spectral Broadening by [a] Turbulent Shear Layer

Bernstein (1981) calls elliptical style a "disfigurement of the language." The author, or editor, may prefer to retain (or restore) articles in symbol lists, figure captions, headings, and titles.

1.5.2. Unit Modifiers

Technical writing abounds with unit modifiers, that is, combinations of words that modify another word:

> The *annular suspension and pointing* system for space experiments is described.
>
> These values identify the beginning of *shock wave boundary layer* interaction.
>
> *Separated flow wing heating rate* values increase sharply toward a constant value.

Authors and editors often have difficulty deciding when and how to hyphenate these modifiers. Bernstein (1981) considers hyphens a necessary evil to be used only to avoid ambiguity. Certainly, unit modifiers need not always be hyphenated and hyphenation does not always prevent ambiguity.

Before agonizing over hyphenation of these modifiers, consider changing them to prepositional phrases to clarify their meaning. Perhaps this change only a few times in a report is sufficient to clarify the unit modifier when it appears subsequently.

Surely the prepositional phrases in the following sentences are clearer than the hyphenated unit modifiers:

Unit modifier	The annular suspension-and-pointing system for space experiments is described.
Prep. phrase	The annular system for suspension and pointing of space experiments is described.
Unit modifier	These values identify the beginning of shock-wave–boundary-layer interaction.
Prep. phrase	These values identify the beginning of interaction between the shock wave and boundary layer.
Unit modifier	Separated-flow wing heating-rate values increase sharply toward a constant value.
Prep. phrase	Heating rates on the wing over which the flow is separated increase sharply toward a constant value.

Too many prepositional phrases can make the sentence awkward and hard to read, as in the last example. The following might be preferable:

> Separated-flow heating rates on the wing increase sharply toward a constant value.

Probably the best authority on hyphenation of unit modifiers is the G.P.O. (1984). Unfortunately we sometimes forget rule 6.16:

> Where meaning is clear and readability is not aided, it is not necessary to use a hyphen to form a temporary or made compound. Restraint

should be exercised in forming unnecessary combinations of words used in normal sequence.

- A unit modifier *should not* be hyphenated
  - When the unit modifier is a predicate adjective: The aircraft was *flight tested.*

    Note that an adjective that is hyphenated in the dictionary is hyphenated as a predicate adjective (IRS 1962): The method is *well-known.*
  - When the first element of the unit modifier is a comparative or superlative: *higher order* calculations
  - When the first element is an adverb ending in *ly: relatively accurate* prediction
  - When the unit modifier is a foreign phrase: *a priori* condition
  - When the unit modifier is a proper name: *North Carolina* coast (but *Anglo-American* plan)
  - When the unit modifier has a letter or number designation as its second element: *material 3* properties
  - When the unit modifier is enclosed in quotation marks: *"elliptical style"* symbol list
  - When the unit modifier is a scientific name of a chemical, an animal, or a plant which is not normally hyphenated: *nitric oxide* formation
- A unit modifier *should always* be hyphenated
  - When the unit modifier contains a past or present participle: *flight-tested model, decay-producing* moment
  - When the unit modifier is a combination of color terms: *blue-gray* residue
  - When a connecting word is implied in the unit modifier: *lift-drag* ratio, *Newton-Raphson iteration*
  - When the unit modifier contains numbers (other than number designations): *three-degree-of-freedom* simulator, *0.3-meter* tunnel

    Note: we prefer that a number and unit of measurement not modify the quantity measured:

Poor	3° angle of attack
Correct	angle of attack of 3°
Poor	15 000-ft altitude
Correct	altitude of 15 000 ft

Of course, there are many instances other than those listed above when a unit modifier may be hyphenated. See Skillin et al. (1974) and G.P.O.

(1984) for discussions of permissible temporary compound words. The above guidelines are based on the hyphenation rules proposed by Murdock (1982). She attempted to eliminate the need for subjective decisions concerning the clarity of unit modifiers. Unfortunately, her rules do not always ensure clarity. It seems that authors and editors must subjectively decide whether or not a unit modifier is clear and readable without a hyphen.

1.6. Adverbs

Adverbs modify verbs, adjectives, and even other adverbs, but not nouns or pronouns. Adjectives can modify only nouns and pronouns. Grammatical errors sometimes occur when an adjective tries to modify a verb:

Wrong	The balance was mounted internal to the model.
Correct	The balance was internally mounted on the model.
Or	The balance was mounted inside the model.

Note the position of the adverb *internally* in the above example. The natural place for a single-word adverb is within the verb phrase. However, some adverbs can be moved within a sentence to change emphasis (see section 2.6). Although adverbial words and phrases can be moved easily within a sentence, they can be misplaced when their modification is not clear.

See section 2.5.1 for discussion of degree (positive, comparative, and superlative) of adverbs.

1.6.1. Misplaced Adverbs

Some adverbs such as *only, almost, nearly, also, quite, merely,* and *actually* must be placed as close as possible to the words that they modify (see the discussion of "only" in Bernstein 1981):

Misplaced	The approximation is only valid for $u = 0$.
Correct	The approximation is valid only for $u = 0$.
Misplaced	The flow had separated nearly over the whole wing.
Correct	The flow had separated over nearly the whole wing.
Misplaced	It is only necessary to apply equations (6) to (12) to compute D.
Correct	It is necessary to apply only equations (6) to (12) to compute D.

1.6.2. Squinting Adverbs

An adverb "squints" when it is not clear whether it modifies the preceding or the following words:

Squinting	Although the operator eventually replaced the thermocouple, *during that test,* the temperature measurements were inconsistent.
Either	Although *during that test,* the operator eventually replaced the thermocouple, the temperature measurements were inconsistent.
Or	Although the operator eventually replaced the thermocouple, the temperature measurements were inconsistent *during that test.*

1.6.3. Split Infinitives

Despite the fact that split infinitives have usually been proscribed in formal writing, most, if not all, grammar authorities recommend splitting an infinitive to avoid ambiguity or awkwardness. In particular, do not place an adverb before or after an infinitive if in that position the adverb might appear to modify a word other than the infinitive:

Split	He agreed to *immediately* recalibrate the surface pressure instrumentation on the wing.
Squinting	He agreed *immediately* to recalibrate the surface pressure instrumentation on the wing.
Awkward	He agreed to recalibrate *immediately* the surface pressure instrumentation on the wing.
Split	The flow at $\delta = 0°$ was the first to *completely* establish itself over the wing.
Awkward	The flow at $\delta = 0°$ was the first *completely* to establish itself over the wing.
Squinting	The flow at $\delta = 0°$ was the first to establish itself *completely* over the wing.

- Avoid splitting an infinitive with a phrasal adverb. Such split infinitives are usually awkward.

1.7. Prepositions

Prepositions are handy little words that connect a phrase to a sentence and at the same time impart meaning. Prepositional phrases can function as adjectives, adverbs, or nouns.

When prepositions are used redundantly or unnecessarily, they should be deleted for the sake of brevity (see section 2.4.1).

1.7.1. Prepositional Idioms

Choosing the right preposition to use in a particular construction is a matter of idiomatic usage, not governed by grammatical rules. Therefore, when questions arise concerning prepositional idioms, consult the dictionary, a usage reference (such as Bernstein 1981), or a list of such idioms (Skillin et al. 1974 and Rowland 1962 contain sections entitled "The Right Preposition"). Some examples of prepositional idioms follow:

analogous to	correlation with
attempt (n.) at	implicit in
attempt (v.) to	similar to
coincident with	theorize about
different from	variance with

1.7.2. Terminal Prepositions

Most authorities agree that ending a sentence with a preposition is grammatical, although they often recommend avoiding terminal prepositions because sentences should end with strong words rather than weak ones (see section 2.6 for positions of emphasis in a sentence). If deleting a terminal preposition results in an awkward sentence or changes emphasis in the sentence, nothing has been gained:

Term. prep.	This hypothesis is intuitively difficult to disagree with.
Awkward	This is an intuitively difficult hypothesis with which to disagree.
Change emphasis	To disagree with this hypothesis is intuitively difficult.

Bernstein (1981) provides an excellent discussion of this topic. He summarizes by stating, "If by trying to avoid ending a sentence with a preposition you have seemed to twist words out of their normal order and have created a pompous-sounding locution, abandon the effort."

1.7.3. Repeating Prepositions

Prepositions must be repeated in coordinate phrases only when they are required for clarity or when their omission breaks rules of parallelism:

Unclear	Shock tests were conducted in nitrogen and oxygen.
Either	Shock tests were conducted in nitrogen and in oxygen.
Or	Shock tests were conducted in a mixture of oxygen and nitrogen.
Not parallel	Tests were conducted not only in nitrogen but also oxygen.
Correct	Tests were conducted not only in nitrogen but also in oxygen.

Of course, prepositions (and articles) can be repeated for emphasis.

1.8. Conjunctions

Conjunctions are classified as coordinating, joining sentence elements of equal grammatical rank, and as subordinating, joining elements of unequal rank.

1.8.1. Coordinating Conjunctions

Coordinating conjunctions join grammatically equal sentence elements; that is, they join a word to a word, a phrase to a phrase, or a clause to a clause. They thus provide important opportunities to use parallelism. See section 2.3 for a discussion of parallel construction. The three types of coordinating conjunctions are

Coordinate conjunctions: *and, but, or, nor*

Correlative conjunctions: *either ... or, both ... and, not only ... but also*

Conjunctive adverbs: *therefore, however, thus, hence, otherwise*

Coordinate conjunctions

Coordinate conjunctions can join words, phrases, and clauses. The elements that they join must be equal grammatically. A coordinate conjunction cannot join a noun and prepositional phrase, for example:

Wrong	Pressures at the bulkhead, the seal, *and* in the cove are shown.
Correct	Pressures at the bulkhead, at the seal, *and* in the cove are shown.

Nor can a coordinate conjunction join a noun and a clause:

Wrong	Notable characteristics of the air duct system are the acoustic treatment of the ducts *and* that the compressor can force flow both ways through the system.
Correct	Notable characteristics of the air duct system are the acoustic treatment of the ducts *and* the ability of the compressor to force flow both ways through the system.

Correlative conjunctions

Correlative conjunctions are pairs of words that connect parallel sentence elements.

- Each member of the correlative must be followed by the same part of speech:

Wrong	The microprocessor provides *both* radiometer control functions *and* formats the data.
Correct	The microprocessor *both* controls the radiometer *and* formats the data.

Also it is good practice to keep elements joined by correlatives strictly parallel:

Poor	The subsystem *not only* measures temperature *but* it *also* provides real-time displays.
Better	The subsystem *not only* measures temperature *but also* provides real-time displays.
Poor	This duct serves *either* as an eductor that provides an exit to the atmosphere *or* as an inductor sucking air into the system.
Better	This duct serves *either* as an eductor exiting air to the atmosphere *or* as an inductor sucking air into the system.

Conjunctive adverbs

Conjunctive adverbs can be used to join independent clauses only. In contrast to coordinate conjunctions, conjunctive adverbs have more modifying character and less connective force.

- Clauses joined by conjunctive adverbs must be separated by a semicolon (or a period):

Coord. conj.	The differences were generally about 11 percent, *but* larger differences occurred at $\alpha = 15°$.
Conj. adv.	The differences were generally about 11 percent; *however,* larger differences occurred at $\alpha = 15°$.

1.8.2. Subordinating Conjunctions

Subordinating conjunctions connect dependent clauses to independent clauses. They are discussed in three categories:

Adverbial conjunctions, which join adverbial clauses to independent clauses: for example, *because, though, after, where, so that.*

Relative pronouns, which are discussed in section 1.3.3.

That, which is used as a function word to introduce dependent clauses.

Adverbial conjunctions

Subordinating conjunctions that join adverbial clauses to independent clauses are called adverbial conjunctions. The biggest problem with these conjunctions is deciding whether the dependent clause is restrictive or not in order that the sentence can be properly punctuated (see section 3.5.2).

Some of these conjunctions are often used improperly:

- *As, since,* and *while* have meanings other than those involving time, so that care must be taken to ensure that their meaning is clear.

- *If* introduces clauses indicating condition; *whether* introduces clauses indicating alternatives:

Wrong	Aerodynamic forces were studied on a two-dimensional wing section to determine if similar trends would be calculated.
Correct	Aerodynamic forces were studied on a two-dimensional wing section to determine whether similar trends would be calculated.

- *Where* refers to place or location. It is often used incorrectly to replace *that, when,* or a relative pronoun:

Wrong	This formulation is equivalent to the Prandtl-Glauert transformation, where the body is stretched to correct for the actual distance.
Correct	This formulation is equivalent to the Prandtl-Glauert transformation, by which the body is stretched to correct for the actual distance.

- *While* used in the sense of *although* or *whereas* is becoming accepted, with reservation. Skillin et al. (1974) approve of using *while* to mean *although* so long as its use "does not defy the sense of *at the same time.*" Bernstein (1981) describes this usage of *while* as acceptable, "but with less universal sanction."

For a better understanding of these or other usage problems, consult Bernstein (1981) or other usage references.

The subordinating conjunction that

The subordinating conjunction *that* is defined in the dictionary as a function word that introduces several types of dependent clauses, for example, noun clauses:

> That the seven-term function does not result in a good approximation is apparent.

- *That* may sometimes be omitted in noun clauses (particularly following such verbs as *say, think,* and *believe*), but this omission is not recommended:

Correct	The listeners believe the noise might hurt them.
Better	The listeners believe that the noise might hurt them.
Correct	The computation is adequate provided it is converged with respect to collocation order.
Better	The computation is adequate provided that it is converged with respect to collocation order.

- When a phrase or clause intervenes between *that* and the rest of the dependent clause, *that* is sometimes incorrectly repeated:

Wrong	He concluded that because checks were made with 128 collocation points and only small differences were found, that the results shown were converged.
Either	He concluded that because checks were made with 128 collocation points and only small differences were found, the results shown were converged.
Or	Because he made checks with 128 collocation points and found only small differences, he concluded that the results shown were converged.

1.9. Verbals

The three types of verbals are the gerund (verb ending in *ing* used as a noun), the participle (verb used as an adjective), and the infinitive (verb preceded by *to* used as an adverb, adjective, or noun).

1.9.1. Coordinate Gerunds and Infinitives

Grammar authorities all remind us that a gerund takes a singular verb:

> Substituting the expression into equation (2) yields ...

But these authorities are silent on the number of a verb following coordinate gerund subjects:

> Substituting this expression in equation (2) and simplifying the result yields ...

- We prefer a singular verb if a series of actions expressed by coordinate gerunds can be considered a single process.
- Likewise, the prepositions should not be repeated before coordinate gerunds or infinitives that express a process (Rowland 1962):

> The following expression results from substituting equation (1) into equation (2), integrating by parts, and taking the limit.
>
> The test procedure was to combine the samples in a large vat, stir the mixture, and then withdraw samples for analysis.

See section 1.7.3 concerning repetition of prepositions in coordinate phrases.

1.9.2. Idiom Requiring Gerund or Infinitive

Whether a particular verb should be followed by an infinitive or a gerund phrase is a matter of idiom, for example,

Correct	The display helped the pilot to cope with the increased work load.
Wrong	The display aided the pilot to cope with the increased work load.

Although the meaning of these two sentences is the same, changing the verb changes the verbal required by idiom:

Correct	The display aided the pilot in coping with the increased work load.

Consult a usage reference (for example, Skillin et al. 1974) to check for these idioms; the dictionary also offers an indication of idiomatic usage.

1.9.3. Dangling Verbals

An infinitive, gerund, or participle dangles when the agent of the action that it expresses is not clear.

Some authorities (IRS 1962; Tichy and Fourdrinier 1988) consider an introductory gerund or infinitive phrase to dangle when it does not modify the subject:

> When *using* a nonaligning pitot static tube, the total velocity component cannot be exactly measured because of the swirl component.
>
> *To predict* the thrust and power coefficients of the propeller, the aerodynamic coefficients must be provided.

Rowland (1962) considers such gerund phrases acceptable because "they are employed so frequently in technical writing that they may be said to be idiomatic." The same can be said of introductory infinitive phrases. These introductory phrases are clearly adverbial because no one would attribute their action to the subject. Note that the verbs in the above sentences are in passive voice, so that an unknown agent can be supplied for the verbals' actions. When the verb is in active voice, the verbal tends to dangle:

> When using a nonaligning pitot probe, the swirl component precludes exact measurement of total velocity.

- Introductory gerund and infinitive phrases do dangle when they modify a noun in the sentence other than the subject:

Wrong	When using a nonaligning pitot static tube, total velocity cannot be measured exactly by the investigator because of the swirl component.
Correct	When using a nonaligning pitot static tube, the investigator cannot exactly measure total velocity because of the swirl component.

Although Rowland justifies introductory adverbial gerund and infinitive phrases because they are idiomatic and clearly adverbial, he does not extend this argument to participles. He condemns dangling participles as "slovenly English" and "weak constructions that should be replaced by more robust phrasing." Are dangling participles slovenly English? Or, like the dangling gerund, are they becoming idiomatic?

Absolute participles

A class of apparently dangling participial phrases that have become idiomatic are absolute participles (Bernstein 1981). They have no antecedent and none is intended; that is, they are indefinite, for example,

> The density mode is preferred *provided* that optical properties are measured.
>
> *Given* a variable factor, the fluctuating flow components can be calculated from equations (31) to (38).
>
> Either the density mode or the pressure mode can be used, *depending* on whether supporting optical measurements or probe measurements are made.

Other idiomatic absolute participles are

generally speaking	concerning
considering	regarding
judging	beginning

Such constructions must be truly absolute, with no antecedent in the sentence. In the following sentence, what appears to be an absolute participle is actually dangling:

Dang. partic.	An arbitrary factor controls the accuracy of the calculation *depending* on pressure fluctuations.
Better	A variable factor depending on pressure fluctuations controls the accuracy of the calculation.

Technical writing often contains absolute participles that are not idiomatic, for example,

> The arbitrary factor can be assumed to be small and therefore can be neglected, *yielding* a first-order solution.

Such a participle might be justified by arguing that it is an absolute adjective construction modifying the whole sentence. However these participles can sometimes be made adverbial:

> The arbitrary factor can be assumed to be small and therefore can be neglected to yield a first-order solution.

Sometimes a participle at the end of a sentence is not absolute, but actually modifies the subject in a nonrestrictive way:

Nonrestrictive partic.	Increasing the leak area caused the boundary layer to attach, thus *decreasing* heat transferred to the cove interior.

The MLA's Line by Line (Cook 1985) does not object to such placement of a participle. However, these participles can usually be changed to a compound predicate:

Compound predicate	Increasing the leak area caused the boundary layer to attach and thus decreased heat transferred to the cove interior.

Do not confuse absolute participles with nominative absolute constructions, which are perfectly grammatical. Nominative absolutes have their own subjects and modify the whole sentence:

Dang. partic.	Maraging steels are promising for cryogenic service, *having* hardness at $-320°F$ of $38R_c$.
Nom. abs.	Maraging steels are promising for cryogenic service, their hardness at $-320°F$ being $38R_c$.

Adverbial participles

What appears to be a dangling participle is left when the preposition *by* is dropped from an adverbial gerund phrase. These "adverbial participles" may appear after the verb or at the beginning of the sentence:

Adverb. partic.	The logarithmic derivative is obtained *using* this least squares representation.
Gerund phrase	The logarithmic derivative is obtained *by using* this least squares representation.
Adverb. partic.	*Neglecting* the dependence of n on Reynolds number, the results of figure 11 can be used to estimate n.
Gerund phrase	*By neglecting* the dependence of n on Reynolds number, the results of figure 11 can be used to estimate n.
Adverb. partic.	*Substituting* equation (34) instead of equation (14), the terms for the fluctuating modes can be rewritten.
Gerund phrase	*By substituting* equation (34) instead of equation (14), the terms for the fluctuating modes can be rewritten.

Restoring *by* to these phrases adds very little to the above sentences. The participles in these sentences clearly modify the verbs; thus their meaning is clear. But participles are, by definition, adjectives, so that adverbial participles are not grammatical. Also there are methods of revising adverbial participles other than restoring their *by*. In the following sentences, stronger constructions replace the participial phrases:

Prep. phrase	The logarithmic derivative is obtained *from* this least squares representation.

Prep. phrase	*With* the dependence of n on Reynolds number neglected, the results of figure 11 can be used to estimate n.
Gerund subject	*Substituting* equation (34) instead of equation (15) allows the terms for the fluctuating modes to be rewritten.

Dangling participles

When a participle genuinely appears to modify the wrong noun, it is truly dangling and thus much more offensive:

Dang. partic.	*Using* a nonaligning pitot probe, the swirl component precludes exact measurement of total velocity.
Better	When a nonaligning pitot tube is used, the swirl component precludes exact measurement of total velocity.
Dang. partic.	The shock is essentially normal near the body, *producing* subsonic flow.
Better	Near the body is an essentially normal shock producing subsonic flow.
Dang. partic.	*Encouraged* by these results, a new research effort was begun.
Better	Encouraged by these results, we began a new research effort.

Recommendations

- When an introductory gerund or infinitive phrase is clearly adverbial, we consider its use idiomatic and therefore we do not consider it dangling.

  Although no writing authorities now claim that adverbial participles and nonidiomatic absolute participles are becoming acceptable in technical writing, such participles are widely used and well understood. Forbidding their use is perhaps like forbidding the tide to rise. These participial constructions are certainly not grammatical, but they are rarely misunderstood.
- So long as an adverbial or absolute participle does not appear to modify the wrong noun, it is acceptable, but not encouraged.

Chapter 2. Sentence Structure

2.1. Sentence Structure and Effective Writing

Effective writing involves far more than following rules of grammar. There is a craft to creating phrases, sentences, and paragraphs that ensure communication. An editor, with the vantage point of a reader, can contribute to this craft by looking for opportunities to improve sentence structure.

2.2. Subjects and Verbs

A sentence can make three types of statements:

- A subject does something (active verb)

  Researchers write reports.

- A subject has something done to it (passive verb)

  The *reports are reviewed* by editors.

- A subject is equal to something else (linking verb)

  Reports are Langley's research product.

In all three types of sentences, the subject and verb are the most important elements. Since the subject and verb are the most important elements in a sentence, improving their relationship, clarifying the subject, or making the verb more vigorous will improve the sentence.

2.2.1. Clarify Subject

The importance of subject and verb may be an elementary idea, but the writer of the following sentences has surely forgotten it:

> An *indication* of probable asymmetric throat area reduction between the upper and lower throats of this nozzle during reverse thrust operation *is shown* by the jet-lift coefficients presented in figure 28.
>
> At NPR < 4, *there is* a large reduction in discharge coefficient due to reverse thrust operation, indicating a decrease in the effective throat area for the nozzle.

The subject of a sentence should be expressed with clear, concrete words; and in technical documents, it usually is. However, this clearly expressed topic of the sentence is often not the grammatical subject. In the first sample sentence, *indication* is not the true subject; in the second sample,

the subject and verb positions have been wasted by an indirect construction, *there is.*

Effective Revenue Writing 2 (Linton 1962) suggests that the real subject of a sentence can be found by identifying the real action in the sentence; the subject is then either receiving the action or preferably performing it. In the first sample sentence, identify the action. From among the several words of action (indication, reduction, operation, is shown, presented), *indication* seems most important. Two revisions come to mind when *indicate* becomes the main verb:

> Asymmetric throat area reduction between the upper and lower throats of this nozzle during reverse thrust operation is probably indicated by the jet lift coefficients presented in figure 28.

> The jet lift coefficients presented in figure 28 indicate a probable asymmetric throat area reduction between the upper and lower throats of this nozzle during reverse thrust operation.

Which sounds best? The second revision, with an active verb close to its subject, is certainly easier to read. Out of context, it is preferable. Context affects the choice of subject. For good transition from one sentence to another, the subject of a sentence should relate to the previous sentence.

Now consider the second sample sentence, containing the indirect construction. The expletive *there* forces the true action of the sentence, *indicating,* into a participial construction. Making *indicate* the main verb results in

> At NPR < 4, a large reduction in discharge coefficient due to reverse thrust operation indicates a decrease in the effective throat area for the nozzles.

Another indirect construction involves the pronoun *it*:

Indirect	It appears that grain refining improved the toughness of maraging steels.
Better	Grain refining seemed to improve the toughness of maraging steels.
Indirect	It is obvious that a blackbody laser is feasible as a space power system.
Better	Obviously a blackbody laser is feasible as a space power system.

As with any valid grammatical construction, indirect constructions sometimes serve a function, but many grammar and writing books criticize them as being wordy (see section 2.4.1) and unnecessary. Rowland (1962) states that "expletives serve only to mark time until the true grammatical subject appears." In Tichy and Fourdrinier's (1988) opinion, as well as in

Rowland's, indirect constructions can be ambiguous. Such idioms as "it is known" or "it is believed" indicate general knowledge or belief:

> It is believed that this is a nozzle-aspect-ratio effect.

In most technical writing, these constructions refer to the author's belief or knowledge. Perhaps a personal pronoun is appropriate (see section 1.3.2):

> We believe that this back pressure increase is a nozzle-aspect-ratio effect.

Note the change in the subordinate clause of this sentence. Demonstrative pronouns (*this, these, that,* or *those* used as nouns) with "broad reference" (Ebbitt and Ebbitt 1982) can be undesirable and ungrammatical when their antecedent is not clear (see section 1.3.1):

Poor	Mass flow rate increased in the cove. This resulted in increased cove gas temperature.
Better	The increasing mass flow rate in the cove increased cove gas temperature.

Please do not insert stock abstract words such as *result, effect,* or *apparatus* after every demonstrative pronoun. Remember that the subject of a sentence (or clause) should be clear and concrete and should relate to previous ideas.

2.2.2. Make Verbs Vigorous

The only words capable of expressing action are verbs and their derivatives. Invigorating verbs will make writing more concise and easier to read. In the following phrases, the action of the verb *reduce* is progressively deemphasized:

Active voice	If we *reduce* drag, ...
Passive voice	If drag *is reduced,* ...
Verbal	With *reduced* drag, ...
Verb-derived noun	With *reduction* of drag, ...

Weak verbs

One of the most common causes of weak verbs has already been discussed; when the real verb of a sentence becomes the subject, a weaker verb must be substituted:

Poor	A comparison of lift coefficients for the two configurations is presented in table II.
Better	Lift coefficients for the two configurations are compared in table II.

Poor	The agreement between calculated and experimental heating rates was within 30 percent.
Better	Calculated and experimental heating rates agreed to within 30 percent.
Poor	Asymmetric throat area reduction between the upper and lower throats occurred during reverse thrust operation.
Better	Throat area decreased asymmetrically between the upper and lower throats during reverse thrust operation.

Another method of weakening verbs is to hedge with such words as *might, may, seem to, appear to,* or *tend to.* Hedges not only weaken the verb, as they are meant to, but also imply indecision on the part of the author. They should not be overused (see section 2.4.1).

Active versus passive voice

As discussed in section 1.4.3, writing authorities overwhelmingly prefer active voice to passive voice. However, Tichy and Fourdrinier (1988) list five situations when passive voice is appropriate:

- When the actor is unimportant, not known, or not to be mentioned
- When the receiver of the action should be emphasized
- When the sentence is abrupt in active voice
- When variety is needed in an active voice passage
- When a weak imperative is needed

Although the first two items justify much of the passive voice in technical documents, the converse of the fourth item must also be considered. In our passive voice reports, an occasional active voice sentence is needed for variety. (Tichy and Fourdrinier 1988 also discuss the importance of sentence variety to good style.) Thus editors should watch for sentences that could appropriately be revised to active voice:

Passive	The dependence of n on Mach number *was reduced* at higher Reynolds numbers.
Active	The dependence of n on Mach number *decreased* at higher Reynolds numbers.
Or	Increasing Reynolds number *reduced* the dependence of n on Mach number.
Passive	The reduction in discharge coefficient *is* probably *caused* by an increase in back pressure.
Active	An increase in back pressure probably *causes* the reduction in discharge coefficient.

Passive	Pressures and cold-wall heating rates, normalized with respect to wing surface conditions, *are shown* in figures 2 and 3.
Active	Figures 2 and 3 *show* pressures and cold-wall heating rates, normalized with respect to wing surface conditions.

The active version of the last example ascribes a human ability (to show) to an inanimate object (figure), a rhetorical device commonly called personification. Rowland (1962) states, "Personification, if not overdone, is an effective means of conferring vigor and emphasis... and affords relief from excessive use of passive voice." Bernstein (1981) agrees, but both caution against ludicrous attributions (called pathetic fallacy); for example,

Path. fallacy	Nonessential loads can take advantage of voltage regulation, but essential loads cannot.
Better	For nonessential loads, designers can take advantage of voltage regulation, but for essential loads, they cannot.

Linking verbs also can sometimes be converted to active voice:

Linking verb	The velocity and density sensitivities *are* both dependent on Mach number.
Active	The velocity and density sensitivities both *depend* on Mach number.

Verbals

Active writing does not require active voice, since there are other types of active constructions (Linton 1962):

Prepositional phrase:	methods for reduction of ...
Gerund phrase:	methods for reducing ...
Infinitive phrase:	methods to reduce ...

The emphasis on the action increases from the prepositional to the gerund phrase and from the gerund to the infinitive phrase.

2.2.3. Improve Subject-Verb Relationship

The subject and verb should be the most important elements of a sentence. Too many modifiers, particularly between the subject and verb, can overpower these elements. If modifiers are more interesting and active than the sentence itself (subject-verb-object), the action of at least some modifiers should be transferred either to the main verb or to a new sentence or independent clause:

Poor	The test medium is the combustion products of methane and air, which are produced in a high-pressure combustor, expanded through an axisymmetric contoured nozzle, and diffused and pumped from the test section to the atmosphere through an annular air ejector.

Better	The test medium, the combustion products of methane and air, is produced in a high-pressure combustor, expanded through an axisymmetric contoured nozzle, and diffused and pumped from the test section to the atmosphere through an annular air ejector.
Or	The test medium is the combustion products of methane and air. These gases are burned in a high-pressure combustor, and the combustion products are expanded through an axisymmetric contoured nozzle and diffused and pumped from the test section to the atmosphere through an annular air ejector.

When placed between the subject and verb, too many modifiers can ruin the continuity of the sentence. A reader may not be able to recall the subject by the time the verb comes along. Adverbial modifiers can often be moved, but adjective phrases and clauses present a special problem because they cannot wander far from the noun that they modify:

> Pressures that were sensed at discrete locations such as in the cavity just behind the seal, at the bulkhead, and at the base of the elevon and ramp are also given.

When a long adjective phrase or clause intrudes between the subject and verb, four choices for revision are available:

- Shorten the intervening adjective:

> Pressures sensed at discrete locations, such as at the bulkhead, are also given.

- Invert the subject and verb:

> Also given are pressures that were sensed at discrete locations such as in the cavity just behind the seal, at the bulkhead, and at the base of the elevon and ramp.

Inverting a sentence drastically changes emphasis and often sounds artificial.

- Place the verb between the subject and the adjective if the verb phrase is short and modification is clear:

> Pressures are also given which were sensed at discrete locations such as in the cavity just behind the seal, at the bulkhead, and at the base of the elevon and the ramp.

We realize that it is ungrammatical to place a verb between a relative clause and its antecedent. *Effective Revenue Writing 2* (Linton 1962) condones this infraction as long as modification is clear.

- Change the adjective clause to an adverbial phrase:

> Pressures are also given for discrete locations such as in the cavity just behind the seal, at the bulkhead, and at the base of the elevon and the ramp.

Changing adjectives to adverbs often changes meaning.

2.3. Parallelism

Parallelism is an important and often neglected syntactic consideration. To quote Tichy and Fourdrinier (1988),

> A major device for sentence emphasis is parallel construction. Equal thoughts demand expression in the same grammatical form. Repetition of structure within a sentence is a most effective device for making the long sentence easy to read, and repetition of structure in two or more sentences connects them. An understanding of parallelism is therefore essential for emphasis and coherence.

When should sentence elements be parallel and how do we make them so? When two or more ideas are logically equal, they should be made parallel by writing them in the same grammatical structure. Grammatically, words are equal (parallel) to words, phrases to phrases, subordinate clauses to subordinate clauses, and independent clauses to independent clauses. Parallel grammatical elements are also called "coordinate."

Logic dictates the use of parallelism, or coordination. For example, the two coordinate clauses in the following sentence are not logically equal:

> The compressor may be operated in the compression mode, and then the flow is expelled from the anechoic room to the test duct.

This sentence calls for subordination, not coordination:

> When the compressor operates in the compression mode, the flow is expelled from the anechoic room to the test duct.

Except for coordinate clauses, such as the example above, sentence elements that are not logically parallel are rarely found in parallel construction. However, logically parallel ideas are often not written in grammatically parallel structure.

2.3.1. Connectives Requiring Parallelism

Effective Revenue Writing 2 (Linton 1962) lists four types of connectives requiring parallelism: coordinate conjunctions (*and, or, but*), correlative conjunctions (*either ... or, both ... and, not only ... but also*), conjunctive adverbs (*therefore, otherwise, however*), and the semicolon used to connect independent clauses.

Coordinate conjunctions probably provide the most opportunities to use parallelism. As discussed in section 1.8.1, they join words, phrases, and clauses of equal grammatical rank. Coordinate clauses joined by a

coordinate conjunction should be logically equal. Similarity in grammatical structure, if possible, is also a good idea. For example, the voice of the verb might be kept the same:

Acceptable	The mixing noise is the dominant component of the spectrum, but the background noise peaks at a high frequency.
Better	The mixing noise dominates the spectrum, but the background noise peaks at a high frequency.

Correlative conjunctions demand strict parallelism: Both elements of the correlative must be followed by the same part of speech (see section 1.8.1).

Independent clauses joined by conjunctive adverbs or simply by a semicolon should also be logically coordinate; however, grammatical parallelism is an option to be used for emphasis or contrast:

> In the compression mode, the duct serves as an eductor; in the exhaust mode, it serves as an inductor.

2.3.2. Itemization

As mentioned earlier, repetition of structure is effective in making long sentences easy to read. Itemization is another important device for making a sentence containing several long parallel elements easy, perhaps possible, to read. Itemization can also be used to emphasize the individual parallel elements.

Itemization is a special form of parallelism. The introductory phrase or clause leading into the list should read logically into each item:

> The test indicated
>
> 1. That continuous thermal exposure degraded the strength of the composite material.
> 2. That cyclic thermal exposure did not degrade the strength of the composite material.

In the above example, the common element, *that* would usually be included in the introductory clause: "The test indicated that."

In an itemization, all items must be the same grammatical construction, for example, all prepositional phrases, all noun phrases, or all complete sentences:

Poor	Continuous cyclic exposure resulted in 1. The matrix diffusing to the reaction layer 2. Degradation of the strength of the composite material
Better	Continuous cyclic exposure resulted in 1. Diffusion of the matrix to the reaction layer 2. Degradation of the strength of the composite material

Poor	The investigation was conducted 1. To determine mechanisms causing strength degradation 2. Because the rate of degradation varied widely depending on the composite matrix
Better	The investigation was conducted 1. To determine mechanisms causing strength degradation 2. To explain the wide variation in degradation rate for various composite matrixes

2.4. Brevity and Conciseness

Technical writing should be concise, free of redundancy and unnecessary detail. Minimizing the number of words to achieve brevity does not necessarily result in conciseness and may destroy the emphasis, the pace, and perhaps the meaning of a passage. However, wordiness seems to be a common fault of technical writing, and editors should delete unnecessary or redundant words.

2.4.1. Wordiness

Many reference books contain sections containing lists of wordy, redundant, or trite expressions (for example, Skillin et al. 1974, p. 407ff; and Rowland 1962, chapter XIV). We suggest that writers and editors occasionally peruse such lists in order to remain sensitive to unnecessary wordiness. Tichy and Fourdrinier (1988) classify seven types of common wordiness and list numerous examples of each:

- Tautology, the unnecessary repetition of an idea

ac current	Omit *current*
20 sec in duration	Omit *in duration*
close proximity	Omit *close*
in the range of 1 to 10	Replace *in the range of* with *from*

- Dilute verbs (see section 2.2.2)

are found to be in agreement	Use *agree*
analyses were made	Use *analyze*
make adjustments to	Use *adjust*
give consideration to	Use *consider*
take measurements of	Use *measure*

- Hiccups, superfluous prepositions and adverbs

of from	Omit *of*
call for	Use *demand*
enter into	Omit *into*
in between	Omit *in*
inside of	Omit *of*
go on with	Use *continue*

- Roundabout constructions

Poor	*There are* three distinct flow characteristics in these photographs.

Better	These photographs show three distinct flow characteristics.
Poor	*It* might be expected that *there* would be some flow separation.
Better	Some flow separation might be expected.
Poor	*It* appears that the flow field over the nozzles is complex.
Better	The flow field over the nozzles appears to be complex.
Poor	*It* was shown in reference 1 that ...
Better	Reference 1 showed that ...
Or	Hathwell (ref. 1) showed that ...

- Hedging and intensifying

Hedge	Lift *tends to* increase with angle of attack.
Better	Lift increases with angle of attack.
Hedge	This alloy *appears to* be a candidate material for ...
Better	This alloy is a candidate material for ...

- Unnecessary intensifiers

  more dominant
  quite impossible
  very unique

- Pointless words and phrases

  It is interesting to note that
  It might be stated that
  In the case when

- False elegance

a majority of	Use *most* (unless over 50% is meant)
due to the fact that	Use *because*
in close proximity	Use *near*
with the exception of	Use *except*

2.4.2. Shortening Text

Occasionally, a passage may be wordy, to the point of being difficult to read, or it may exceed a limiting number of words (for example, NASA limits abstracts to 200 words). Linton (1962) suggests five ways to economize:

- Reduce syntactic weight by subordinating sentences, changing subordinate clauses to phrases, and reducing phrases to adverbs and adjectives:

  > Any ash *that was not carried into the stratosphere* moved *toward the northeast* into a bank of mammatus clouds. *Mammatus clouds have downward accelerations and upward velocities.* They thus allow the larger particles to drift downward.
  >
  > Any ash *not carried into the stratosphere* moved *northeasterly* into a bank of mammatus clouds. *The downward acceleration and upward velocity of these clouds* allowed the larger particles to drift downward.

- Avoid redundant and roundabout phrases (see section 2.4.1).
- Avoid passive voice (see section 2.2.2).
- Prefer active verbs to verbs expressing state of being, that is, linking verbs and such words as *appear* and *seem.*
- Combine ideas of several sentences into one. Of course, avoid long, confusing sentences; but many short, simple sentences waste words:

  > There were three distinct flow characteristics. Ahead of the wing, a bow wave of water droplets was observed. On the wing surface, a continuous water film formed. Between 16.7 and 41.7 percent of the chord, the film broke down into discrete runoff streams.
  >
  > The three observed flow characteristics were a bow wave of water droplets ahead of the wing, a continuous water film on the wing surface, and discrete runoff streams beginning at 16.7 to 41.7 percent of the chord.

2.4.3. Shortening Titles

Conciseness is especially important in titles; a short title improves the appearance of the cover and a precise title indicates what readers can expect to find inside the cover. Brevity and preciseness must be balanced so that in a minimum number of words, the title is correct (it presents the topic of the paper), complete (it expresses the limits of the paper), comprehensible (potential readers will understand it), and concise (it is as efficient as possible).

A title which passes this evaluation (from Rathbone 1985) may be anything but brief. Rathbone also suggests that titles be shortened by deleting familiar phrases which concern reporting or information gathering. Such phrases as

> An Investigation of ...
> An Analysis of ...
> Conference on ...

can often simply be dropped without changing the meaning of the title. Unnecessary articles should also be deleted. Often a title becomes lengthy and awkward because several prepositional phrases have been added to qualify it. Several approaches can be taken. A prepositional phrase can be changed to a unit modifier:

Title	Analysis *of Hydroelastic Vibrations* of Shells Partially *Filled With a Liquid* Using a Series Representation of the Liquid
Revision	*Hydroelastic Vibration* Analysis of Partially *Liquid-Filled* Shells Using a Series Representation of the Liquid

Note: In this title, *analysis* cannot be deleted because *using* modifies it.

- Care must be taken to keep the title comprehensible. A string of unit modifiers can be as awkward as a series of prepositional phrases, and far more ambiguous.

Another approach for reducing the number of prepositions is to make subtitles:

Title	Low-Speed Wind-Tunnel Investigation of Flight Spoilers as Trailing-Vortex-Alleviation Devices on a Medium-Range Wide-Body Tri-Jet Airplane Model
Revision	Flight Spoilers for Trailing Vortex Alleviation—Low-Speed Wind-Tunnel Results for a Medium-Range Wide-Body Tri-Jet Airplane Model

Note: This revision not only removes a prepositional phrase, but also emphasizes the theme of the paper.

A title can be livened up and prepositions removed by changing verb-derived nouns to verbals, for example,

Title	Alleviation of Trailing Vortexes by Use of Flight Spoilers
Revision	Alleviating Trailing Vortexes by Deflecting Flight Spoilers

Of course, titles must not be shortened indiscriminately. Keep in mind the goal of maximum information in a minimum of words. In the previous example, *use* was not changed to *deflect* with brevity in mind. However, the word *deflect* adds to the spirit of conciseness because it means more. Consider replacing or clarifying words with vague meaning such as *method,*

system, facility, use, or *approach.* The following example illustrates this point:

Title	An Instrumentation System for Helicopter Blade Flight Research Measurements
Revision	A Rotor-Mounted Digital Instrumentation System for Helicopter Blade Flight Research

The revision is two words longer, but it seems more concise because it says so much more with only two more words.

2.5. Comparisons

Comparisons are of major importance in technical writing; experimental results are compared with predictions, results at standard or control conditions with results at test conditions, full-scale data with model-scale data, characteristics of one configuration with those of another. Such comparisons can be complicated and therefore should be expressed as simple, straightforward constructions.

The most frequent problem with comparison is ambiguity concerning the items being compared:

Poor	Comparison between pressures on the nozzle and boattail and the tail boom indicates ...
Better	Comparison of pressures on the nozzle and boattail with those on the tail boom indicates ...
Poor	The goal of the program was to obtain tougher martensitic steel alloys.
Better	The goal of the program was to obtain tougher martensitic steel alloys than are commercially available.

2.5.1. Comparison of Adjectives and Adverbs

Adjectives and adverbs change form to indicate degree of comparison (IRS 1962):

- Positive degree merely indicates existence of a quality.
- Comparative degree indicates a quality existing to a greater or lesser degree in one thing than in another.
- Superlative degree indicates a quality existing to the greatest or least degree in a group of things.

Comparative degree is formed by adding the suffix *er* or adding *more* or *less* before the modifier. Superlative degree is formed by adding the suffix *est* or adding *most* or *least* before the modifier.

Most adjectives with three or more syllables and almost all adverbs are compared by adding *more* and *most* (or *less* and *least*). In addition,

some modifiers, for example, *good,* have irregular comparisons; the words themselves change:

Positive	Comparative	Superlative
high	higher	highest
dependable	more dependable	most dependable
carefully	less carefully	least carefully
good	better	best
far	farther, further	farthest, furthest

- The comparative degree is used to compare two persons or things or to compare a person or thing with a class:

  Pressures were higher on the left nozzle than on the right nozzle.

  The values from the second test varied more than those from the first test.

  Pressures were higher at orifice 7 than at the other 47 orifices.

  Note the use of *other* in the last example; either *other* or *else* is required when a person or thing is compared with a class in comparative degree.

- The superlative degree is used to compare more than two persons or things. The word *all* (not *any*) is used with superlative degree for comparison with a class.

  Of four nozzle configurations, the dry power nozzle experienced the highest pressures

  The values from the eighth test varied most.

  Pressures at orifice 7 were highest of those at all 48 orifices.

2.5.2. Ambiguous Comparisons

Tichy and Fourdrinier (1988) discuss several types of errors which obscure meaning in comparisons: incomplete comparisons and omission of standard are often encountered in technical writing.

Incomplete comparisons

Unless all necessary words are included, many comparison sentences have two meanings:

Ambig.	The astronaut could hear her companion better than the control operator.
Either	The astronaut could hear her companion better than the control operator could.
Or	The astronaut could hear her companion better than she could hear the control operator.

Demonstrative pronouns are often used to complete comparisons (see section 1.3.4):

Poor	The pressures on the left dry-power nozzle are lower than the right afterburning-power nozzle.
Better	The pressures on the left dry-power nozzle are lower than those on the right afterburning-power nozzle.
Or	The pressures are lower on the left dry-power nozzle than on the right afterburning-power nozzle.

If the antecedent of the demonstrative pronoun is obscure, reword the sentence or repeat the subject of comparison.

Poor	The axial force on the left dry-power nozzle in the presence of a right afterburning-power nozzle was lower than that in the presence of a right dry-power nozzle.
Better	The axial force on the left dry-power nozzle was lower in the presence of a right afterburning-power nozzle than in the presence of a right dry-power nozzle.

Omission of standard of comparison

Unless the standard of comparison is clear, comparisons are meaningless:

Poor	At the higher angles of attack, flow separation is extensive.
Better	At high angles of attack, flow separation is extensive.
Poor	Higher strength martensitic steels are attractive candidate cryogenic materials.
Better	Martensitic steels, which are stronger than ferritic steels, are attractive candidate cryogenic materials.

2.5.3. Comparison Constructions

So far in this section, only comparison constructions involving *than* have been discussed. Several other constructions may be used, or misused, to express comparisons.

Compare with

The verb *compare* takes either *to* or *with,* depending on meaning. Bernstein (1981), explains the use of *with* quite clearly: "When the purpose is to place one thing side by side with another, to examine their differences or their similarities, use *with.*" In technical writing, do comparisons ever have any other purpose?

The participle *compared with* is often used (sometimes in a dangling construction) when another construction would be better:

Poor	The grain-refined material was much tougher compared with the control material.

Better	The grain-refined material was much tougher than the control material.
Poor	The grain-refining heat treatment increased toughness by 10 percent compared with the control material.
Better	The grain-refining heat treatment increased toughness of the control material by 10 percent.
Poor	The configuration with fuselage incidence experienced an increase in drag coefficient of 2 percent compared with the baseline configuration.
Better	The configuration with fuselage incidence experienced an increase in drag coefficient of 2 percent over that of the baseline configuration.

As . . . as

The correlative construction *as . . . as* is an excellent method of indicating similarity, or dissimilarity:

> The ferritic steels are not as tough at cryogenic temperature as at room temperature.

The second *as* should not be omitted when a comparative degree modifier intervenes:

Poor	After grain refinement, the steel is as hard if not harder than before.
Better	After grain refinement, the steel is as hard as, if not harder than, before.
Or	After grain refinement, the steel is as hard as before, if not harder.

Different

The adjective *different* is often used superfluously:

Poor	Figure 16 presents data from two different wind-tunnel runs.
Better	Figure 16 presents data from two wind-tunnel runs.

Note that *different* should not be indiscriminately deleted. The above sentence could have meant

> Figure 16 presents data from two wind-tunnel runs at different conditions.

When possible, change the predicate adjective *different* to the verb *differ,* a more vigorous construction (see section 2.2.2):

> The trends on the lower surface are different from those on the upper surface.

> The trends on the lower surface differ from those on the upper surface.

- *Different* takes the preposition *from*:

Poor	The measurements on the lower surface showed a different trend than those on the upper surface.
Better	The measurements on the lower surface showed a different trend from those on the upper surface.

Bernstein (1981) explains the rare occasions when *different than* is appropriate to avoid the elaborate construction *from that which*:

> In error analysis, standard deviation may be calculated with a different equation than in statistical analysis.

Just as demonstrative pronouns are sometimes needed to complete a comparison (section 2.5.2), they are sometimes needed with *different*:

Poor	The interpretation of "standard deviation" in error analysis is different from statistical analysis.
Better	The interpretation of "standard deviation" in error analysis is different from that in statistical analysis.

The . . . , the

An effective method of comparison is the idiomatic correlative construction involving *the . . . , the*:

> The lower the temperature, the more brittle the steel becomes.

2.6. Emphasis

The subject of sentence emphasis is often neglected by authors and editors. Many writers must resort to underlining (or italicizing) to emphasize an idea because they do not understand methods of emphasis (see section 3.9.1). Editors who do not pay attention to emphasis cannot assist these authors and, worse yet, may overlook the effect that editorial revisions have on sentence emphasis.

"Any sentence markedly different from the preceding sentences receives stress—a short sentence after several long ones; a periodic sentence after loose sentences; a simple sentence after a series of complex, compound, or compound-complex sentences" (Tichy and Fourdrinier 1988). Be sure that a contrasting sentence contains an important idea.

2.6.1. Emphasizing With Sentence Structure

The above quote from Tichy and Fourdrinier illustrates a most effective method of emphasis: parallelism. As discussed in sections 1.8.1 and 2.3, parallelism is grammatically required at times. It can also be used to emphasize the likeness or contrast between items. In parallel constructions, emphasis on the individual parallel items can be increased by repeating articles, prepositions, or introductory words:

Pressure distributions were obtained *on* the wing, elevon, and cove walls.

Pressure distributions were obtained *on* the wing, *on* the elevon, and *on* the cove walls.

The study indicated *that* thermal cycling caused matrix cracking and fatigue cycling caused no damage.

The study indicated *that* thermal cycling caused matrix cracking and *that* fatigue cycling caused no damage.

Of course, the most emphatic way to list parallel elements is to itemize them:

The study indicated that

1. Thermal cycling caused matrix cracking.
2. Fatigue cycling caused no damage.

Positions of emphasis in a sentence are the beginning and the end. Therefore, if a modifying phrase is moved to the beginning of a sentence, that phrase receives emphasis:

Cove cold-wall heating rates at zero leakage decreased from 2 percent of the wing heating rate.

At zero leakage, cove cold-wall heating rates decreased from 2 percent of the wing heating rate.

Emphasis can be added to internal sentence elements by moving them to an unusual position:

After each session of noise, the subjects rated overall noisiness, among other things.

After each session of noise, the subjects rated, among other things, the overall noisiness.

Be careful not to misplace the modifier:

After each session of noise, the subjects, among other things, rated the overall noisiness.

Rhetorical connectives, such as *however, therefore, hence,* and *thus,* can serve to emphasize elements of a sentence. Placing such adverbs within a sentence emphasizes the words immediately preceding them (Linton 1962):

However, isothermal exposure did increase ductility in the matrix material.

Isothermal exposure, however, did increase ductility in the matrix material.

> Isothermal exposure did, however, increase ductility in the matrix material.

Commas around such adverbs may be omitted to decrease emphasis, and of course commas would never be used around these adverbs when they are restrictive (Rowland 1962):

> Isothermal exposure thus increased ductility in the matrix material.

2.6.2. Emphasizing With Punctuation

As indicated above, commas around rhetorical adverbs and other interrupting elements (section 3.5.2) increase emphasis on the enclosed element. A comma between coordinate adjectives adds emphasis to the adjectives as separate modifiers:

> The delta function has a long, controversial history

Replacing the comma with *and* further increases this emphasis:

> The delta function has a long and controversial history

Note however that only coordinate adjectives can be punctuated this way (see section 3.5.1).

Other marks of punctuation affect emphasis. Using a colon to introduce a list tends to emphasize the list:

> The scatterometer is separated into a gimbal, a transmitter-receiver assembly, and rack-mounted electronics.

> The scatterometer is separated into three assemblies: a gimbal, a transmitter-receiver assembly, and rack-mounted electronics.

The dash, when used carefully, is an emphatic mark—it can be used to emphasize interrupting elements, nonrestrictive modifiers, and explanatory phrases and clauses (see section 3.6):

> Auxiliary meteorological data used herein—such as vorticity—have been computed from NMC isobaric height fields.

> The one-sided spectrum—engineers call it simply "spectrum"—is the output of most spectral analyzers.

> Other random processes have average properties that vary appreciably with time—for example, the load demand on an electric power generating system.

Chapter 3. Punctuation

3.1. A Functional Concept of Punctuation

Punctuation is placed in text to make meaning clear and to make reading easier. The various punctuation marks perform four functions: they (1) separate (a period separates sentences), (2) group or enclose (parentheses enclose extraneous information), (3) connect (a hyphen connects a unit modifier), and (4) impart meaning (a question mark may make an otherwise declarative sentence interrogative). The function of a punctuation mark is the basis for the rules governing its use (Linton 1962) and should be the basis for determining whether or not it is needed. The modern tendency is to punctuate to prevent misreading (open style) rather than to use all punctuation that the grammatical structure will allow (close style). Although the open style results in a more inviting product, it does allow subjectivity, perhaps arbitrariness, in the use of some marks, for example, the comma and hyphen. Consistency in the author's or editor's subjective decisions is vital to a well-punctuated report.

This chapter addresses the marks of punctuation, in alphabetical order, presenting their functions, situations when the marks are required or incorrect, and situations when the marks are appropriate but optional. Because the exclamation point is so rare in technical writing, it is not covered herein. Guidelines for its use parallel those for the question mark (section 3.13).

3.2. Apostrophe

The functions of the apostrophe are to indicate possession; to form the plurals of abbreviations, characters, and signs; and to indicate omitted characters in contractions.

The rules for forming the possessive case of nouns are presented in section 1.2.1. An apostrophe is never used to form the possessive of a personal pronoun.

- We prefer to follow the G.P.O. (1984) and to use the *'s* to form the plural of symbols, abbreviations, acronyms, designations, signs, numbers, and years:

x's	α's	C-130's
PMT's	M.A.'s	4's
+'s	1970's	60's

Note: Chicago Press (1982) and Skillin et al. (1974) recommend that the apostrophe be used in such plural constructions only when necessary to avoid confusion.

[redacted]

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- An *'s* is used to form the plural of a word referred to as the word itself, but the apostrophe is not necessary when the word retains its meaning:

  There can be no ands, ifs, and buts. (meaning no conditions)

  There can be no *and*'s, *if*'s, and *but*'s. (meaning the words cannot appear)

- The apostrophe indicates letters left out of contractions, for example, it's (it is), Gov't, and nat'l. Since contractions are rare in formal writing, such use of the apostrophe is also rare.

3.3. Brackets

The nonmathematical function of brackets is to enclose editorial insertions, corrections, and comments in quoted material and in reference citations:

> "These instruments [the radiometer and scatterometer] have been used successfully aboard satellites as well as aircraft."
>
> Boeing Commercial Airplane Co.: Integrated Application of Active Controls Technology. NASA CR-000000, [1977].

Although some authorities (Chicago Press 1982; Skillin et al. 1974; and Ebbitt and Ebbitt 1982) recommend brackets to enclose material within parentheses, particularly in legal and scholarly works, we have not found the nonmathematical use of parentheses within parentheses to be misleading in Langley reports. Thus, we do not recommend that brackets be used.

3.4. Colon

The function of the colon is to separate and introduce lists, clauses, and quotations, along with several conventional uses. Authorities disagree on usage of the colon and capitalization after a colon. The following guidelines generally correspond to *Words Into Type* (Skillin et al. 1974).

3.4.1. Colons That Introduce

A colon has the same separating force as a period. It thus brings a sentence almost to a halt (Bernstein 1981).

- Because of its strong separating function, an introductory colon should generally be used only after a complete sentence. In particular, do not use a colon between a verb or preposition and its direct object:

Wrong	The components of the rack-mounted electronics are: power supplies, the gimbal controller, ...
Correct	The components of the rack-mounted electronics are power supplies, the gimbal controller, ...
Wrong	The scatterometer is separated into: a gimbal, a transmitter-receiver assembly, and rack-mounted electronics.
Correct	The scatterometer is separated into a gimbal, a transmitter-receiver assembly, and rack-mounted electronics.

Nor should a colon be used after such introductory phases as *that is, for example,* and *such as* (the colon replaces them):

Wrong	Microwave instruments are used for remote sensing of environmental variables such as: sea ice, soil moisture, and surface wind speed.
Either	Microwave instruments are used for remote sensing of environmental variables, such as sea ice, soil moisture, and surface wind speed.
Or	Microwave instruments are used for remote sensing of environmental variables: sea ice, soil moisture, and surface wind speed.

- When items of a list are numbered, the numbers do not affect the punctuation:

  The quantities calculated from microwave instruments are (1) radiometer wind speed, (2) radiometer rain rate, and (3) scatterometer wind vector.

Remember that the colon has strong separating force; do not use it where separation is not grammatically desirable.

When using a colon incorrectly, an author probably wants to emphasize the material that follows. The editor should consider a correction that preserves this emphasis, for example, itemization (see section 2.6) or correct use of the colon.

Lists

A colon is an elegant way of introducing a list and at the same time emphasizing the elements of the list (by separating them from the rest of the sentence). Such lists might consist of words, phrases (prepositional, infinitive, or noun), or even clauses.

- Use a colon to introduce a list in apposition to a noun:

  The scatterometer is separated into three assemblies: a gimbal, a transmitter-receiver assembly, and rack-mounted electronics.

- Use a colon to introduce a list whose introductory statement contains the words *as follows* or *the following:*

  The rack-mounted electronics consist of the following: power supplies, the gimbal controller, ...

- Use a colon to introduce a list that amplifies an introductory sentence:

  The purpose of this report is twofold: to evaluate the performance of the instruments and to expand the data base.

One very effective way to emphasize a list, and at the same time make a long list easy to read (see section 2.3.2), is to number and display the list:

> The scatterometer is separated into three assemblies:
>
> 1. A gimbal
> 2. A transmitter-receiver assembly
> 3. Rack-mounted electronics

- When the introduction to a displayed list is not a complete sentence (the items of the list complete it), no colon is used (Chicago Press 1982; and Skillin et al. 1974):

> The purposes of this report are
>
> 1. To evaluate the performance of the instruments
> 2. To expand the data base

There is a trend toward using a colon after a verb preceding a displayed list (*are* in the above example). Such use of the colon is grammatically suspect and unnecessary.

Clauses

A colon may be used between two clauses when the second amplifies or restates the first, for example,

> The toughness of pseudo-maraging steel degrades at cryogenic temperatures: at −320°F, its Charpy impact energy is 6 ft-lb.

> **Note:** The first word after a colon may be capital only when the capital begins a complete sentence; however, capitalization of a complete sentence after a colon is optional.

The dash (section 3.6.2) and semicolon (section 3.15.1) may also be used in this situation. The colon is more formal than the dash (Ebbitt and Ebbitt 1982) and has more introductory force than the semicolon.

A colon is particularly useful for introducing displayed equations (which can be considered clauses), particularly when the equation symbolically restates the preceding sentence:

> The out-of-plane deflection w^o can be approximated by a truncated kinematically admissible series:

$$w^o \approx \sum_{k=1}^{s} w_{2k-1} \cos\left[(2k-1)\frac{\pi y}{2b}\right]$$

Quotations

A colon may be used to introduce a direct quotation, particularly if the quote is long (more than one sentence) or not built closely into the sentence (Ebbitt and Ebbitt 1982):

> In reference 6, he states this conclusion: "Thermal neutron fluxes up to 10^{20} might be required."

However, a comma is usually sufficient for direct quotations (section 3.5.1):

> In reference 6 he states, "Thermal neutron fluxes up to 10^{20} might be required."

Neither a colon nor a comma should be used before an indirect quotation:

> In reference 6, he concludes that thermal neutron fluxes up to 10^{20} might be required.

3.4.2. Conventional Uses of the Colon

The colon is used by convention as follows:

- After the salutation in formal letters: *Dear Sir:*
- Between hours and minutes in time: *11:30 a.m.*
- In reference citations: *Slater, Philip N.: Remote Sensing ...*
- To express ratios: *2:1 mixture*

3.4.3. Use With Other Marks

A colon follows closing parentheses and closing quotation marks.

3.5. Comma

Of all the marks of punctuation, the comma requires the most judgment. To punctuate with commas requires not only compliance with a set of rules but also thorough understanding of the material being punctuated. Commas can change meaning!

The primary functions of the comma are to separate and to enclose elements of a sentence. The function of a particular comma is important: when it separates, it stands alone, but when it encloses, it needs a partner. The instances when commas separate sentence elements are discussed first in this section, and then the instances when commas enclose.

3.5.1. Commas That Separate

Many separating uses of the comma are optional in an open style. If commas are used whenever possible, they chop up the text and can even render it difficult to read, contrary to the purpose of punctuation.

Independent clauses

Independent clauses joined by coordinate conjunctions (see section 1.8.1) may be separated by a comma:

> The mixing noise dominates the spectrum, but the background noise peaks at a high frequency.

- When the independent clauses are short and closely related, the comma may be omitted:

> Each performance of an experiment is called a trial and its result is called an outcome.

The comma is usually retained between clauses joined by the coordinate conjunctions *but* and *for,* in order to emphasize the contrast.

- When the independent clauses are complicated and contain internal commas, a semicolon may be used to separate them.
- Do not use a comma to separate independent clauses without a coordinate conjunction:

Wrong	The differences were generally about 11 percent, however, larger differences occurred at $\alpha = 15°$.
Either	The differences were generally about 11 percent, but larger differences occurred at $\alpha = 15°$.
Or	The differences were generally about 11 percent; however, larger differences occurred at $\alpha = 15°$.

- Do not separate compound predicates with a comma unless they are long and require a comma for clarity.

Poor	Viewing through the atmosphere increases the apparent reflectance for low-reflectance objects (e.g., $\rho = 0.1$), and decreases the apparent reflectance for high-reflectance objects (e.g., $\rho = 0.7$).
Correct	Viewing through the atmosphere increases the apparent reflectance for low-reflectance objects (e.g., $\rho = 0.1$) and decreases the apparent reflectance for high-reflectance objects (e.g., $\rho = 0.7$).

When compound predicates are so long that a comma seems appropriate, they are perhaps too long. A comma to separate them may not sufficiently clarify them.

Elements of series

Commas (at least) are required to separate series of three or more elements:

> The flight navigation system also provides altitude, roll, pitch, yaw, and ground speed.
>
> Pressures at the bulkhead, in the cove, and at the seal were measured.
>
> Wind speed is obtained from antenna brightness temperature, rain rate is obtained from the brightness temperature difference at two frequencies, and wind vector is obtained from radar cross section.

We prefer a comma before the conjunction in a series. This serial comma is often necessary to prevent misreading.

Introductory phrases and clauses

A comma may be used to separate an introductory phrase or clause from the main clause:

> If the variable t is actually time, then a is frequency.
>
> As discussed in reference 4, one has considerable freedom in defining the Fourier transform pair.
>
> With this definition of a transform pair, the $(2\pi)^{-1}$ factor must be preserved during integration.

- It is standard practice to put the comma after all introductory clauses and all introductory phrases containing a verb form (Ebbitt and Ebbitt 1982):

Clause	*Although some mathematicians are not comfortable with this intuitive definition,* it is widely used.
Partic. phrase	*Called mean square calculus,* this theory is based on the concept of mean square convergence.
Gerund phrase	*In analyzing the experiment,* we try to statistically describe the whole random process.
Infinitive phrase	*To understand this concept,* note that periodic functions may be expanded in Fourier series.

- The comma is optional after a short introductory adverbial phrase unless the comma is required for clarity:

Either	In recent years, the delta function has been rigorously defined.
Or	In recent years the delta function has been rigorously defined.

Wrong	Soon after the photon density becomes steady as gains and losses balance each other.
Better	Soon after, the photon density becomes steady as gains and losses balance each other.

- Do not place a comma after an introductory phrase that immediately precedes the verb it modifies:

Wrong	Only in recent years, has the delta function been rigorously defined.
Correct	Only in recent years has the delta function been rigorously defined.

Remember that after introductory clauses and phrases the comma is separating, not enclosing. A comma is appropriate after an internal phrase or clause, but it is not appropriate before unless the phrase or clause is nonrestrictive (see section 3.5.2).

- A comma follows, but does not precede, restrictive introductory elements:

Wrong	Recombination rate is larger than quenching rate, and, *after lasing is achieved,* both are smaller than photodissociation rate.
Correct	Recombination rate is larger than quenching rate, and *after lasing is achieved,* both are smaller than photodissociation rate.
Wrong	The laser pulse was reasonably stationary, although, *at 1.6 msec,* motion of the arc is evident.
Correct	The laser pulse was reasonably stationary, although *at 1.6 msec,* motion of the arc is evident.

- A comma both precedes and follows nonrestrictive introductory elements:

Correct	Note that, *even though they are unbounded,* the delta functions are plotted as arrows with their heights representing the coefficient magnitudes.

Coordinate adjectives

"Adjectives are coordinate if (1) they can be linked by *and* and (2) they independently modify the substantive" (Linton 1962).

- Separate by commas only those consecutive adjectives that are coordinate. Deciding whether adjectives are coordinate can be tricky; two tests might help. First try inserting *and* between the adjectives:

> The delta function has a long controversial history. *(long and controversial?)*

A comma is appropriate between *long* and *controversial.*

> Consider a linear shift-invariant system. *(linear and shift-invariant?)*

If still in doubt, try reversing the adjectives (if they independently modify the noun, order makes no difference):

> Consider a shift-invariant linear system.

The adjectives *shift-invariant* and *linear* are probably coordinate, but the final decision requires someone who understands the technical meaning of the adjectives. (Good luck with trying to explain this grammatical dilemma!)

When in doubt, do not insert the comma between adjectives. The current tendency is to omit the comma between two coordinate adjectives anyway (Ebbitt and Ebbitt 1982). The comma adds emphasis though to the adjectives as separate modifiers.

Elliptical constructions

When clauses in a sentence contain repeated elements (for example, the verb), the omission of these elements is indicated by a comma:

> Wind speed is obtained from antenna brightness temperature; rain rate, from the brightness temperature difference at two frequencies; and wind vector, from radar cross section.

The comma may be omitted if the clauses are short:

> Wind speed is obtained from antenna brightness temperature, and wind vector from radar cross section.

Note: See section 3.15.4 for the use of the semicolon in elliptical constructions.

Direct quotations and questions

Direct quotations and questions are separated from the rest of the sentence with either commas or colons. A colon is used to introduce a long or formal quotation (see section 3.4.1).

- Separate a direct quotation or question from the rest of the sentence with a comma:

> In reference 6, he states, "Thermal neutron fluxes up to 10^{20} might be required."
>
> The obvious question is, how good is this estimate?

Note: The first word of the question may or may not be capitalized.

- Neither a comma nor a colon sets off an indirect quotation or one that is part of the grammatical structure of the sentence:

  In reference 6, he stated that thermal neutron fluxes up to 10^{20} may be required.

  In case of fire, the command for stopping the test is "Recover, fire."

3.5.2. Commas That Enclose

A comma that encloses requires a partner, which may be another comma or a colon, semicolon, period, question mark, or exclamation mark.

Nonrestrictive modifiers

A nonrestrictive modifier does not affect the meaning of the basic sentence; it could be removed from the sentence without altering meaning.

- Nonrestrictive modifiers must be enclosed by commas (at least). The important point to remember is that an enclosing comma requires a partner, which can be another comma or another mark of punctuation.

  The nonrestrictive prepositional and verbal phrases are enclosed with commas in the following examples:

  The record need not be continuous but may, *in fact,* be digital data.

  Theoreticians prefer to work in terms of radian frequency, *defined for both positive and negative frequencies.*

  The power spectral density is integrated over some finite bandwidth, *such as a one-third octave.*

  The second integral, *being the integral of an odd function over even limits,* is zero.

- Be sure to distinguish between restrictive and nonrestrictive internal phrases that introduce clauses (see section 3.5.1):

Rest.	A random process is stationary if *for all* n, its nth density function is independent of time.
Nonrest.	The coefficient could be placed elsewhere because, *though preferred,* the placement shown is arbitrary.

- Nonrestrictive relative clauses are enclosed with commas:

Rest.	The most common panel methods are the codes *which Hess and Smith (ref. 26) designed for nonlifting bodies.*
Nonrest.	The most common panel methods are the codes of Hess and Smith (ref. 26), *which were developed for nonlifting bodies.*

- Nonrestrictive adverbial clauses are enclosed with commas:

Rest.	The last chapter introduces specialized areas *where research is in progress.*
Nonrest.	The power spectral density of the signal is shown in figure 9, *where arrows represent delta functions.*
Rest.	Two random processes are uncorrelated *if their cross correlation satisfies equation (6).*
Nonrest.	Independent random processes are uncorrelated, *since their cross correlation always satisfies equation (6).*

- Whether restrictive or nonrestrictive, an introductory adverbial clause is separated by a comma from the clause it modifies (see section 3.5.1).
- When an internal adverbial clause precedes the clause that it modifies, do not place a comma before it unless it is clearly nonrestrictive:

Wrong	Recombination rate is larger than quenching rate, and, *after lasing is achieved,* both are smaller than photodissociation rate.
Correct	Recombination rate is larger than quenching rate, and *after lasing is achieved,* both are smaller than photodissociation rate.

The following guidelines, taken from Rowland (1962), might be helpful in determining whether the clause is restrictive or nonrestrictive. Adverbial clauses can be categorized as follows:

- Time clauses—introduced by *when, whenever, after, as soon as, just as, before, since, until, while*—are restrictive when they modify the main verb.
- Place clauses—introduced by *after, before, where, wherever*—are usually restrictive, but may be nonrestrictive.
- Manner clauses—introduced by *how, just as, as, as if, as though*—are usually restrictive.
- Comparison or degree clauses—introduced by *else, other, rather, as, than*—are usually restrictive.
- Condition clauses—introduced by *if, as though, except, provided, unless, whether*—are usually restrictive.
- Concession clauses—introduced by *although, even, while, whereas, though*—are always nonrestrictive.
- Cause or reason clauses introduced by *because* are usually restrictive, but those introduced by *since, as, inasmuch as* are usually nonrestrictive.
- Purpose clauses—introduced by *so that, in order that*—are restrictive.
- Result clauses—introduced by *so that*—are nonrestrictive.

Appositives

Words or phrases in apposition are enclosed by commas unless the appositive is restrictive. A restrictive appositive is required to distinguish its antecedent from other members of the same class:

Rest.	The noble gas *argon* was chosen for the lasant gas.
Nonrest.	Argon, *the lightest noble gas that will lase,* was chosen for the lasant gas.

- Dashes (em) may enclose appositives to improve clarity, particularly when the appositive contains commas (section 3.6.1).
- The word *or* often precedes nonrestrictive appositives. The appositional *or* always requires enclosure:

  The concept of a laser powered directly by nuclear energy, or a direct nuclear-pumped laser, came into existence shortly after discovery of the laser.

- Commas are usually omitted around symbolic appositives, whether restrictive or not:

Rest.	The coefficients C_L *and* C_m are plotted in figure 23.
Nonrest.	The lift coefficient C_L is plotted in figure 23.

However, if the author or editor prefers, nonrestrictive symbolic appositives may be enclosed by commas:

The two most sensitive parameters in the estimations, α *and* β, are compared with measured values in table II.

Interrupting elements

Parenthetical phrases, rhetorical adverbs, antithetical phrases, introductory words, and other interruptive sentence elements may be enclosed by commas when they are nonrestrictive:

- Parenthetical phrase

  Auxiliary meteorological data used herein, *such as vorticity,* have been computed from NMC isobaric height fields.

- Rhetorical adverb

  The time between independent measurements cannot be reliably estimated; it can be assumed, *however,* to lie between 20 and 120 minutes.

  Note: The placement and punctuation of rhetorical adverbs affect emphasis (see section 2.6).

- Antithetical elements

  In winter, clouds near the tropopause are associated with negative vorticity, *not with positive vorticity as most meteorologists are accustomed to believing.*

- Interruptive words or phrases

  For 33-μm-diameter particles, *for example,* partial loss of laminar flow is predicted for large number densities.

Phrases with common termination

Enclose by commas a phrase with termination that also reads back to a previous phrase:

An aircraft flying through clouds will lose a significant portion, *if not all,* of its laminar flow.

The particle-concentration data have nearly the same latitudinal, *but a significantly different seasonal,* distribution from that of the cloud-encounter data.

Nominative absolute

A nominative absolute phrase (that is, a noun with no grammatical function in the sentence modified by a participle) is nonrestrictive and thus is enclosed by commas:

Most confidence may be placed in the statistics for the 30°N to 60°N latitude band, *more data having been taken at these latitudes.*

3.5.3. Conventional Uses of the Comma

The following conventional uses of the comma should be considered enclosure rather than separation:

- Dates

	The study was conducted from January 15, 1975, to February 1, 1979, aboard commercial airliners.
But	The study was conducted from January 1975 to February 1979 aboard commercial airliners.

- Geographical names and addresses

  These instruments were carried on commercial airliners en route from Chicago, Illinois, to London, England.

  The computer program is available from COSMIC, 112 Barrow Hall, University of Georgia, Athens, GA 30602.

- Specifying phrases

  This conclusion was drawn from data in Volume II, page 157, of reference 16.

- Degrees, titles, affiliations, etc.

  Members of the committee consisted of J. J. Deluisi, Ph.D., NOAA Environmental Research Laboratory; J. P. Friend III, Drexel University; and M. P. McCormick, chairman, NASA Langley Research Center.

- Names

  Refer to the report by J. J. Deluisi, Jr., and James P. Friend III:

  Deluisi, J. J., Jr.; and Friend, James P., III: Listing of Multi-Spectral

The comma is used by convention to separate thousands in numbers of five or more digits; but in technical work, we prefer a (thin) space over a comma because in some foreign languages the comma indicates the decimal point:

- Numbers

Correct	There were 88,000 data points, 2500 of which had to be discarded.
Preferred	There were 88 000 data points, 2500 of which had to be discarded.

3.5.4. Use With Other Marks

Commas are used with other marks of punctuation as follows:

- Commas precede closing quotation marks.
- Commas follow a closing parenthesis if the comma would appear without the parenthetical matter.
- Commas rarely precede an open parenthesis, only if the parenthetical matter clearly limits the following word (see section 3.10).
- Other marks of punctuation—semicolon, colon, dash, period—supercede and replace the comma; thus the "partner" of an enclosing comma may be another mark of punctuation.

3.6. Em Dash

Like the comma, the em dash[2] is used both to enclose and to separate; and, like the comma, an enclosing dash needs a partner. In fact, enclosing dashes

[2] In typeset material, there are two dashes: the em dash, which is the width of the letter *M*, and the en dash, which is half as wide. In typewritten material, the em dash is represented by two hyphens with no space around them, and an en dash is represented by a hyphen. Here the em dash will be referred to as simply "dash."

are replacements for enclosing commas in order to add emphasis. Ebbitt and Ebbitt (1982) suggest a useful philosophy toward using the dash:

> If used sparingly, the dash suggests a definite tone, often a note of surprise or an emphasis equivalent to a mild exclamation. If used regularly in place of commas, colons, and semicolons, it loses all its distinctiveness and becomes a sloppy substitute for conventional punctuation. At its best the dash is a lively, emphatic mark.

3.6.1. Dashes That Enclose

Dashes may replace commas in enclosing interrupting elements and nonrestrictive modifiers and appositives (see section 3.5.2).

- Dashes are appropriate when a comma might be misread, for example, as a serial comma:

Wrong	The lasant gas, argon, and ^{3}He were allowed to mix for 45 minutes.
Better	The lasant gas—argon—and ^{3}He were allowed to mix for 45 minutes.

- Dashes are also appropriate when the enclosed element contains internal commas:

> Of the lasant gases studied—argon, xenon, krypton, and neon—argon offers the most promise.
>
> The most promising lasant gas—argon, which is the lightest gas studied—produced laser output power of 4 W.

- Use dashes when the enclosed element needs emphasis.
- Enclose by dashes a complete sentence that interrupts another:

Wrong	The one-sided spectrum, engineers call it simply "spectrum," is the output of most spectral analyzers.
Correct	The one-sided spectrum—engineers call it simply "spectrum"—is the output of most spectral analyzers.

Commas are insufficient to enclose an interrupting sentence; dashes or parentheses are required.

The choice of commas, dashes, or parentheses to enclose a nonrestrictive or interrupting element depends on the relation of the element to the rest of the sentence and on the emphasis it requires (*Effective Revenue Writing 1,* IRS 1962):

- Commas (most frequently used) indicate only a slight separation in thought from the rest of the sentence.
- Dashes emphasize the element enclosed and clarify meaning when the element contains internal commas.
- Parentheses indicate that the enclosed element is only loosely connected to the rest of the sentence and therefore tend to de-emphasize it.

3.6.2. Dashes That Separate

The dash is used to separate sentence elements in essentially three situations:

- A dash separates a group of antecedents from their pronoun that is the subject of the sentence:

  Argon, xenon, krypton, and neon—these are the possible choices of noble gases for use in nuclear pumped lasers.

- In a displayed list, a dash may separate the item from an explanatory statement:

  Support systems for the facility supply the following:

  1. Air—The 600-psi system can deliver a flow rate of 300 lb/sec for 3 min.
  2. Cooling water—The closed-loop system delivers 450 gal/min at 550 psig.
  3. Gaseous propellants—Hydrogen, oxygen, and nitrogen are supplied from tanks at 2400 psia.

- A dash may separate two clauses when the second amplifies or restates the first:

  The toughness of pseudo-maraging steel degrades at cryogenic temperatures—at −320°F, its Charpy impact energy is 6 ft-lb.

The colon (section 3.4.1) or semicolon (section 3.15.1) may also be used for this purpose. The dash is less formal than the colon and more emphatic than the semicolon.

- A dash may precede a phrase like *that is, namely,* and *for example* when it introduces a summarizing or explanatory phrase or clause at the end of a sentence, but a comma or semicolon may also be used (Rowland 1962). If an explanatory clause follows the sentence, a semicolon is necessary; if an explanatory phrase follows, a comma is sufficient. If the explanatory phrase or clause receives enough emphasis by being at the end of the sentence, use a comma or semicolon, whichever is appropriate:

Moderate emphasis	Other random processes have average properties that vary appreciably with time, for example, the load demand on an electric power generating system.
	Some random processes are reasonably independent of the precise time; that is, measurements made at different times are similar in their average properties.

A dash would further emphasize the explanatory material:

Emphatic	Other random processes have average properties that vary appreciably with time—for example, the load demand on an electric power generating system.

Some random processes are reasonably independent of the precise time—that is, measurements made at different times are similar in their average properties.

3.6.3. Conventional Uses of the Dash

The dash is used by convention as follows:

- To separate a title and subtitle

  Large Space Systems Technology—1984
  Energy Efficient Transport Technology—Program Summary and Bibliography

- In vague or open-ended dates

  1974— 1980 to 19—

3.6.4. Use With Other Marks

A semicolon, colon, question mark, period, or exclamation point—but not a comma—supercede and replace a dash; that is, a semicolon, colon, or period may be the "partner" of an enclosing dash.

3.7. En Dash

The uses of the en dash[3] are conventional:

- The en dash indicates inclusive or continuing numbers or dates:

  pp. 233–235 Oct. 1975–Jan. 1976

  The en dash is not appropriate in a *from ... to ...* or a *between ... and ...* construction:

  Wrong between 1975–1978

  Wrong from 1975–1978

- The en dash connects a unit modifier with a two-word or hyphenated element:

  New York–London flight
  shock-wave–boundary-layer interaction

  See section 3.16 for discussion of the slash (/) used in place of an en dash.

- The en dash is used in place of a hyphen in all capital text.

[3] An en dash (which is half the width of an em dash) is available in typeset material. In typewritten material, a hyphen is used in place of an en dash.

3.8. Hyphen

The hyphen[4] is used to connect words or parts of words: it connects the syllables of words broken at the ends of lines, it connects prefixes and suffixes to words, and it connects compound words. The modern trend is away from hyphenation. Permanent compounds tend to become solid, and temporary compounds tend to be hyphenated only when necessary to avoid ambiguity.

3.8.1. Word Division

Words may be hyphenated at the ends of lines between syllables. Proper places to break words are determined from your favorite dictionary. We prefer

> *Webster's Third New International Dictionary of the English Language, Unabridged.* G. & C. Merriam Co., c.1967.
>
> *Webster's Ninth New Collegiate Dictionary.* Merriam-Webster, Inc., c.1983.

In general, end-of-line hyphens should be avoided when possible. To avoid extremely ragged right margins in unjustified text or to avoid large spaces between words in justified text, words may be hyphenated at the ends of lines. The following guidelines for end-of-line hyphenation are taken from *The Chicago Manual of Style* (Chicago Press 1982):

- Words may be divided only between syllables. Consult a dictionary for syllabification.
- Divisions leaving one letter at the end or beginning of a line are not permissible.
- Two-letter syllables may be left at the end of a line, but two-letter endings may not be carried to the next line.
- The last word of a paragraph, page, or similar item (e.g., reference citation, figure caption) should not be divided.
- A hyphenated compound should be divided only at the hyphen. Likewise it is best to divide solid compounds at the natural breaks (after-body), after prefixes (dis-comfort), and before suffixes (other-wise).
- Avoid, if possible, several consecutive end-of-line hyphens.

3.8.2. Prefixes

Hyphens are sometimes used to connect a prefix to a word. The tendency is to eliminate the hyphen after a prefix.

- Hyphens are always required with the following prefixes:

all-	quasi-
half-	self-
quarter-	ex-

[4] In typewritten material, the hyphen represents an en dash, and two hyphens with no space around them are preferred for representing an em dash.

- Use a hyphen to attach a prefix to a proper noun or adjective:

  un-American
  anti-Arab

- Hyphenate a homograph (a word with two meanings) that might be misunderstood without the hyphen:

unionized	un-ionized
recover	re-cover
coop	co-op
multiply	multi-ply

- Hyphenate a word that might be misread or difficult to read without the hyphen:

  un-uniform
  post-stall
  sub-subcommittee

- When a vowel would be doubled or a consonant tripled, use the hyphen:

  micro-organism
  anti-inflation

  Note: the prefixes *co, de, pre, pro,* and *re* are printed solid even if a vowel will be doubled:

  cooperation
  preexist

- Use a hyphen to attach a prefix to a hyphenated compound word:

  non-civil-service position
  pseudo-steady-state system

3.8.3. Suffixes

Hyphens are rarely used to connect a suffix to a word.

- Use the hyphen to avoid tripling a consonant:

  shell-like
  hull-less

- Use the hyphen when the suffix *like* is attached to a proper noun.

3.8.4. Compound Words

Compound words may be (1) permanent, their form (solid or hyphenated) being determined by usage and often appearing in dictionaries, or (2) temporary, being hyphenated. Most permanent compounds tend to become solid (without hyphen) with usage, and most authorities (Bernstein 1981; G.P.O. 1984; and Skillin et al. 1974) prefer to avoid forming temporary compounds. Thus, the trend is away from hyphenation.

Compound nouns

Most permanent prepositional-phrase compound nouns are hyphenated, and most other permanent compound nouns are solid:

right-of-way	workbench
mother-in-law	cupboard

Some noun phrases are in the process of becoming permanent compounds; but although they are defined in the dictionary, they are not yet hyphenated. For example, *Webster's Ninth New Collegiate Dictionary* lists

	right-of-way, n. & adj.
But	state of the art, n.; state-of-the-art, adj.

The dictionary is the best source for hyphenation and spelling of permanent compound nouns.

Formation of a temporary compound noun with a hyphen is appropriate when a combination of several nouns is one entity:

wing-body
writer-editor

Compound verbs

Hyphenate an active compound verb derived from a noun form consisting of separate words:

Langley *flight-tested* that configuration.
To *cross-brace* such a structure is impossible.

But the passive verb form need not be hyphenated:

That configuration was *flight tested.*
Such a structure could not be *cross braced.*

Unit modifiers

Most authorities (for example, Bernstein 1981 and G.P.O. 1984) advocate hyphenating unit modifiers only when necessary to avoid ambiguity. See section 1.5.2; the guidelines for hyphenation are repeated here:

- A unit modifier *should not* be hyphenated
  - When the unit modifier is a predicate adjective: The aircraft was *flight tested.*

    Note that an adjective that is hyphenated in the dictionary is hyphenated as a predicate adjective (IRS 1962): The method is *well-known.*

  - When the first element of the unit modifier is a comparative or superlative: *higher order* calculations
  - When the first element is an adverb ending in *ly: relatively accurate* prediction
  - When the unit modifier is a foreign phrase: *a priori* condition
  - When the unit modifier is a proper name: *North Carolina* coast (but *Anglo-American* plan)
  - When the unit modifier has a letter or number designation as its second element: *material 3* properties
  - When the unit modifier is enclosed in quotation marks: *"elliptical style"* symbol list
  - When the unit modifier is a scientific name of a chemical, an animal, or a plant which is not normally hyphenated: *nitric oxide* formation
- A unit modifier *should always* be hyphenated
  - When the unit modifier contains a past or present participle: *flight-tested model, decay-producing* moment
  - When the unit modifier is a combination of color terms: *blue-gray* residue
  - When a connecting word is implied in the unit modifier: *lift-drag* ratio, *Newton-Raphson iteration*
  - When the unit modifier contains numbers (other than number designations): *three-degree-of-freedom* simulator, *0.3-meter* tunnel

3.9. Italics

Why is a section on italics appearing in a chapter on punctuation? The purpose of italics very closely resembles the purpose of punctuation, to make meaning clear and reading easier. According to *Words Into Type* (Skillin et al. 1974), "Italics are used to distinguish letters, words, or phrases from the rest of the sentence so that the writer's thought or the meaning and use of the italicized words will be quickly understood." Italics are used to distinguish elements to be emphasized, special terminology, symbols, and words or letters to be differentiated from text. In addition, there are several conventional uses for italics.

In typewritten text, underscore replaces italics and should be used only when absolutely necessary. In many instances, underscore is not used in typewritten text when italics would be appropriate in typeset text.

3.9.1. Italics for Emphasis

Words may be italicized when they would be stressed if spoken (Ebbitt and Ebbitt 1982). Italics are especially appropriate if the emphasis would be lost when written:

> Of all the events affecting Langley history, only two have caused major trauma. The *second* was the Sputnik crisis.

Only rarely would a whole sentence be italicized for emphasis and never a whole passage (Chicago Press 1982). As a matter of fact, overuse of italics causes them to lose their force. Italics for special effects "are used less and less ..., especially by mature writers who prefer to obtain their effect structurally ... writers who find themselves underlining frequently for emphasis might consider (1) whether many of the italics are not superfluous, the emphasis being apparent from the context, or (2) if the emphasis is not apparent, whether it cannot be achieved more gracefully by recasting the sentence" (Chicago Press 1982). Consider the following sentences:

> Although holographic interferometry and modulation transfer function techniques were applied, a simple *shadowgraph* system eventually identified the flow-visualization problem.
>
> The flow-visualization problem was eventually identified not by holographic interferometry, not by modulation transfer function techniques, but by a simple shadowgraph system.

3.9.2. Italics for Special Terminology

A key term in a discussion or a technical term accompanied by its definition is often italicized on first use:

> *Caustics,* concentrations of light corresponding to a family of rays, manifest themselves as bright streaks on the photographs.

For coined terms or technical terms used in a nonstandard way, quotes are preferred to italics (see section 3.14.2).

3.9.3. Italics for Differentiation

Italicize a word used not to represent an idea as usual, but as the word itself:

> A colon is not used after *that is, for example,* or *such as.*

Likewise, letters used as letters are italicized:

> The operator presses the letter n to indicate "no" and the letter y to indicate "yes."

Letters indicating shape (V-tail, L-shaped), letter designations (case A, appendix C), and letters indicating subdivisions (figure 1(a), equation (2c)) are not italic. Sans serif letters may be used to indicate shape, but roman type is also acceptable (Skillin et al. 1974).

Note that the plurals of italic words used as words and italic letters used as letters are formed with roman *s*'s:

> *and*'s, *if*'s, and *but*'s
> *i*'s and *o*'s

3.9.4. Italics for Symbology

Most mathematical symbols and letter symbols representing a physical concept are italic, whether within roman or italic text. Chemical symbols, computer symbols, and abbreviations are not italic. Symbols representing vectors, tensors, and matrices may be set in boldface roman type if available.

In typewritten text, we recommend double spacing around symbols to distinguish those that would normally be italic.

3.9.5. Conventional Uses for Italics

There are several items that are italicized by convention:

- Titles and subtitles of books, reports,[5] compilations, newspapers, and periodicals are italicized, but not titles of articles, meeting papers, theses, papers in compilations, or patents:

  Slater, Philip N. 1980: *Remote Sensing—Optics and Optical Systems.* Addison-Wesley Publ. Co., Inc.

  Elterman, L. 1970: *Vertical-Attenuation Model With Eight Surface Meteorological Ranges 2 to 14 Kilometers.* AFCRL-70-0200, U.S. Air Force, Mar. (Available from DTIC as AD 707 488.)

  Bowker, D. E.; Davis, R. E.; Von Ofenheim, W. H. C.; and Myrick, D. L. 1983: Estimation of Spectral Reflectance Signatures From Spectral Radiance Profiles. *Proceedings of the Seventeenth International Symposium on Remote Sensing of Environment, Volume II,* Environmental Research Inst. of Michigan, pp. 795–814.

  Allen, William A.; and Richardson, Arthur J. 1968: Interaction of Light With a Plant Canopy. *J. Opt. Soc. America,* vol. 58, no. 8, Aug., pp. 1923–1928.

  Weidner, Elizabeth H.; and Drummond, J. Philip 1981: A Parametric Study of Staged Fuel Injector Configurations for Scramjet Applications. AIAA-81-1468, July.

  Nemeth, Michael Paul 1983: Buckling Behavior of Orthotropic Composite Plates With Centrally Located Cutouts. Ph.D. Diss., Virginia Polytechnic Inst. & State Univ., May.

- Foreign words that will be unfamiliar to readers are italicized, but not foreign proper names (Challais-Meudon, Göttingen), foreign currency (lira, franc), foreign titles of documents, or foreign phrases that have been adopted into English (see list of foreign words and phrases, p. 481ff., Skillin et al. 1974).

- Biological names of genera, species, and varieties are italicized, but not higher classifications. Refer to CBE (1978) for more complete information.

[5] Most authorities on style do not indicate whether or not to italicize report titles; Tichy and Fourdrinier (1988) recommend italics for titles of long reports. We prefer italic report titles.

- The name of a specific aircraft, spacecraft, ship, or train is italicized, but not the name or designation of a class of craft or the abbreviations S.S. or H.M.S.:

S.S. *United States*	*but*	DC-3
Space Shuttle *Columbia*		F-14 Tomcat
Apollo 12		Project Apollo

3.9.6. Italics With Typefaces Other Than Roman

The rules and guidelines discussed so far in this section are based on the assumption that the surrounding text is roman. If the surrounding text is not roman, adjustments must be made:

- The typeface used for symbols remains italic even when the surrounding typeface changes.
- Items other than symbols that are normally set in italic on roman type are set in roman on italic type.
- Items other than symbols that are normally set in italic on roman type may be quoted in caps and small caps or boldface type.

3.9.7. Italics With Punctuation

The standard printer's rule is to set punctuation marks in the typeface of the letter preceding them (Chicago Press 1982). This rule does not apply to parentheses and brackets however. Also Skillin et al. (1974) prefer that quotation marks, question marks, and exclamation marks, as well as parentheses, be set according to the context of the sentence.

3.10. Parentheses

Parentheses may be used to enclose nonrestrictive or interrupting elements. Commas or dashes may also be used for this purpose (see section 3.6.1).

- Parentheses are most appropriate to enclose a nonrestrictive element that is only loosely connected to the sentence and could be left out without damaging the sentence.
- Do not insert a parenthetical element with no relation whatever to the rest of the sentence. The following example is taken from Fowler (1944):

> In writing this straightforward and workmanlike biography of his grandfather (the book was finished before the war and delayed in publication) Mr. Walter Jerrold has aimed at doing justice to Douglas Jerrold ....

The parenthetical idea has no bearing on the sentence!

- Parentheses enclose numbers in an enumeration within a sentence:

> The scatterometer is separated into (1) a gimbal, (2) a transmitter-receiver assembly, and (3) rack-mounted electronics.

When the enumerated list is displayed, a period following the number is sufficient to set it off (Skillin et al. 1974; and Chicago Press 1982):

> The scatterometer is separated into
>
> 1. A gimbal
> 2. A transmitter-receiver assembly
> 3. Rack-mounted electronics

Ebbitt and Ebbitt (1982) neatly explain use of parentheses with other punctuation marks as follows:

> When a complete sentence in parentheses comes within a sentence (notice the punctuation of this one), it needs neither a capital letter nor a period. Commas and other marks of punctuation in the main sentence always *follow* the parenthesis (as here and in the preceding sentence). (A sentence in parentheses, like this one, that does not stand within another sentence has the end punctuation before the closing parenthesis.)

Punctuation (for example, question marks, quotation marks) of the ideas within parentheses remains within parentheses, while punctuation of the main sentence remains outside, almost always after the closing parenthesis rather than before an opening parenthesis. A comma precedes an open parenthesis if the parenthetical matter clearly limits the word following it (Skillin et al. 1974):

> Despite these differences, (digital) image-gathering systems can be compared with optical imaging systems.

3.11. Period

The period is a mark of separation. Its primary purpose is to separate complete thoughts, to mark the end of declarative and imperative sentences. (Interrogative sentences end with a question mark; exclamatory, with an exclamation point.) The key word here is *complete*; a period should be used only after a sentence complete with subject and predicate.

- Do not use a period after headings on separate lines (run-in headings are often separated from text by a period), after running heads, after table titles, or after items in an enumerated, displayed list unless one or more of the items are complete sentences:

> The purposes of this report are
>
> 1. To evaluate the performance of instruments
> 2. To expand the data base
>
> We can define the requirements of the power converter as follows:
>
> 1. Energy conversion should be high.
> 2. Efficiency should be independent of laser wavelength.

- It is customary to end figure captions with a period whether or not they are complete sentences:

  Figure 1. Computing scheme for algorithm.
  Figure 1. Concluded.

3.11.1. Abbreviations

A period may follow abbreviations except those for units of measure. The trend is away from periods for abbreviations (Skillin et al. 1974; and Chicago Press 1982), but they are retained for many word abbreviations, particularly those that may be confused with an unabbreviated word:

fig. 1	no. 269
Co.	Mr.

- Periods are not used for abbreviations of units of measure (except inch), for acronyms, or for contractions (with apostrophe):

ft	cm	lb
NASA	V/STOL	nat'l

A period does follow the abbreviation for inch

1 in.	*but*	in^2, in/hr,
14 lb/in.		in-lb, 6-in-wide

Whether or not to end an abbreviation with a period is best determined by consulting

G.P.O. Style Manual
Webster's Collegiate or Unabridged Dictionary

3.11.2. Conventional Uses of the Period

The period is so useful for separation that several conventional uses exist:

- A period precedes decimal numbers:

  0.2 .68 29.32

- A period separates dollars and cents:

  $6.50 *but* 50¢ or cents

- In enumerations, a period usually follows the number or other designator:

  Volume I. Theory
  Figure 2. Response times.

  The options are

  1. Optical rectification
  2. Laser-driven magnetohydrodynamics
  3. Laser photovoltaics

- Periods are used in section numbers

  1. Introduction

  This subject is discussed in section I.A.1 of reference 3 and in section 5.2 of this paper.

3.11.3. Use With Other Marks

A period may be used only with quotation marks, parentheses and brackets, and points of ellipsis, but not with other marks unless the period marks an abbreviation:

(In this fig., the dots denote . . .)
(e.g., decimal numbers)
(Why include the following three pp.?)

But a period is never repeated after an abbreviation:

I prefer the abbreviation Ms.

- Place periods before closing quotation marks.

  The operator presses the letter *n* to indicate "no" and the letter *y* to indicate "yes."

  The word pultruded is defined to mean the opposite of "extruded."

- Generally periods are placed outside closing parentheses; place the period inside only when a complete parenthetical sentence does not stand within another sentence (see section 3.10):

  (Parenthesized sentences, like this one, that do not stand within other sentences have a period before the closing parenthesis.)

3.12. Points of Ellipsis

Points of ellipsis (three evenly spaced periods) are used in formal writing to indicate an omission from quoted matter:

This combination caused Wright to wonder whether "since the interference velocities due to . . . walls are of opposite signs . . . , opposite effects might be so combined in a slotted tunnel as to produce zero blockage."

- Ellipsis points should not be used (Chicago Press 1982)
  - Before or after a quotation run in the text
  - Before a block quotation beginning with a complete sentence
  - After a block quotation ending with a complete sentence

Points of ellipsis are commonly used with other punctuation marks. Ellipsis points in a quotation always occur within the quotation marks.

Punctuation in the quote before or after the ellipsis should be retained if it will enhance meaning:

> "The gangs were of all races and conditions: ... part of the huge compost of America."
>
> "In the city of Hampton alone, hundreds of families emigrated ..., scores were made jobless, houses were empty and business generally suffered."

- The terminal period (at the end of a sentence) is always retained before an ellipsis and may be retained after ellipsis to enhance meaning:

Period before ellipsis	At a Mach number of 0.98, "the needle of the Mach meter took an abrupt jump past $M = 1.0$ and went against the peg, which is a distance equal to about 0.05 in Mach number past 1.0...."
Period after ellipsis	"When the Mach number went off the scale, the pilot shut down all cylinders .... Preliminary NASA data work-up indicates that a Mach number of 1.06 was reached."

Note the difference in spacing of periods before and after points of ellipsis.

3.13. Question Mark

The purpose of the question mark is to terminate a direct question, whether the question is an independent sentence, a clause within a sentence, or a direct quotation:

> What system identification procedure should be used for a statically unstable aircraft?
>
> The question addressed by this research project is, What system identification procedure should be used for a statically unstable aircraft?
>
> In reference 2, Jones asks, "What system identification procedure should be used for a statically unstable aircraft?"

When the direct question occurs within a sentence (as in the second example above), the author may or may not choose to capitalize the first word of the question.

- When the question is a single word, such as *when, how,* or *why,* within a sentence, neither a question mark nor a capital is necessary; the word is often italicized:

> The announcement should answer the questions *who, what, where, when,* and *why.*

- A question mark should not follow an indirect question:

> This research project addresses what system identification procedure should be used for statically unstable aircraft.

A question mark may be used with other marks of punctuation as follows:

- The question mark supersedes a period or comma.
- A question mark precedes a closing quotation mark or parenthesis only if it is part of the quoted or parenthetical matter:

  Because of the ambiguous use of the slash, the reader might well ask the question, What is meant by "molecular/atomic collision"?

  The obvious question is, how accurate is this estimate (compared with the accuracy of the input measurements)?

- When the question mark ends a sentence, the period is, of course, omitted. When the question mark does not end the sentence, it should never be followed by a comma; if required, a semicolon may follow a question mark:

  The obvious question is, how good is this estimate? and equation (6) provides a tool for answering it.

  The reader might well ask the question, What is meant by "molecular/atomic collision"?; the slash gives no clue to the meaning.

3.14. Quotation Marks

Quotation marks are used to enclose words quoted from another source, direct discourse, or words requiring differentiation from the surrounding text. Since they enclose, they always come in pairs. They can also be overused and render a text visually hard to read.

Double quotation marks (" ") are used most of the time. Single quotation marks (' ') are used only within double quotation marks.

3.14.1. Quoted Material

If a document quotes extensively from other sources, consult an authority, such as Chicago Press (1982), chapter 10, for details of correctly setting up quotations.

Quotation marks enclose material taken verbatim from another source. The quote can be of any length, from a phrase to several paragraphs:

Diehl argued that a transonic research plane was necessary to demonstrate that the sound barrier was "just a steep hill."

As Richard P. Hallion has explained: "They gave the fuselage a pointed nose then gradually thickened the body—that is, increased the cross-sectional area—until the fuselage reached its maximum diameter near the middle."

- The source of a quote should always be clear, either from the context or with a reference citation.

- Long quotations are usually set off from the text and set in smaller type if typeset. Such block quotations are not enclosed by quotation marks:

> Stack allowed Whitcomb to present his area rule at the next meeting of Langley's elite technical seminar.
>
> > At the end of presentation there was silence. Finally, Adolf Busemann stood up. Turning to his colleagues, the pioneer of sweptwing technology remarked, "Some people come up with half-baked ideas and call them theories. Whitcomb comes up with a brilliant idea and calls it a rule of thumb."

Note the double quotes within the quotation. If the quotation had not been set off but had been run in the text and enclosed in quotation marks, then single quotes would have enclosed Busemann's remark.

3.14.2. Words Requiring Differentiation

Quotation marks may enclose words that need to be differentiated from the text in order to make meaning clear. Italics are used for much the same purpose (see section 3.9.3) and are sometimes interchangeable with quotation marks.

- Enclose in quotes a word or phrase whose meaning is being referred to:

> The operator presses the letter *n* to indicate "no" and the letter *y* to indicate "yes."
>
> The word *pultruded* is defined to mean the opposite of "extruded."

Words used simply as words are usually italicized:

> A colon is not used after *that is, for example,* or *such as.*

- Enclose words or phrases following *entitled, the term, marked, designated, classified, named, enclosed, cited as, referred to as,* or *signed,* but do not enclose an expression following *known as, called,* or *so-called* unless the expression is slang (G.P.O. 1984). Of course, an italicized phrase or word (for example, a title) would not be further differentiated with quotation marks.
- Do not routinely enclose slang or technical jargon (if used) in quotation marks, unless it is expected to be foreign to the vocabulary of the reader:

Quotes unnec.	The pilot "captured" the glide slope at an altitude of 300 m.
Quotes OK	Recently, "cepstrum" analysis has come into prominence; the name is derived from inverting the first four letters in *spectrum*

Such terms are normally quoted only the first time they are used.

- Enclose in quotation marks coined terms or technical terms used in a nonstandard way:

  > Synoptic data (or "snapshots" of global parameters) are required.
  >
  > If the results satisfied a set of general, and sometimes intuitive, criteria, they were accepted as being "good."

  Such terms are normally quoted only the first time they are used.

- Enclose in quotation marks the titles of parts (sections, chapters) of a report or book and the titles of published papers, articles, etc., that are not italicized (see section 3.9.5):

  > The aircraft is described in more detail under the section entitled "Flight Facility."
  >
  > The runway is marked in accord with FAA circular AC 150/5300-2B, "Airport Design Standards—Site Requirements for Terminal Navigational Facilities."

  Langley drops quotation marks in reference lists and bibliographies; the number of quotes in these sections makes them unsightly and hard to read.

3.14.3. Use With Other Marks

Quotation marks may be used with all other marks of punctuation.

- Closing quotation marks always follow commas and periods, regardless of the context.
- Closing quotation marks always precede semicolons and colons (because they are always dropped at the end of quoted material).
- Closing quotation marks always follow points of ellipsis indicating omitted matter in the quote; ending a quote with ellipsis is rarely necessary.
- Other marks of punctuation (parentheses, question mark) are placed outside quotation marks if they are not a part of the quoted matter.

3.15. Semicolon

The semicolon separates coordinate clauses, long internally punctuated elements of series, explanatory phrases and clauses, and elliptical clauses. The semicolon denotes nearly a full stop; thus its uses are "as much a matter of personal choice as of correct punctuation" (Ebbitt and Ebbitt 1982).

3.15.1. Coordinate Clauses

Coordinate clauses may be joined by a semicolon.

- If coordinate clauses are not joined by a coordinate conjunction, they must be joined by a semicolon:

  > The first two flight runs for each pilot were treated as practice; only the last four runs were used in the analysis.

- If coordinate clauses are joined by a coordinate conjunction but the clauses are long, complicated, or internally punctuated with commas, they may be separated by a semicolon:

  > The pilots unanimously preferred the new display format because of the steadiness of the horizon, runway image, and pitch grid during turbulence; and they felt that this steadiness resulted in less distraction and better situational awareness.

- If coordinate clauses are joined by a conjunctive adverb (*however, thus, therefore, hence*), a semicolon (or a period) must precede the conjunctive adverb:

  > The differences were generally about 11 percent; however, larger differences occurred at $\alpha = 15$.

Whether a period, semicolon, or comma is used between clauses is a matter of style. Ebbitt and Ebbitt (1982) discuss semicolons and style: "Semicolons are usually more suitable in the longer, more complicated sentences of formal styles .... In general styles commas are often used where semicolons might appear in formal writing, or else clauses that could be linked by semicolons are written as separate sentences." A semicolon slows the pace and has more separating force than a comma while still tending to *join* clauses; a period simply *separates* sentences. The semicolon is particularly effective between contrasting clauses:

> One pilot performed slightly better with the attitude-aligned display; the other pilot performed much worse.

A dash (section 3.6.2) or colon (section 3.4.1) may also separate two clauses when the second amplifies or restates the first. The colon is more formal and has more introductory force than the semicolon, and the dash is more emphatic than the semicolon.

3.15.2. Series

When elements of a series are long, complex, or internally punctuated with commas, separating the elements with commas may not make meaning clear.

- Semicolons may separate elements of a series that are complex or require internal commas:

  > Committee members were H. Melfi, NASA Goddard Space Flight Center, Greenbelt, Maryland; A. L. Carswell, York University, North York, Canada; and E. V. Browell, NASA Langley Research Center, Hampton, Virginia.

Remember that a semicolon signals nearly a full stop. Semicolons may clarify the elements of a series, but at the same time disrupt the flow:

> The goal was to accelerate application of composites to primary structures in new civil transport aircraft by development of design techniques

> for empennage, wing, and fuselage structures; dissemination of technology throughout the transport industry; and extensive flight service evaluations.

Another way to clarify the series might be devised, for example, enumeration or rearrangement of elements of the series:

> The goal was to accelerate application of composites to primary structures in new civil transport aircraft by (1) development of design techniques for empennage, wing, and fuselage structures, (2) dissemination of technology throughout the transport industry, and (3) extensive flight service evaluations.
>
> The goal was to accelerate application of composites to primary structures in new civil transport aircraft by dissemination of technology throughout the transport industry, extensive flight service evaluations, and development of design techniques for empennage, wing, and fuselage structures.

3.15.3. Explanatory Phrases and Clauses

In technical writing explanatory information often follows such introductory phrases as *that is, namely, for example, in other words, for instance.*

- A semicolon must precede a phrase like *that is, namely,* and *for example* when it introduces an independent clause:

> Some random processes are reasonably independent of the precise time; that is, measurements made at different times are similar in their average properties.

3.15.4. Elliptical Constructions

When commas are necessary to indicate the omission in an elliptical construction, a semicolon separates the elliptical clauses:

> Wind speed is obtained from antenna brightness temperature; rain rate, from the brightness temperature difference at two frequencies; and wind vector, from radar cross section.

Of course, if the commas are unnecessary to indicate omission, the semicolon can be replaced by a comma so long as the clauses are joined by a conjunction:

> Wind speed is obtained from antenna brightness temperature, and wind vector from radar cross section.

But

> Wind speed is obtained from antenna brightness temperature; wind vector, from radar cross section.

3.15.5. Use With Other Marks

Semicolons always follow closing parentheses and quotation marks; semicolons are always dropped at the end of quoted material (Chicago Press 1982).

3.16. Slash

A slash, also called *solidus* or *virgule*, can be correctly used (1) in *and/or*, (2) in fractions (x/y), (3) to indicate *per* (m/sec), and (4) when quoting poetry.

Although most usage and grammar authorities do not acknowledge use of the slash in a temporary compound, it is being widely used to indicate temporary compounds. In drafts of NASA reports, we frequently find such constructions as

hoop/column antenna
boundary-layer/shock-wave interaction
matrices/vectors
lateral/directional characteristics

In the first example (*hoop/column*), those coining the new technical term seem to have chosen (erroneously) to use a slash rather than a hyphen; however, this term, meaning a combination of a hoop and a column, has been widely used with the slash. In the second example (*boundary-layer/shock-wave interaction*), the slash is being used as an en dash, or "long hyphen." In the third example (*matrices/vectors*), the slash indicates alternatives, a usage that Tichy and Fourdrinier (1988) accept with caution. In the last example (*lateral/directional*), the slash is being used in a unit modifier that has been hyphenated for years.

These four examples illustrate our objection to use of the slash in temporary compounds: Its meaning is not clear.

- We therefore prefer that the slash be changed to a hyphen,

  The 15-m *hoop-column* antenna is a deployable and restowable structure.

  to an en dash,

  These phenomena result from *shock-wave–boundary-layer* interaction.

  or to *and, or,* or *and/or,*

  Operator splitting is additive decomposition of some *matrices and vectors* in the model.

  Of course, some technical terms have become standard with the slash (for example, *V/STOL, stall/spin*).

- A term that is accepted as standard with a slash may be used with the slash.

Chapter 4. Capitalization

4.1. Introduction

"It is impossible to give rules that will cover every conceivable problem in capitalization" (G.P.O. 1984). Actually, what is capitalized is mostly a matter of editorial style and preference rather than a matter of generally accepted rules. In addition, although there is a clearly recognized rule requiring capitalization of proper nouns and adjectives, opinions differ concerning what a proper noun is.

First we should define terms used when discussing capitalization:

- *Full caps* means that every letter in an expression is capital, LIKE THIS.
- *Caps & lc* means that the principal words of an expression are capitalized, Like This.
- *Caps and small caps* refers to a particular font of type containing small capital letters instead of lowercase letters.

Elements in a document such as headings, titles, and captions may be capitalized in either *sentence style* or *headline style*:

- Sentence style calls for capitalization of the first letter, and proper nouns of course.
- Headline style calls for capitalization of all principal words (also called caps & lc).

Modern publishers tend toward a *down* style of capitalization, that is, toward use of fewer capitals, rather than an *up* style (Chicago Press 1982).

This chapter presents guidelines and Langley editorial preference for capitalization. There is so much difference of opinion among authorities as well as individuals concerning proper nouns and adjectives that total consistency among editors and authors is impossible. The important goal should be consistency within a particular document. The next three sections deal with the more clear-cut uses for capitalization; the last section deals with the most difficult area, proper nouns and adjectives.

4.2. Sentence Style Capitalization

It is second nature for us to capitalize the beginnings of such things as sentences, quotations, and captions. Rules hardly need to be expressed to cover these areas; however this section briefly addresses them and indicates Langley's preferred style.

4.2.1. Sentences

The first word in a sentence is ordinarily capitalized.

- A sentence enclosed in parentheses within another sentence does not begin with a capital:

  > In applying the foregoing approach to a tetrahedral grid (the tetrahedral grid was chosen because of its attractive features for space construction), a typical repeating element is first isolated from the grid.

  However, a parenthesized sentence that does not stand within another sentence begins with a capital:

  > The foregoing approach is now applied to a tetrahedral grid. (The tetrahedral grid was chosen because of its attractive features for space construction.) A typical repeating element is first isolated from the grid.

- In the rare instances that fragment sentences may appear in a document, they should begin with a capital:

Wrong	Can system identification procedures be applied to statically unstable aircraft? if so, to which aircraft?
Correct	Can system identification procedures be applied to statically unstable aircraft? If so, to which aircraft?

- The first word after a colon may be capitalized when the capital begins a complete sentence; however, capitalization of a complete sentence after a colon is optional:

Correct	The toughness of pseudo-maraging steel degrades at cryogenic temperatures: At −320°F, its Charpy impact energy is 6 ft-lb.
Equally correct	The toughness of pseudo-maraging steel degrades at cryogenic temperatures: at −320°F, its Charpy impact energy is 6 ft-lb.

4.2.2. Quotations

The beginning of quoted material is capitalized as follows:

- A direct quotation that is not syntactically joined to the rest of the sentence (often set off by commas) begins with a capital, even if the initial letter is not capital in the source (Chicago Press 1982; and Skillin et al. 1974):

  > In the law establishing the NACA, Congress states: "It shall be the duty of the Advisory Committee for Aeronautics to supervise and direct the scientific study of the problems of flight with a view to their practical solution."

  When the quote is syntactically dependent on the rest of the sentence, it begins with a lowercase letter, even if the initial letter is capital in the source:

> Congress established the NACA in 1915 "to supervise and direct the scientific study of the problems of flight with a view to their practical solution."

When ellipsis points in a quotation follow a period (that is, four dots), the first word of the sentence following the ellipsis may be capitalized, even if it is not capital in the source:

> "The airplane then accelerated to a Mach number of 0.98. . . . The needle of the Mach meter took an abrupt jump past $M = 1.0$."

4.2.3. Questions

When a direct question occurs within a sentence, the author may or may not choose to capitalize the first word of the question:

Correct	The question addressed by this research project is, What system identification procedure should be used for a statically unstable aircraft?
Equally correct	The question addressed by this research project is, what system identification procedure should be used for a statically unstable aircraft?

Of course, an indirect question is never capitalized:

> This research project addresses what system identification procedure should be used for statically unstable aircraft.

4.2.4. Lists

Items in a displayed list should begin with a capital whether they are complete sentences or not:

> The purposes of this report are
> 1. To evaluate the performance of the instruments
> 2. To expand the data base
>
> We can define the requirements of the power converter as follows:
> 1. Energy conversion should be high.
> 2. Efficiency should be independent of laser wavelength.
>
> Support systems for the facility supply the following:
> 1. Air—The 600-psi system can deliver a flow rate of 300 lb/sec for 3 min.
> 2. Cooling water—The closed-loop system delivers 450 gal/min at 550 psig.
> 3. Gaseous propellants—Hydrogen, oxygen, and nitrogen are supplied from 60 000-ft^3 tube trailers at 2400 psia.

Skillin et al. (1974) indicate that capitalizing nonsentence displayed items is optional, but we prefer the capitals. When lists are not displayed, the items are, of course, not capitalized:

> The purposes of this report are (1) to evaluate the performance of the instruments and (2) to expand the data base.

4.2.5. Stylistic Uses for Sentence Style Capitalization

Nonsentence elements, such as table entries, captions, or footnotes, are often capitalized as a matter of style. The following elements are capitalized in sentence style in Langley reports:

- Run-in headings
- Table subtitles, headnotes, boxheads, and entries consisting of words, phrases, or sentences
- Footnotes to either the text or a table
- Figure captions:

  Figure 1. Three-view sketch of the research aircraft. Dimensions are in inches.

  Figure 1. Computing scheme for algorithm.

  Figure 1. Concluded.

- Figure labels (we prefer initial cap over full caps or caps & lc for labels in figures)
- A word or phrase appearing in a symbolic expression:

$$W_\lambda = \bar{T}_\lambda \bar{S}_\lambda(\text{Constant})$$

$$C_m = \frac{\text{Pitching moment}}{q_\infty S_{\text{ref}} \bar{c}}$$

4.3. Headline Style Capitalization

Headline style calls for all principal words to be capitalized (also called caps & lc). Unfortunately authorities differ widely on what words are principal. Langley rules for headline style capitalization are based on the G.P.O. (1984) and are as follows:

- Do not capitalize the articles *a, an,* and *the*; the prepositions or adverbs *at, by, for, of, in, up, on,* and *to*; and the conjunctions *and, as, but, if, or,* and *nor.* In effect, this rule means that words of four or more letters are considered principal words and are capitalized.
- Capitalize the first and last words:

  Procedure After All Questionnaires Are In

- Capitalize both elements of a two-element hyphenated compound word except the second element of a compound numeral:

  Application of the Pin Level Stuck-At
  Fault Model to VLSI Circuits

  Vapor-Screen Systems for In-Flight Flow Visualization

  Evaluation of Twenty-one
  High-Resolution Graphics Work Stations

- In a hyphenated phrase of three or more words, the first element and other elements that are principal words are capitalized (Skillin et al. 1974):

  Drag-Due-to-Lift Measurements
  for a High-Speed Fighter

- If a normally lowercase short word is used parallel with a capitalized word of like significance, the short word should be capitalized:

  Carbon-Fiber Risk In and Around Airports

- Capitalize the infinitive *to* (note that some authorities, for example, Chicago Press 1982, recommend lowercase for the infinitive):

  Grain-Refining Heat Treatments To Improve
  Cryogenic Toughness of High-Strength Steels

  Grain-Refining Heat Treatments
  Resulting in Improvements to Cryogenic
  Toughness of High-Strength Steels

- Normally lowercase abbreviations should always be left lowercase, particularly abbreviations for units of measure:

  Toughness of 1-ft by 1.5-ft Specimens

  Toughness of 0.5-cm-Thick Specimens

  Noise Exposure From 10:00 p.m. to 6:00 a.m.

  But

  Flow Visualization in the 0.3-Meter
  Transonic Cryogenic Tunnel

- Headline style capitalization is used for proper nouns (see section 4.5).

  As a matter of preferred style, the following elements are capitalized in headline style in Langley reports:

- Displayed (not run-in) headings
- Table titles:

  Table IV. Test Results for HP-9-4-20

  Table IV. Concluded

4.4. Acronyms and Abbreviations

Before beginning a discussion of capitalization of abbreviations and acronyms, the two must be clearly distinguished. An abbreviation is a shortened version of a word or phrase and is often followed by a period, for example, *c.o.d.*, *ft-lb*, *St.*, or *publ.* Abbreviations usually have become standard so that their form can be looked up in a reference book. Acronyms, on the other hand, are "words formed from the initial letters of successive parts of a term" (Skillin et al. 1974), for example, NASA, NASTRAN, STIF, NASP. They never contain periods and are often not standard, so that definition is required.

4.4.1. Capitalization With Acronyms

Acronyms are always formed with capital letters. A few words have crept into our language which were initially acronyms, for example, *laser* and *radar*. But generally acronyms remain in full caps.

Acronyms are often coined for a particular program or study and therefore require definition. The letters of the acronym are not capitalized in the definition unless the acronym stands for a proper name:

Wrong	The best electronic publishing systems combine What You See Is What You Get (WYSIWYG) features with the power of noninteractive text formatters.
Correct	The best electronic publishing systems combine what you see is what you get (WYSIWYG) features with the power of noninteractive text formatters.
But	Langley is involved with the National Aero-Space Plane (NASP) Program.

Nor is it usually necessary to indicate, for example, with italics, which letters are used in the acronym.

4.4.2. Capitalization of Abbreviations

"In general, an abbreviation follows the capitalization ... of the word or words abbreviated" (G.P.O. 1984). The best way to determine the form of an unfamiliar abbreviation is to consult a reference, for example,

Webster's Collegiate or Unabridged Dictionary
G.P.O. Style Manual

In material such as titles or headings in which principal words are capitalized (caps & lc), normally lowercase abbreviations should always be left lowercase, particularly abbreviations for units of measure:

Toughness of 1-ft by 1.5-ft Specimens

Toughness of 0.5-cm-Thick Specimens

Noise Exposure From 10:00 p.m. to 6:00 a.m.

4.5. Proper Nouns and Adjectives

As mentioned in the Introduction to this chapter, there is a clearly recognized rule requiring capitalization of proper nouns and adjectives. The problem is that no one agrees on exactly what constitutes a proper noun. Proper nouns are defined as "the name of a particular person, place, or thing." Thus, the names of such things as organizations, political divisions, calendar divisions, and historic events and holidays are capitalized just as personal names and geographic names are.

Whether or not a particular word or phrase is a proper noun is often a matter of opinion. Langley follows the current trend and prefers a down style, that is, fewer capitals. The following sections provide guidelines; if difficulty arises over a particular noun, consult references such as a dictionary, Skillin et al. (1974), G.P.O. (1984), or Chicago Press (1982).

- In general, proper nouns and derivatives of proper nouns used in a proper sense are capitalized:

Italy	Italian
Rome	Roman (of Rome)
Alps	Alpine
Newton	Newtonian

- However, derivatives of proper nouns that have acquired an independent meaning are not capitalized:

roman (numeral)	pascal (the unit)
pasteurize	italicize

"Defining the distinction between proper adjectives with a *proper* meaning and derivatives ... with a *common* meaning is sometimes difficult" (Skillin et al. 1974):

Coulomb's Law	20 coulombs
G. B. Venturi	venturi tube
Gauss' equation	Gaussian distribution
Euclidean algorithm	euclidean geometry

The dictionary is a good reference for guidance in this matter, but is not always definitive. For example, in *Webster's Ninth New Collegiate Dictionary, euclidean geometry* has the label *"often cap E,"* which means that "it is as acceptable with an uppercase initial as it is with one in lowercase." Thus, usage in the given field and author preference should prevail.

- A common noun in a proper name is capitalized, but not when used alone:

> The experimental investigation was conducted in the Langley 16-Foot Transonic *Tunnel.* This single-return *tunnel* has continuous air exchange.

However, when a common noun alone becomes a well-known short form for the proper name, it is capitalized:

> United States, the States
> U.S. Army, the Army
> President of the United States, the President

- The plural form in a proper name is capitalized (G.P.O. 1984):

> Seventh and Ninth Streets
> Lakes Erie and Ontario
> Langley 16-Foot and 30- by 60-Foot Tunnels

- A common noun used with a number or letter for purposes of designation is not capitalized (G.P.O. 1984):

chapter 4	part I
figure 1	reference 25
case 8	run 234

- Only when the word *the* is part of an official name is it capitalized:

  The College of William and Mary
  the National Aeronautics and Space Administration

4.5.1. Personal Names and Titles

Rarely is there any question concerning capitalization of personal names.

- In foreign names, particles such as *d', de, du,* and *von* are capitalized unless preceded by a forename or title:

E. I. du Pont	Du Pont
Theodore von Karman	Von Karman Institute

- Remember that a personal name that is used in a common sense is no longer capitalized:

  the units curie, watt, newton, and kelvin

  But

  degree Celsius
  degree Rankine
  degree Fahrenheit

- Civil and professional titles are capitalized when they precede a personal name as part of the name (Chicago Press 1982):

  President Reagan
  Director Petersen
  Chief Scientist Barnwell
  Engineer-in-Charge Reid

  Such titles are not capitalized in apposition however:

  the chief scientist, Richard Barnwell
  the chief of Materials Division, Darrel Tenney

- Civil and professional titles following or in place of a personal name are rarely capitalized (Chicago Press 1982):

  Richard Petersen, director of Langley Research Center; the director

  A. J. Hansbrough, chief of the Research Information and Applications Division; the division chief

Perry Deal, chief test pilot

Richard A. Culpepper, test director; the test director

But, to indicate distinction, a common noun title after a name is capitalized (G.P.O. 1984):

Ronald Reagan, President of the United States

- In a document to a very specific audience, a common noun used as part of or in place of a personal name may be capitalized (Skillin et al. 1974). Thus, in a Langley memo, letter, or internal document, such titles as *Director, Associate Director, Division Chief,* and *Branch Head* may be capitalized.

4.5.2. Geographic Names

The names of particular regions, localities, countries, and geographic features are capitalized:

- Names of geographic features

Northern Hemisphere	Southern Hemisphere
Arctic Circle	North Pole
Equator	Tropic of Cancer

But

equatorial	the tropics
polar region	north latitude

- Names of regions and localities

Middle East	Southeast Asia
Gulf States[6]	North Atlantic States[6]
Great Plains	Corn Belt
North and South (Civil War period)	

But

western Virginia	northern manufacturers
eastern Gulf states	northern Michigan

Directions of the compass are capitalized only as a part of a name that has been established by usage to designate particular regions.

[6] These are two examples of the divisions of the United States that are used by the Bureau of Census; see G.P.O. (1984) for a complete listing.

- Names of rivers, mountains, bays, and cities

James River	San Francisco Bay
Mount Everest	Del Marva Peninsula
New York City	Lake Michigan

But

The satellite orbit often crossed the Sahara Desert. In parts of this *desert,* seasonal transitions occur between desert and vegetated land.

When generic terms such as *lake, city,* and *river* are used to refer to a specific place, they are still lowercase except in a few established instances:

the Canal (Panama Canal)
the Channel (English Channel)

4.5.3. Administrative Names

Official designations of political divisions and of other organized bodies are capitalized:

- Names of political divisions

Canada	United States
New York State	Ontario Province
Northwest Territories	Virgin Islands

- Names of governmental units

U.S. Government
Executive Department
U.S. Congress
Environmental Protection Agency
U.S. Army
U.S. Navy
Technical Editing Branch

But

naval power
the government
congressional committee

- Names of organizations and their members

Democratic Party, Catholic Church
a Democrat, a Catholic (members)
Democratic administration, Catholic doctrine
Society of Automotive Engineers

But

democratic government (a democracy)
catholicity (character of being liberal)

4.5.4. Names of Public Places and Institutions

The proper names of public places, facilities, and structures are capitalized:

White House
Langley Research Center
National Transonic Facility
H. J. E. Reid Auditorium

But

building 1195B

- The names of permanent research facilities at Langley Research Center (and other institutions) are capitalized, but not temporary (that is, not officially permanent) apparatuses and facilities:
  - Permanent

    Langley Aircraft Landing Dynamics Facility
    Langley 55-Foot Vacuum Chamber

  - Temporary

    neutron generator at the Langley Research Center
    outdoor anechoic test apparatus at the Langley Research Center

4.5.5. Calendar and Time Designations

Various holidays, historic events, and other time designations are capitalized:

- Names of months and days of the week

January	December
Sunday	Thursday

But seasons are not capitalized:

fall	spring

- Historic events

Revolutionary War	Sputnik Crisis
Renaissance	Louisiana Purchase

- Holidays

Veterans Day	Memorial Day
Thanksgiving	Presidents' Day

- Time zones are not capitalized:

  eastern standard time
  mountain daylight time
  noon

  But

  Greenwich mean time
  Pacific standard time

4.5.6. Scientific Names

In several scientific disciplines, there are conventions for capitalization of names, for example, the names of celestial bodies in astronomy and the names of soil groups in geology.

- Geologic names

  Upper Cambrian Period, Bronze Age (geologic periods)
  Laterite, Tundra (soil groups)

- Names of celestial bodies

  North Star, Halley's Comet
  Venus, Earth (the planet)
  the Sun, the Moon (Earth's)

  But

  earth (the ground) moons of Jupiter

- Biological names

  Arthropoda (phylum)
  Crustacea (class)
  Hypoparia (order)
  Agnostidae (family)
  Agnostus (genus)

  But

  canadensis (species)

Consult CBE (1978) or other specialized references for details of capitalization of biological names.

4.5.7. Titles of Works Titles of written and artistic works are capitalized.

- Historic documents

  Declaration of Independence
  Treaty of Paris

- Titles of documents, essays, and articles

  Slater, Philip N. 1980: *Remote Sensing—Optics and Optical Systems.* Addison-Wesley Publ. Co., Inc.

  Elterman, L. 1970: *Vertical-Attenuation Model With Eight Surface Meteorological Ranges From 2 to 14 Kilometers.* AFCRL-70-0200, U.S. Air Force, Mar. (Available from DTIC as AD 707 488.)

  Bowker, D. E.; Davis, R. E.; Von Ofenheim, W. H. C.; and Myrick, D. L. 1983: Estimation of Spectral Reflectance Signatures From Spectral Radiance Profiles. *Proceedings of the Seventeenth International Symposium on Remote Sensing of Environment, Volume II,* Environmental Research Inst. of Michigan, pp. 795–814.

  Allen, William A.; and Richardson, Arthur J. 1968: Interaction of Light With a Plant Canopy. *J. Opt. Soc. America,* vol. 58, no. 8, Aug., pp. 1923–1928.

  Note that a down style of capitalization for titles (Chicago Press 1982) is recommended by some publishers. We prefer an up style.

- Names of computer programs that are published (for example, in COSMIC):

  Optimal Regulator Algorithms for the Control of Linear Systems (ORACLS)
  Interaction of Structures, Aerodynamics, and Controls (ISAC)
  Aircraft Noise Prediction Program (ANOPP)

  But

  extended least squares algorithm (module of ISAC)
  optimization algorithm (in ORACLS)

- Public laws

  Freedom of Information Act
  Executive Order No. 24
  Public Law 271

- Works of art and music

  Blue Boy, Whistler's Mother
  Star Spangled Banner

4.5.8. Miscellaneous Names

The following are additional types of proper names:

- Races and tribes

Asian	Caucasian
Nordic	Cherokee

- Trade names

Kevlar	Macintosh
Xerox	Plexiglas

Note: To protect the owners of trade names, they should be used only as adjectives. Also, NASA's policy is to list the owner of a trade name, if the trade name is given at all.

- Official names of research missions, programs, and vehicles

Project Mercury
Space Shuttle
Aircraft Energy Efficiency Program
Apollo 12
Space Station *Freedom*

But

a space shuttle (generic sense)
Space Shuttle orbiter and external tank
Langley basic research program (not official name)
space station (generic sense)

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Glossary

The terms defined in this glossary are those used in the text. These definitions closely match any definitions given in the text and generally conform to the definitions found in Skillin et al. (1974).

active voice—sentence or verb whose subject is performing the action

adjective—word that modifies a noun, pronoun, or other substantive

adverb—word that can modify verbs, adjectives, and even other adverbs

antecedent—noun or substantive to which a pronoun refers

apostrophe—punctuation mark (') used to indicate possession, to form the plurals of abbreviations, characters, and signs, and to indicate omitted characters in contractions

appositive—the second of two nouns together which repeats the meaning of, or identifies, the first

argumentation—discourse that convinces by reasoning

article—the words *a, an,* or *the*

auxiliary verb—verb used with another verb to indicate voice, mood, and tense (*are, can, do, have, may, must, shall, will*)

broad reference—using pronouns to refer to the idea of the previous sentence or clause rather than to a particular antecedent (Ebbitt and Ebbitt 1982)

brackets—punctuation marks ([ ]) used to enclose editorial insertions, corrections, and comments in quoted material and in reference citations (nonmathematical)

caps & lc—capitalization of the principal words of an expression, Like This

case—form or position of a noun or substantive indicating its relation to other words in a sentence; see **nominative, objective, possessive**)

clause—group of words containing a subject and a predicate

close style of punctuation—using all punctuation that the grammatical structure will allow

collective noun—name of a group of people or things

colon—punctuation mark (:) used to separate and introduce lists, clauses, and quotations

comma—punctuation mark (,) used to separate and to enclose elements of a sentence in order to prevent misreading

common noun—name of a class or kind

comparative degree of modifier—modifier that indicates a quality existing to a greater or lesser degree in one thing than in another

compound predicates—two or more predicates in a sentence with the same subject

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conjunction—connective that joins sentences, clauses, phrases, or words

conjunctive adverb—adverb used as coordinating conjunction to join independent clauses (*therefore, however, thus, hence, otherwise*)

coordinate adjectives—adjectives that independently modify a noun

coordinate conjunction—conjunction that joins words, phrases, and clauses of equal rank (*and, but, or, nor*)

coordinating conjunction—conjunction that joins grammatically equal sentence elements, that is, a word to a word, a phrase to a phrase, or a clause to a clause, see **coordinate conjunction, correlative conjunction, conjunctive adverb**

correlative conjunction—pair of words that connect parallel sentence elements (*either . . . or, both . . . and, not only . . . but also*)

dash—punctuation mark (—) used to enclose and to separate sentence elements when the elements contain internal commas or when emphasis or suspense of the sense is desired

demonstrative pronoun—pronoun that refers to something present or near (*this, these*) or to something more remote (*that, those*)

dependent clause—clause that is subordinate to, or dependent on, the independent clause

description—discourse that gives a mental image

direct quotation—repetition without change of another's language; compare **indirect quotation**

em dash—see **dash**

en dash—punctuation mark (–) used to indicate inclusive numbers and to connect a unit modifier with a two-word element

exposition—discourse that explains how and why things happen

full caps—capitalization of every letter in an expression, LIKE THIS

gerund—verb ending in *ing* used as a noun

grammar—study of the classes of words, their inflections (changes in form to distinguish case, gender, tense, etc.), and functions in a sentence (Webster's New Collegiate Dictionary)

headline style capitalization—capitalization of all principal words (also called caps & lc)

hyphen—punctuation mark (-) used to connect words broken at the ends of lines, prefixes and suffixes to words, and compound words

imperative mood—verb form indicating a command

independent clause—clause on which the rest of the sentence depends

indicative mood—verb form indicating fact

indirect quotation or question—quotation or question expressed as a subordinate clause

infinitive—verb preceded by *to* used as an adverb, adjective, or noun

modifier—word, phrase, or clause that affects the meaning of another word or group of words; see **restrictive, nonrestrictive**

mood—form of verb indicating manner of doing or being; see **indicative, imperative, subjunctive**

narration—discourse that tells what happened

nominative absolute—noun or substantive not grammatically connected to the sentence and modified by a participle

nominative case—noun that is subject to a verb, a predicate nominative, in apposition to a nominative, or a nominative absolute

nonrestrictive modifier—modifier that does not limit or confine the meaning of the basic sentence

noun—word that names a person, place, or thing; see **common, proper**

objective case—noun that is object of a verb, preposition, or verbal

open style of punctuation—using only the punctuation necessary to prevent misreading

parallelism—writing logically equal ideas in the same grammatical structure

parentheses—punctuation marks (( )) used to enclose nonrestrictive or interrupting elements

participle—verb used as an adjective; may be present, ending in *ing*, or past, ending in *ed*

passive voice—verb or sentence whose subject is receiving the action

period—punctuation mark (.) used to mark the end of declarative and imperative sentences and other complete thoughts and to indicate abbreviations

personal pronoun—pronoun that refers to a person; may be first person (*I, we*), second person (*you*), third person (*he, she, they*)

points of ellipsis—three evenly spaced periods (. . .) used to indicate an omission, particularly from quoted matter

positive degree of modifier—modifier that indicates existence of a quality

possessive case—noun that denotes possession

predicate—verb in a sentence along with its modifiers and object

predicate nominative—substantive that completes a verb expressing state of being such as *to be, to appear, to become*

preposition—word governing a substantive—the object of the preposition—and connecting a phrase to a sentence

pronoun—word used in place of a noun

proper noun—the name of a particular person, place, or thing

question mark—punctuation mark (?) used to terminate a direct question

quotation marks—punctuation marks (' ' or " ") used to enclose words quoted from another source, direct discourse, or words requiring differentiation

relative pronoun—pronoun that replaces a noun in a dependent clause and connects the clause to the rest of the sentence

restrictive modifier—modifier that defines and thus cannot be omitted without changing the meaning of the basic sentence

semicolon—punctuation mark (;) used whenever a comma would not be sufficient to separate coordinate clauses, long internally punctuated elements of series, explanatory phrases and clauses, and elliptical clauses

sentence style capitalization—capitalization of the first letter of an element, for example, a figure caption or a item in a list

slash—punctuation mark (/) correctly used in *and/or,* in fractions (x/y), to indicate *per* (m/sec), and when quoting poetry; also used, with little grammatical basis, to indicate temporary compounds, particularly to indicate alternatives

subject—substantive along with its modifiers that tells what the sentence is about

subjunctive mood—verb form indicating a wish, a condition contrary to to fact, or a demand

subordinating conjunctions—conjunction that joins a dependent clause to an independent clause

substantive—word, phrase, or clause used as a noun

superlative degree of modifier—modifier that indicates a quality existing to the greatest or least degree in a group of things

tense—time of the action or state of being expressed by a verb

unit modifier—combination of words that modify another word

verb—word that can express action or state of being

verbal—word derived from a verb used as another part of speech; see **gerund, participle, infinitive**

voice—form of verb indicating whether the subject is performing the action (active) or receiving the action (passive)

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