



Technical Writing Guide

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1. INTRODUCTION

Technical writing requires a strong foundation in general writing, including knowledge of common grammar and punctuation conventions. The process is iterative and involves multiple reviews and revisions prior to publication. The Chicago Manual of Style is used in this guide because it is the College of Engineering standard. Be aware that other style manuals are often required as a writing standard.

This writing guide provides a format for writing and revising text and details on how to develop content that meets professional standards. Prior to submitting work, complete several iterations of editing and improving the text. Proofread again after several days, or at least hours, after the last examination. Then request an external reviewer to provide detailed constructive criticism. Consider and incorporate relevant feedback, then proofread the final document before submitting.

The Biosystems Engineering program provides many opportunities to learn from feedback on written assignments. By writing and revising, the ability to communicate effectively with both clarity and brevity will improve. Writing well is hard work but critical to academic and professional success.

2. TECHNICAL WRITING

Technical writing is direct, informative, clear, and concise language written specifically for an identified audience. The content must be accurate and complete with no exaggerations. To deliver the intended message, the text must be objective and persuasive without being argumentative. Developing technical documents that meet these requirements and standard guidelines is time consuming. This section provides an overview of those standards and a process for create interesting, informative text.

Before composing the text, identify the audience, determine the message, collect adequate information, brainstorm, and then develop a detailed outline. Details of each process are provided below.

1. Identify the audience by answering the following questions:
 - Who is the intended audience (one or multiple)?
 - What subject knowledge, vocabulary, and biases will the intended audience have?
 - How will the report be used?
 - What information must be conveyed and how much detail will be expected?
2. Determine the purpose of the report by evaluating the intended message. A clear message will help focus on what to include and what to discard.
3. Collect adequate relevant information with sufficient depth for the intended audience before starting to write.
4. Brainstorm by listing relevant ideas. Then group related thoughts together. Organize the key points and supporting details in a logical order. Ensure that each section relates to and supports the message, eliminating irrelevant ideas.
5. Develop an outline of heading and subheadings that convey key points; for example, use *Analytic Results of Energy Production* in place of *Results*. Then assign a length to each topic.

Next, develop figures and tables. Then begin writing, remembering to maintain consistency and use appropriate language. Create interesting text by developing coherent paragraphs that incorporate transitional words and sentence variety. Use correct grammar and punctuation.

A Technical Report Checklist is provided in Appendix A to assist with finalizing a document, and additional Style Guide Resources are provided in Appendix B.

2.1. PRODUCE FIGURES AND TABLES

Figures and tables enhance the report and explain the intended message. Distinguish between figures (schematic drawings, photographs, charts, graphs, etc.) and tables (tabular compilations of data or computational results). Follow these guidelines to assist the reader with understanding key points.

1. Make figures large enough to be easily read, generally at least one-third of a page in size. When feasible, maintain a consistent figure size throughout a report.
2. Select distinguishable line types and symbols, shades with patterns, and contrasting colors rather than color alone to maintain legibility in both color and black and white. Also use contrasting lettering (for example, white letters on darker images) to identify landmarks on photographs. This enables printing or copying in black and white, which is more common due to the expense of color.
3. Include a key if there are two or more lines, and use distinguishable symbol shapes and line types. Label both axes and include dimensions.
4. Use a photograph when an illustration is not adequate. When taking photographs, step back and think about the purpose of the photograph, take time to look at the composition and remove objects that pose a distraction. Make sure there is a strong contrast between objects. Take multiple photographs including close-up views to ensure that the object is large enough to be effective as an illustration. Use a flash or portrait setting to illuminate the target image, even in the daytime.
5. Provide a short descriptive title that provides content clarity so the figure or table will stand alone if removed from the report (e.g., *Figure 1. Schematic of the water treatment process*).
6. When a landmark, road name, or other information is referenced in the text, this information must be provided on the figure (e.g., Shaw Hall, Snow Road).
7. Horizontally center, within the report margins, figures and tables and the corresponding titles. Place figure titles below the figure and table titles above the table. Use portrait orientation whenever feasible. If landscape orientation is used, orient the base of the figure or table towards the right-hand side of the page and center within the report margins.
8. Refer to every figure and table in the text and number in the order referenced. Place the figure or table immediately following the text or paragraph that includes the reference. If this is not practical, place the figure or table on the next page. When the report has section numbers or appendices, include the section or appendix number within the figure and table number (e.g., Figure 4.3 is the third figure in Section 4, Table 5.1 is the first table in Section 5, and Figure A-1 is the first figure in Appendix A).
9. The title is part of the figure or table and requires a unique format. Use a bold font, sized 2 points smaller than the text, and format it as a “caption” style in Word.
10. Two-dimensional graphs and charts convey information more clearly than in three dimensions. Therefore, critically evaluate whether a three dimensional presentation of the information is necessary to convey the message.
11. Round values as needed for comprehension using Microsoft formatting options (Appendix C), and use the correct number of significant figures (Appendix D).
12. Use tables if there will be more than three to four entries.

For assistance with techniques for effective presentation of figures and tables, investigate the following resources available in the Biosystems Engineering Career Center:

Nicol, Adelheid A. M. and Penny M. Pexman. 2003. *Displaying Your Findings: A Practical Guide for Creating Figures, Posters, and Presentations*. Washington DC: American Psychological Association.

Davis, Martha. 2002. *Scientific Papers and Presentations*. San Diego, CA: Academic Press.

2.2. MAINTAIN CONSISTENCY

Clearly convey technical information by formatting the document consistently. Correctly and uniformly spell, capitalize, abbreviate, hyphenate, bold, and italicize text. Use correct grammar, punctuation, and spelling. Precede a number with a value less than one with a zero (e.g., 0.5), and use the correct number of significant figures (Appendix D).

To simplify the task of formatting uniformly, use Microsoft Word tools (highlighted in Appendix C) and follow these guidelines.

1. Use Times Roman typeface for easier reading. Apply Helvetica typeface, such as Arial, for viewing at a distance, although Arial's capital "i" is not different from the lower case "l" as in low.
2. Maintain a 2-point font size difference between subheading and main headings and use 11 or 12-point for the text. (This writing guide uses bold 18-point for the main headings, bold 16 and 14-point for the subheadings, and 11-point for the text.)
3. Reserve underlining for hyperlinks.
4. Provide 1-inch top, bottom, and side margins and adequate and consistent white space to separate information and make the document visually appealing.
5. Supply uniform spacing before and after headings and paragraphs. Left justify all paragraphs and use 1.5 line spacing except for itemized lists, which can be single spaced. Use two spaces between sentences.
6. Start a main heading on a new page, unless two main topics fit on one page or a section is less than half a page. Provide appropriate page breaks, making sure that content flows from one page to the next. Keep the introductory information on the same page as the list.
7. Keep numbers and salutations on the same text line with dimensions and names; examples include dimensioned numeric value (5 feet), numbered titles (Figure 12), and a salutation with name (Mr. Smith). (*In Microsoft Word hold down SHIFT-CTRL while adding a space or hyphen to keep the text together*)
8. When it is necessary to break a URL (uniform resource locator) or e-mail address, place a break (not a hyphen) between elements, after a slash, equal sign, colon, or the symbol @, but before any other punctuation or symbols. When an address includes a hyphen, avoid breaking at the hyphen to avoid confusion. (*In Microsoft Word add a break using SHIFT-ENTER to keep the URL as one continuous element.*)

[www.legislature.mi.gov/\(S\(hdzekx55hemtgi45fdu15xmz\)\)/mileg.aspx?page=getobject&objectname=mcl-451-1994-ii-2-soil-conservation-erosion-and-sedimentation-control-91&highlight=](http://www.legislature.mi.gov/(S(hdzekx55hemtgi45fdu15xmz))/mileg.aspx?page=getobject&objectname=mcl-451-1994-ii-2-soil-conservation-erosion-and-sedimentation-control-91&highlight=)

2.3. USE APPROPRIATE LANGUAGE

Technical reports use formal English, direct language, and simple terms. Make sure to select the correct term; review the list of commonly misused words in Appendix E. Employ correct scientific terms and conventions for engineers. Replace words that are a problem for the foreign reader, such as the verb “do” and words with multiple meanings (feel, do, as, like).

2.3.1. Formal English

Formal English is explicit even for the foreign reader who uses English as a second language. This requires elimination of contractions (I’m, don’t) and personal pronouns, which include: first person (e.g., I, we, our, us): second person (you, your, yours); and third person (he, her, it, theirs). Technical text is also void of colloquialisms, jargon, clichés, and sexist language – each of which is defined in detail below.

Colloquialisms (local or regional expressions) are characteristic of ordinary spoken or written communication that imitates informal speech, which may not carry the expected meaning. Examples include “gonna” for “going to” and “passed on” for “died.”

Jargon, or slang, is terminology that is used by a particular group of people in a specialized field; it may not be understandable by any other group or individual. If jargon is used, define or explain the meaning. For example, a “hydrostat transmission” is jargon for a “variable pump hydraulic transmission with infinite speed variability.” Examples of slang include “hang on” for “wait” and “run” for “computer simulation.”

Clichés, when first created, were vivid descriptions of something that was current in the minds of the people. As time passed, the descriptions lost their original meaning, and no longer represent descriptive text (e.g., avoid like the plague; a can of worms; in the long run; and by the same token). Technical writing must also be void of recent and current clichés.

Sexist language is inappropriately gender specific. To prevent bias, eliminate gender specific words to describe a category of people who could be either male or female. Do not use adaptations, such as he/she, because they hinder the text flow. As alternatives, use plurals, change words, or simply say he and she, his or her, him and her.

2.3.2. Direct Language

In technical writing, every word must have a place in the sentence and a meaning. Use direct statements and an active voice, avoiding past tense as much as possible, except in the executive summary, where past tense is always used. Use future tense to project into the future

Avoid saying the same thing twice and repeating the same word in a sentence. When a sentence contains the same word twice, try rewriting the sentence. Reword negative language to the positive.

Provide certainty by eliminating auxiliaries such as would, should, could, may, and might. Avoid ambiguous words and phrases by selecting a clearer alternative. Replace wordy text (despite the fact that) with a concise alternative (because). Additional examples of concise alternatives are provided in Appendix F.

2.3.3. Simple Terms

Impress the audience with analysis, not vocabulary. Replace complex words with simple language if it conveys the same meaning. This prevents the audience from interpreting the text, allowing the author to maintain control by forcing the reader to understand the intended meaning. Replacing the word “utilize” with “use” or “altercation” with “dispute” simplifies the text.

2.3.4. Action Verbs

Develop precise and interesting text. Replace verb-preposition combinations with high quality action verbs (go with → accompany, find out → discover, start out → begin). A list of action verbs is provided in Appendix G.

2.4. CREATE TEXT FLOW

Select an appropriate style and tone, and then simply write down ideas and facts without concern for quality or format under each heading and subheading. Then edit, wait, and edit again, eliminating irrelevant information, emotion, unsupported opinions, and judgments.

Organize the ideas into smooth flowing text by developing coherent paragraphs, using transitional words, and incorporating sentence variety. Be selective in the use of acronyms and initialisms. Use numbers or bullets to convey lists of information.

2.4.1. Coherent Paragraphs

Create paragraphs with a single topic or focus, and include supporting details. Each paragraph usually contains around five sentences (although this is not a rule). To improve comprehension, place the key topic at the beginning of a sentence and new information at the end.

All of the ideas contained within a paragraph must relate to one central thought. Arrange factual sentences in a logical order from general to specific. If there are ideas that relate to other foci, construct additional paragraphs.

In order to build the individual paragraphs into a complete paper, take ideas from the beginning paragraph and expand each into subsequent paragraphs. Link paragraphs together by stating what will appear in the next paragraph.

2.4.2. Transitional Words

Use transitional words to connect one idea to the next, one sentence to another, one paragraph to another. Forms of transitional words include: indicators for time order (earlier, later); position in time (rarely); sequence (next); occurrences that happen again (to explain); conclusions (in conclusion); the end of an idea (finally); compare/contrast (also/but); causality (because, as a result, therefore); spatial concerns (neighboring); and other connectors (or, nor, but, subsequently, then, besides, furthermore, similarly, likewise, moreover, in which, nevertheless).

2.4.3. Sentence Variety

Develop clear concise text by writing shorter sentences that are appropriate for the intended audience, avoiding very short sentences. Use a long sentence only when it consists of more than one clause and both the meaning and logical relationships between the clauses are clear. Avoid using phrases with more than three nouns in a row by dividing the phrase into a shorter noun phrase with a relative clause or prepositional phrase, or use hyphens to connect closely related words in the noun string. Compare the first example, which has six nouns in a row, with the rewritten sentence that follows:

The nanotechnology enhanced iron foam column contactor removes phosphorus ...

The column contactor uses nanotechnology-enhanced iron foam to remove phosphorus ...

For clear text that is understandable for non-native English-speaking readers, use simplified verb phrases and tenses. The sentence:

Fabricated steel components should not be welded by beginning students.

Could be written as

Beginning students should not weld fabricated steel components. (Simplified)

Locate previously introduced information in the topic (subject) position of the next sentence to assist with comprehension.

Bob called the dog. The dog stopped immediately.

When using prepositional phrases, make sure it is obvious what each preposition is modifying.

The news report stimulated conversation, but this did not resolve the problem.
(Does *this* refer to the news report or the conversation?)

Avoid ending a sentence in a preposition by selecting a more descriptive action verb.

The burglar finally gave up. The burglar finally surrendered.

To create smooth flowing text and interesting reading, vary the length and beginning of the sentences, arrangement of information, and kinds of sentences. Eliminate repeated words in a single sentence. Use the following diverse sentence structures to provide variety.

Simple sentence: Includes subject-verb-object, in that order.

The laboratory report summarized the results.

Compound sentence: A subordinate clause appears before the main clause.

If you find the answer, it will relieve everyone in the class.

Complex sentence: Consists of an independent clause followed by an independent clause

The final reports were due yesterday, and no one knew who had the original.

Compound/complex sentence: An independent clause is preceded or followed by a subordinate clause and then a second independent clause.

If you find the answer, it will relieve everyone in the class; admiration from all is a nice reward.

2.4.4. Acronyms and Initialisms

Both acronyms and initialisms are abbreviations formed using the first letter of a series of words. Acronyms are pronounced as a word, whereas initialisms are pronounced as a series of letters (IBM).

Sometimes an acronym or initialism is more commonly used than the words themselves. For example, random access memory is known by its acronym, RAM and the International Business Machines Corporation as IBM. Some acronyms, like "scuba" (self-contained underwater breathing apparatus), have become so accepted that their original derivations have been lost and the acronyms have been added as new words to the English language.

Using uncommon acronyms and initialisms makes reading harder for all but a few specialists; therefore, be selective and limit their use. When using either, write the full name or phrase followed by the acronym or initialism in parentheses for the first appearance. However, do not follow this procedure if the acronym is not used again.

An acronym or initialism followed by a simple *s* is the plural form. Whereas an acronym with an *'s* shows the possessive form.

2.5. USE CORRECT GRAMMAR

2.5.1. Parallel Structure

Parallel structure means using the same form for words that have the same level of importance in a sentence or for a list of items that are joined by a coordinating conjunction, such as "and" or "or."

The scientist collected, dried, and weighed the samples.

When preparing bulleted or numbered lists use the same word type (i.e., all nouns, all verbs) and maintain parallel structure. If the listed items complete the introduction grammatically, place a period at the end of every line. Capitalize the first word in a bulleted or numbered list.

In preparation for the FE Exam, the students will review the following:

**Circuits
Economics
Statics**

2.5.2. Subjects and Verbs

It is important for text to flow smoothly. Subject and verb quality and agreement are essential and allow the reader to move through the text. To ensure the reader understands the intended meaning, abide by the following subject and verb rules and use the correct verb tense:

1. Subjects and verbs must agree in person and number---singular with singular, plural with plural.
2. A verb must agree with its subject, not with the words that come between the two.

The Club President, along with the officers, is going to the conference.

3. Subjects joined by "*and*" usually take a plural verb.

Platinum, gold, and lead are available in the laboratory.

4. When subjects are joined by "*or*" or "*nor*", the verb agrees with the subject closest to it.

Cherries or two apple varieties have been used in the study.

5. When using subordinate clauses with a pronoun as subject, the verb agrees with the antecedent to which the pronoun refers.

Robert earned excellent grades, because he worked very hard.

6. A verb agrees with the subject, even though in many cases the subject will follow the verb.

Educating the committee is difficult.

7. When using a linking verb (is, are, was, were, forms of be) the subject is the noun that precedes the verb, not the nouns that follow the verb.

The dogs are running down the street.

8. Select quality verbs that demonstrate an action. A list of action verbs is provided in Appendix G.

take any → accept

talk about → discuss

went up → rose, increased

leave out → exclude

go with → select

written up → composed

2.5.3. Active and Passive Voice

Take responsibility by writing in active voice; use passive voice only when it is appropriate for emphasis or when you lack information. Active voice distinctly identifies the subject and the action taken by the subject. The passive voice indicates that the subject receives, rather than performs, the action.

The sound's reverberation struck the walls.

Passive voice changes the position of the previous subject into an indirect object and focuses the sentence on what receives the action, the walls:

The walls were struck by the sound's reverberation.

When the active voice is appropriate, use it to create concise, energetic text. Only use the passive voice when it is appropriate to say that an action is done to the subject.

The final project was finished by the team. (passive)

The team finished the final project. (active)

For additional examples and explanation, visit the Purdue University Online Writing Lab (OWL) at:

http://owl.english.purdue.edu/handouts/grammar/g_actpass.html.

2.5.4. Cases of Pronouns

1. Nominative Pronouns: Used as a subject in the sentence (I, we, you, he, she, it, who, and they):

Mary and I will attend. The guard who let us in checked our identification.

2. Objective Pronouns: Used as objects of verbs or prepositions (me, us, you, him, whom, and them):

He questioned Susan and me about the copyright. Whom did you ask?

3. Possessive Pronouns: Used to show possession or ownership (my, mine, our, your, his, her, theirs, its, whose, etc.):

The Swartz Company may lose its best customer.

2.5.5. Pronoun and Antecedent Agreement

1. A pronoun and its antecedent must agree in number. Examine the various constructions of compound antecedents and the proper protocol in the examples below.

The owner is concerned about sales, but *they* will rebound.

The President or his advisers should devote part of their time to this issue.

2. A parenthetical expression that appears between an antecedent and a pronoun does not influence the form of the pronoun used.

The accountant, rather than any of the other officers, will be asked for his or her opinion of this purchase.

3. If the antecedent is a collective noun that refers to a group as a single unit, a singular pronoun is needed. Company names are generally considered to be collective nouns.

Stein & Smith has sold its Chicago properties.

4. For clarity, make pronoun usage clear and understandable by avoiding vague references.

I worked hard on the experiment, and it was difficult. Does the writer want us to consider the experiment as difficult, the work that was done as difficult, or that it was difficult to work hard?

2.5.6. Compound Words

A compound word conveys a unit that is not as clearly conveyed by separate words.

1. Use a hyphen to connect elements of compound numbers from twenty-one to ninety-nine and in adjective compounds with a numerical first element. The hyphen not only unites but also separates the component words.

7-hour day, 3-inch ruler, eighty-five.

2. Use a hyphen after the “e” to designate “electronic”:

e-mail, e-commerce, e-article

3. Omit the hyphen when words appear in regular order and the omission of the hyphen causes no confusion in sound or meaning.

palm oil, eye opener, living costs

4. Use a hyphen for clarification when four nouns appear in a row.

A sand-filtered purification system. The end-of-year report.

2.5.7. Capitalization

1. Capitalize the name of a particular person, place, or thing, as well as an adjective that refers to a specific name.

Canada/Canadian, Tibetan Alpacas

2. Capitalize descriptive names that are substituted frequently for the real proper names.

the Windy City, Honest Abe

3. Capitalize brand names and trademarked names.
Palmolive soap, Maxwell House coffee
4. Generally capitalize a noun that is followed by a number or letter used to identify a unit or division.
Lot 14, Tract 833, Volume III, Chapter 8, Policy No. 12345, Catalog No. 214.
5. Capitalize the names of courses of study only if they are derived from proper nouns.
English, shorthand, history, German, Business Mathematics 121
6. Unless a comma intervenes, capitalize titles that precede names; generally, do not capitalize those that follow names.
I have never met Congressman Nelson.
I have never met our congressman, Tim Nelson.
Professor Swartz did the research.
7. A name that indicates a family relationship is usually capitalized unless a noun or a pronoun in the possessive case precedes it.
Uncle Ralph, Mother
My aunt Millie, my mother
8. The names for the points of the compass and their derivatives are capitalized when used to name regions, but not when used to indicate directions.
This sweater was made in the East. Turn west on M-20.
9. Capitalize the name of a season or the word "nature" only if it is spoken of as if it were human.
Old Man Winter left a foot of snow; our spring suits are on sale.
10. All words except articles (a, an, the), conjunctions, and short prepositions are capitalized in names or titles that consist of more than one word. Do not capitalize "the" if it precedes the name of an organization but is not actually a part of that organization's name.
Official Draft of the NBA; the Eastman Kodak Company
11. Do not capitalize classes (freshman, sophomore, junior, or senior), degrees (doctorate, doctor's, master's, bachelor's, baccalaureate), or seasons (spring, summer, fall, winter), unless they appear at the beginning of a sentence or in a headline.
12. Readability studies have shown that text is more easily read when in lower case as opposed to all caps. When too many words are capitalized, they lose their importance. Emphasis is achieved more effectively by using various font styles and sizes.

2.5.8. Numbers as Words

1. Generally spell out isolated numbers from one to ten.

The discussion lasted for ten minutes.

2. Unless emphasizing them, spell out indefinite numbers that may be expressed in one or two words.

Approximately thirty appliances were damaged.

3. Spell out a number that introduces a sentence. If the number is long, recast the sentence to avoid awkwardness.

Twenty people attended the lecture.

4. Spell out common fractions that are used alone. However, use figures in writing a mixed number.

He refused to accept his one-fourth share.

The hike was 10 ½ miles long.

5. When two numbers come together, express one in figures and the other in words. As a rule, spell the first number unless the second number is a significantly shorter word; i.e.,

Sixty \$5 bills or 500 four-page booklets.

6. When rounding numbers, spell out million or billion to make reading easier.

This tax legislation will increase revenue by \$7 million.

2.5.9. Numbers – Text or Digits

1. Generally use numerals to express all exact numbers above ten.

The corporate file has been missing for 31 days.

2. Use the written form of a number for values 10 and below except to express market quotations, dimensions, temperature, decimals, street numbers, pages and divisions of a book, time, weights and measures, and identification numbers.

The experiment had three independent variables staged at 5, 10, and 15 degrees Kelvin.

3. If several numbers in a sentence perform similar functions, express them uniformly. If one is written as a figure, write all as figures.

The inventory shows 21 ranges, 9 refrigerators, 37 washers, and 10 dryers.

The 32 tables sold in five days. (The numbers do not perform similar functions.)

2.5.10. That and Which

Generally “that” defines and restricts; “which” provides additional information.

“That” is used restrictively to narrow a category or identify a particular thing. The information following “that” is critical to the reader’s understanding.

The article *that* was printed in the newspaper yesterday is inaccurate.

“Which” is used nonrestrictively to add some descriptive but incidental information and is preceded by a comma, a dash, or a parenthesis.

The ballerina was dancing around the room wearing a baseball cap, which is not something you would expect.

“Which” is used restrictively only when it is preceded by a pronoun.

Realize that you will be asked for your opinions about topics in which you do not feel completely comfortable.

For example, note the usage of “*that*” twice, and the lack of commas, in the following text causes confusion.

There are other factors that contribute to the uncertainty that were not considered in the...

The first “*that*” introduces a restrictive clause that essentially describes the noun, “factors,” and the meaning of the sentence. The reader needs to know “*that*” other factors “*contribute to the uncertainty.*” In the case of the second “*that*,” the idea of the factors not being considered is also critical to the understanding of the sentence. The following sentence clarifies the meaning.

There are other factors that will impact funding, which have garnered little interest in the audience.

The rewritten passage uses one “*which*” and one “*that*.” The “*which*” introduces a nonrestrictive clause, which simply provides additional information to the reader. The “*that*” clause contains information that is vital to the context.

2.6. PUNCTUATE PROPERLY

Punctuation is used to clarify the sentence structure and prevent misreading. A comma is used to prevent reading “general errors” in the following sentence.

In general, errors fall into two categories ...

In the following example, simple words run together and cause confusion.

In this experiment error could have been introduced...

Adding a comma prevents confusion.

In this experiment, error could have been introduced...

Eliminate punctuation that clutters the text or detracts from the content. If lack of punctuation hurts the meaning, then add punctuation.

2.6.1. Comma

Commas are the smallest break in sentence structure and indicate a slight pause. They clarify the meaning of a sentence and are used:

1. To separate items in a series. The Chicago Manual of Style requires a comma after each item in a series, including before the conjunction, including both “and” and “or.”

The experiment was conducted quietly, quickly, and satisfactorily.

Please contact Dr. Jones at his office, laboratory, or home.

However, other style guides require a comma before the “and” but not the “or.” When preparing documents, check with the publisher, professor, or company for the required form and be consistent.

2. In a series of clauses.

Included within this report are theory and methods of analysis, equipment and experimental setup, procedure guidelines, results, a discussion of results, and conclusions.

3. Before a coordinate conjunction (and, or, but, nor, for, so) that joins two main (independent — equal elements) clauses in a compound sentence, do not use a comma if the second part of the sentence cannot stand alone.

The final session ended, and the students went home.

John saw the car coming towards the bike, so he started to scream.

The students counted the proceeds and are pleased with the results.

4. After an introductory verbal phrase that is used as a modifier. Look for introductory words such as after, although, as, at, because, before, by, for, if, in, to, unless, until, when, while, and with.

Looking to the future, he began to contribute to an individual retirement account.

5. To separate the items in a date or an address.

On May 15, 2005, we moved.

6. After an introductory adverb clause.

If we advertise our product, our sales will increase.

7. To set off nonrestrictive (not necessary) clauses and phrases.

The four articles, all of which were published in important journals, explained the details of her work.

8. To set off parenthetical elements: as a result, for example, however, if necessary, indeed, it seems, of course, therefore, nevertheless.

This, indeed, is what we expected from the experiment.

All of the test results, it seems, will have to be reanalyzed.

9. To set off parenthetical expressions:

The showcase, showing the true skills of the graduates, was impressive.

Susan, on the other hand, is reserved.

10. To emphasize words that are independent of a main clause or clearly nonrestrictive. Such items may be divided into several categories: Direct address, appositives, interjections, quotations, abbreviations that follow names to indicate such things as titles and degrees, contrasting expressions, and tag questions.

Dr. Jones, chair of the search committee, called the meeting to order.

11. To clarify the meaning of a sentence.

The book *My Life*, written by Mr. Smith, was a best seller. (Nonrestrictive)

The book written by Mr. Smith was a best seller. (Restrictive)

12. When they are needed to prevent misreading.

The parts shipment was, unfortunately, delayed in transit.

13. When they are needed to secure emphasis.

It may be a long, long time before we can reconvene.

14. For clarification.

As we sat down to eat, the cat watched with curiosity.

2.6.2. Colon

Colons link related thoughts, but one of those thoughts must be able to stand alone as a sentence. The series of elements following the colon amplifies what precedes the colon.

The lab needed two more pieces of equipment to fulfill the contract: a vise and a drill press.

Colons may be used in place of a period to introduce a series of related sentences.

He had to make a choice: Should he tell the truth? Or should he protect his family?

When a colon precedes a complete sentence, capitalize the first word after the colon.

The faculty board made a final decision: Students' submitted work must meet technical writing standards throughout their curriculum.

Colons are also used to introduce lists.

Professor Smith's qualifications include:

- a. Designing machinery systems**
- b. Evaluating financial markets**
- c. Working with students**

When used in text with equations, colons are used after the words follow, follows, and following.

Equation (7) is transformed into the following:

$$x + y = 32.7$$

When used in a URL address, no space precedes or follows the colon.

<http://www.egr.msu.edu>

2.6.3. Semicolon

Place a semicolon halfway between the comma and the period in force and restrict the use of a semicolon to the following situations:

1. Before a transitional adverb (however, thus, hence, indeed, accordingly, besides, therefore).

The brochures have already been printed; however, they have not yet been distributed.

2. Between two closely connected but independent clauses of a compound sentence that are not joined by a coordinating conjunction (and, but, or, nor, for, yet, or so).

Make sure to select the correct term; review the list of commonly misused words in Appendix E.

3. Before the coordinating conjunction (and, but, or, nor, for, yet, or so) in a compound sentence when the clauses have internal punctuation or are long or complex.

The research conclusions are exciting; it will revolutionize how cheese—the greatest of all Wisconsin’s exports—will be made in the future.

4. Before the coordinating conjunction in a compound sentence to provide separate emphasis.

It was the resistor; despite all of the modifications, it did not work.

5. To separate items in a series when the items themselves contain commas.

The four most important dates in the firm's history are June 12, 1888; May 10, 1920; October 4, 1939; and December 1, 1982.

6. Before a coordinate conjunction that separates two main clauses, and if there are commas within the clauses:

His determination, his courage, and his sincerity could not be denied; but his methods were often questioned.

2.6.4. Apostrophes

Apostrophes indicate a contraction or a possessive case.

In informal English, apostrophes are used to shorten a phrase, forming a contraction:

I am I'm

They are They're

It is It's (NOTE: *its* is the possessive form--without the apostrophe)

Contractions are not to be used in technical writing.

Use an apostrophe to indicate possession by observing the following rules:

1. Form the possessive case of a singular noun or number by adding an apostrophe and s ('s):

Sue's notebook. 2005's hurricane season.

2. Form the possessive case of a singular noun that has two or more syllables and ends in an s or z sound by adding only an apostrophe:

The waitress' manner. The crisis' origin

3. Form the possessive of a regular plural noun (one ending in s) by adding only an apostrophe after the s:

The boys' accounts

4. Form the possessive of an irregular plural noun (one not ending in s) by adding an apostrophe and s:

Men's hair

5. Form the possessive for names by adding an apostrophe and an s even when the person's name ends in s or another sibilant. Two traditional exceptions include Jesus' and Moses'.

Swartz's home. Marx's property. Hertz's rent a car.

6. When two linked nouns possess the same thing, only the second noun is written in the possessive form. However, if the linked nouns possess different entities (described as one in the sentence), each is written in the possessive form.

Bert and Ernie's dogs are here. (The dogs collectively belongs to both Bert and Ernie)

Bert's and Ernie's dogs are here. (The dogs belong to different entities.)

Do not use an apostrophe to indicate plurals, including the plurals of acronyms and abbreviations unless the result is confusing, for example U's and Us.

There are three 6s in that number. There were four PhDs in last year's class.

Apostrophes are required for bachelor's degree and master's degree, because possession is indicated.

2.6.5. Quotation Marks

Use quotation marks to enclose direct quotes.

Use a single quotation mark when a quote is inside another quote.

Place periods and commas inside quotation marks.

He said, "I will review and edit my documents carefully."

"I will always ask my peers to review my papers before turning them in," said the student.

Colons and semicolons are placed after the quotation marks.

You said, "I will turn in my work before leaving"; it was not in my mailbox.

A question mark goes outside the quotation marks when the entire sentence is a question and inside when the quoted phrase is a question.

When Joe asked the question, "Did you see the roach cross the room?" the roach appeared before our eyes.

Did the delivery person say, "I left the package in the basement"?

An exclamation point is placed inside the quotation mark only when it is part of the quoted material.

The student cried, "The power is on!"

2.6.6. Parentheses

At the end of a sentence, the punctuation is placed inside the parentheses only when a complete sentence is enclosed within the parentheses.

The new fee schedule is effective September 1, 2005. (All students have been notified.)

All faculty will be placed on a nine month appointment (provided other requirements have been met).

2.6.7. Hyphens and Dashes

Hyphen (-) separates characters (when spelling out a word) or separating groups of numbers (telephone).

“My name is p-r-i-n-c-e-s-s and my number is 555-5555,” she told the boy in the club.

En dashes (–) connect numbers and words, and signify *up to and including*.

The test temperature range is 20–32°C.

Em dashes (—) emphasize the text to follow, introduce a list, or restate something.

The pottery lab has many bulk chemicals—aluminum oxide, bentonite, bone ash, borax, bromine, chlorine, dolomite, and nickel oxide.

2.7. IMPROVE THE TEXT

To make the revision process more efficient, review the document in passes. Focus first on content by evaluating the following questions, editing as needed to eliminate unnecessary or conflicting information.

1. Is the purpose and message clearly defined?
2. Are the key points and supporting details easily identified and complete?
3. Are there concepts or background information missing that the reader needs?
4. If information is deleted, will the reader’s understanding be jeopardized?
5. Is the content accurate and complete with no exaggerations?
6. Does the data support the conclusions?
7. Are the conclusions and recommendations clear and logical?
8. Are there contradicting statements?

Using the Technical Writing Checklist (Appendix A) as guidance, evaluate the figures and tables and make needed refinements. Then review for consistency, appropriate language, and text flow. Improve the style by reviewing each paragraph for coherency and considering the selected words, the structure of each sentence, and the information presented. Evaluate how each sentence combines with those preceding and following it. Refine the text to improve the clarity and interest until satisfied.

After an extended time, proofread for grammar, punctuation, and spelling, including correctly spelled but incorrectly used words, such as bases/basis, capitol/capital.

2.8. INCORPORATE PEER REVIEW

Engineers are often requested to review the work of other engineers and provide feedback. The requests range from looking at a document and giving a one-word response to providing a detailed assessment of a technical report with recommendations.

When asking a peer to evaluate a document, request both positive and negative comments along with a detailed explanation of why particular remarks are made. To assist with incorporating group or reviewer comments, add line numbers under Microsoft Word “print layout view” for easy reference and use common editorial marks provided in Appendix H. Offer the Technical Writing Checklist (Appendix A) as a guidance for the reviewer. Consider the comments and incorporate those that clarify and improve the message. Thank the reviewer for the assistance.

3. LABORATORY REPORTS

The principle objective of a laboratory report is to summarize the purpose and results of an experiment. When a Pre-Laboratory Report is requested, prepare a written document prior to conducting the laboratory experiment and include the following in the order listed:

1. Cover page with lab title and objectives and measurement variables clearly indicated
2. Supplies and equipment required for the experiment
3. Start-up procedure
4. Operating procedure
5. Shutdown/clean-up procedure
6. Emergency shut-down procedure
7. General safety hazards and required precautions
8. Theoretical analysis and sample calculations: document the theory governing the experiment; and relevant equations used in the calculations, their limitations, and their sources
9. Blank data sheets to record experimental results

Prepare a transmittal letter and organize the laboratory report content into front matter, report text, and an appendix using the following guidelines.

3.1. FRONT MATTER

Front matter includes the title page, executive summary, nomenclature, acronyms and initialisms, and measurement abbreviations. A detailed description of each is provided below. Consecutively number the front matter with lowercase Roman numerals (i, ii, iii...) in the footer at the bottom center of the page. The title page and executive summary are counted; however, they do not have page numbers.

3.1.1. Title Page

Include on the title page the lab title, course name, completion date, and author names. Do not use abbreviations, acronyms, or jargon in the title. The title page is counted as page "i", but it is not numbered.

3.1.2. Executive Summary

The executive summary is written after the work is complete in past tense. The executive summary is counted as page "ii" but is not numbered. It conveys the key elements of the lab experiment in concise language and includes:

1. Background
2. Why and how the experiment or test was performed
3. The materials and methods used to accomplish the tasks
4. Important results, including the extent of agreement between experimental results and theoretical predictions, and experimental errors and their estimated effects on the results

5. What was discovered, achieved, or concluded
6. Relevant recommendations

3.1.3. Nomenclature

List and define all symbols used in the report in alphabetical order, uppercase then lowercase, followed by Arabic, and then Greek.

3.1.4. Acronyms and Initialisms

List and define acronyms and initialisms used in the report.

3.1.5. Measurement Abbreviations

Summarize measurement abbreviations used in the document, including the appendix, by listing the term, followed by a comma, and then the abbreviation. Examples include:

- degree Celsius, °C
- minute(s), min
- inch, in.
- liter (no abbreviation)

3.2. REPORT TEXT

The lab report text includes the Background, Experimental Equipment, and Procedures, Theoretical Analysis, Results, Discussion, Conclusions and Recommendations, and References sections. Number the report text pages with Arabic numerals in the bottom center of each page (1, 2, 3...). Restrict handwritten information, such as sample calculations, to the appendix. Provide context below each heading for subordinate subheadings.

3.2.1. Background

Provide known information to orient the reader.

3.2.2. Experimental Equipment and Procedures

If the experimental equipment and procedures are not established, include details of the techniques used. Provide enough detail to allow someone familiar with the general area of investigation to reproduce the experiments from the report information.

Specify the equipment used, giving credit to the manufacturer. Provide photographs taken during the experiment or a schematic representation of the equipment or simulation program. Include detailed views of unusual or important components and relevant dimensions. Both photographs and schematics must have adequate contrast to be legible when printed in black and white.

Summarize procedures used (not specific steps). Discuss the type of data collected and the methods used for data collection, reduction, and management.

3.2.3. Theoretical Analysis

Analytically support each experiment by providing mathematical equations used to predict system behavior. Provide and number relevant equations (e.g., Equation 1.3).

The analysis proceeds from the general (and well-known) basic relationships and evolves to the specific formulae used in the data interpretation. Reference previously derived and readily available analytical results using the format in the following example: Equation 6.2 (Smith, 1999). Derivation of the referenced equation is not necessary. Present relevant mathematical analyses, in the order required for the experiment, along with supporting explanations and commentaries needed for the reader to understand the specific analysis.

3.2.4. Results

Clearly present the experimental results in a condensed, logical manner, using tables or graphs. Point out data trends (expound in the Discussion section); and identify concluding observations. Tables and/or graphs containing quality-assurance/quality-control data are required. Provide raw data and sample calculations in an appendix. Use short statements to present the results without discussion. Provide an explanation when needed to prevent incorrect interpretations of the results.

3.2.5. Discussion

Follow a logical progression. Begin with a very brief summary statement of the results and then proceed with a discussion of these results. Focus the discussion on the interpretation of the results; note what is "as expected" and what is unexpected. Comment on future investigations if appropriate.

Include the following, not necessarily in this order:

1. Assessment of the reliability of the data and/or calculated results
2. Comparison of experimental data to theoretical predictions and the results of similar investigations
3. Observed differences and rational explanations for these differences
4. Error analyses, noting measurement accuracy and estimated uncertainties
5. Unusual and/or unexpected observations, and the most likely causes

Keep in mind that good paragraph construction presents an idea and then gives supporting details. Start sentences with known information and then expand upon this information with new related information. Move to the next paragraph when introducing new points.

3.2.6. Conclusions and Recommendations

The conclusions must follow logically and directly from the Results and Discussion sections and must not include any new information. Make sure the conclusions are supported by data or analysis. Direct the reader by stating: "The following conclusions are listed in order of priority and are supported by the results of this study." Then list each conclusion in one or more concise and highly specific (declarative) sentences, using numbers to differentiate each separate conclusion. Remember that engineers, managers, and executives are looking for concise statements that clearly tell them what the results and discussion have formulated. They are not interested at that point about further investigation or explanation. They want the masses of data synthesized into the briefest possible conclusions.

Provide recommendations based on the results and conclusions. Caution the reader about any assumptions and limitations and identify issues that remain unresolved (if appropriate). This section is an opportunity to look to the future and imply that the reader has accepted the author's opinions.

3.2.7. References

Include all references, including established technical specifications (standards) and protocols.

3.3. APPENDICES

Include material such as raw data; sample, intermediate, or lengthy calculations; long derivatives or detailed information not pertinent to the understanding of the lab report in the appendices. The instructor may request inclusion of the Pre Laboratory Report as an appendix.

Identify all appendix materials within the body of the report. When using multiple appendices, label them with capital letters (A, B, ...) and place them in the order referenced in the report. Provide a descriptive name for each appendix (e.g., Appendix A: Rheology Data). Number each appendix page with the corresponding capital letter followed by Arabic numerals in the bottom center of each page (A1, A2, A3..., B1, B2, B3...). This requires inserting "*section breaks/next page*" between appendices.

4. ENGINEERING DESIGN REPORTS

Technical reports incorporate information gathered in an experiment, simulation, or design into a useful document for others. When prepared for a client, the report is accompanied by a transmittal letter using a formal business letter format. The transmittal letter provides an opportunity to thank the client, convey information needed before the report is read, and outline needed actions.

Engineering design reports begin with identifying the core problem and project objectives. This requires completion of the following tasks.

1. Interview the client to identify needs and project constraints.
2. Conduct a literature review to determine if the proposed work is feasible and needed.
3. Investigate industry standards and acceptable quality assurance/quality control practices that may impact or be used during the design process.
4. Refine the problem statement and objectives. Include measurable criteria that will illustrate when each objective is met.
5. Develop a schematic of the current system (if applicable).
6. Identify additional research needs for project design.
7. Prepare a detailed project management plan (Microsoft Project) to organize and prioritize tasks, which will be used in the preparation of an outline for the technical report.

Organize a technical report into front matter, report text, and an appendix using the following guidelines.

4.1. FRONT MATTER

Front matter includes the title page, executive summary, table of contents, list of figures, list of tables, nomenclature, acronyms and initialisms, and measurement abbreviations. A detailed description of each is provided below. Consecutively number the front matter with lowercase Roman numerals (i, ii, iii...) in the bottom center of the page. The title page and executive summary are counted; however, they do not have page numbers.

4.1.1. Title Page

Develop a brief and clear title, using no more than seven to eight words that provide specificity to the report. The title often identifies the purpose of the work and the intended audience. Do not use abbreviations, acronyms, or jargon in the title. Readers use the title to decide whether to read the executive summary. Keep in mind that the title is used by bibliographic systems for paper retrieval; an inappropriate title may miss the target audience.

Include on the title page the report title, course name, completion date, and author name(s). The title page is counted as page "i," but it is not shown.

4.1.2. Executive Summary

The executive summary conveys the key elements in concise language. Compose the executive summary in past tense after the work is complete. To enable the executive summary to “stand alone” when removed from the document, make no reference to the main text or the literature review. Include the following information.

1. Background, including the purpose of the work
2. Problem statement and objectives
3. What has been accomplished
4. Key results
5. Implications of cost
6. Conclusions
7. Recommendations

4.1.3. Acknowledgements

Provide a statement of gratitude to the project sponsor and academic or technical advisors that contributed to the project success.

4.1.4. Table of Contents

Identify report headings (left justified) and subheadings (indented equally) followed by leading periods with the page number justified with the right margin. Use sentence case for headings and subheadings. The pages preceding the Table of Contents are not listed. Use Microsoft Word “headings” and auto-functions to create and automatically update the Table of Contents. View the Table of Contents in this writing guide as an example.

4.1.5. List of Figures

If the report includes more than three figures, list the figure captions and the corresponding page number. Use Microsoft Word functions to create and update the List of Figures. See example below.

List of Figures

Figure 1. Corey's Curves for calculation of relative permeability	7
Figure 2. Two-dimensional view of cherry tank and perimeter spider	14
Figure 3. Three-dimensional view of cherry tank and perimeter spider	15
Figure 4. Two-dimensional view of cherry tank and symmetric spider.....	16

4.1.6. List of Tables

If the report includes more than three tables, list the title captions and the corresponding page number. Use Microsoft Word functions to create and update the List of Tables. Use the same format as shown in the example for List of Figures.

4.1.7. Nomenclature

List and define all symbols used in the report in alphabetical order, uppercase (A, C) then lowercase (d, m), followed by Arabic (ﻭ, ﻑ) and then Greek (Φ , Ω).

4.1.8. Acronyms and Initialisms

List and define acronyms and initialisms used in the report.

4.1.9. Measurement Abbreviations

Summarize measurement abbreviations used in the document, including the appendix, by listing the term, followed by a comma, and then the abbreviation. Examples include:

cubic centimeter, cm³
cubic feet per second, cfs
diameter, diam
foot (feet), ft

4.2. REPORT TEXT

Include the Background, Problem Statement and Objectives, Alternative Selection, Project Design, Results, Economic Analysis of Alternatives, Conclusions and Recommendations, and References sections in the technical report text. The details of each section are explained below.

Number the report text pages with Arabic numerals in the bottom center of each page (1, 2, 3...). Restrict handwritten information, such as sample calculations, to the appendix. Provide context below each heading for subordinate subheadings.

4.2.1. Background

Summarize known information specifically relevant to the project in a logically organized manner; use subheadings if necessary to organize the material. Include published research and significant and relevant results from other studies. Document the feasibility and needs of the project and provide data or information to support the objectives.

4.2.2. Problem Statement and Objectives

Prepare a concise problem statement based on the literature review findings and the client's identified needs. Then develop specific objectives from the problem statement. The objective contains a general statement that is followed by very specific measurable criteria and project constraints, which are client requested and site specific. All further work must be in support of the objective statements.

4.2.3. Alternative Selection

Present a clear description of feasible alternatives that meet the objectives. Include background information for each alternative and their advantages and disadvantages. Consider using a table to summarize the comparisons. Include a level of detail that allows for the selection of alternatives with the most promise and the elimination of those that have no potential and do not require additional consideration. Clearly describe the selection criteria and identify data gaps. Identify data needed to make recommendations.

4.2.4. Project Design

Describe the methodical approach required to fill the data gaps identified in the Alternative Selection section. The detail must be at a level that allows a similarly qualified design team to replicate the work without consulting the authors. Incorporate industry acceptable quality assurance/quality control practices into the design and fully describe data handling and presentation techniques. Experimentation must be in support of the project objectives. List critical assumptions used in developing the design.

4.2.5. Results

Report the project design results in a condensed, logical manner, including tabulated or graphical form. The results must match the project design and be in support of the objectives. Include only data and graphs that meet quality-assurance/quality-control protocols and directly support the objectives and alternative selection. Place supporting data and calculations in the appendix.

Because some will read the Executive Summary and then go directly to the Results, a logical cohesive presentation with a clear explanation of the purpose of each component is necessary.

4.2.6. Economic Analysis of Alternatives

Present a streamlined life-cycle economical analysis of equally effective preliminary alternatives. Further refine the selection using the results from the analysis. The economical analysis must account for the capital, operational, and maintenance costs for the design life, the depreciation of all equipment, and the time value of money. Present the results in easily understood terms such as simple payback period (breakeven analysis) or annual costs over the design life.

The alternative selection from a system's approach may consider non-quantitative factors, including ethical and social impacts, safety issues, and sustainability.

To account for uncertainty, assess the variability of all costs and conduct a sensitivity analyses on those that are volatile and have the potential to influence the selected alternative.

4.2.7. Conclusions and Recommendations

Present the alternative selected (if able to select), the final cost, and the primary reasons. Discuss data gaps and uncertainties.

Include as a recommendation additional experimentation needed to gain more certainty and the advantages and disadvantages of conducting these experiments. Include other observations relevant to the objectives.

4.2.8. References

Documentation of important reference material is essential; however, to prevent plagiarism, use direct quotes rather than paraphrasing the author's words when documenting the results or interpretations of a research article.

When compiling references, check with the publisher, professor, or company to determine the form to follow. If none is specified, use any appropriate form as long as it is consistent. Two commonly used citation styles include the Modern Language Association (MLA) Style Guide or The Chicago Manual of Style. The following sites are examples of available web resources:

University of California Berkeley Library:

www.lib.berkeley.edu/TeachingLib/Guides/Internet/Style.html

The Chicago Manual of Style:

www.chicomanualofstyle.org/tools_citationguide.html

Modern Language Association (MLA) recommendations on documenting website sources:

www.mla.org/publications/style/style_faq/style_faq4

Citing Net Sources - Quick Guide:

<http://gateway.lib.ohio-state.edu/tutor/les7/guide.html>

Use the author-date form for courses, unless an alternative form is approved. Provide the full bibliographic information in the References section and alphabetize by the author's last name. Always give a page or chapter number for books and page numbers for references to journal articles. Cite each reference parenthetically in the text by the author's last name and publication date. If the in-text citation is from a book, include the page(s) being cited, for example (Smith, 2006, 8-11). Separate multiple references by a semicolon.

For unknown or unnamed authors, alphabetize by the organization or agency name. Examples include state and federal regulations (laws and administrative rules) and standards and protocols from professional organizations and governmental agencies such as ISO (International Organization for Standardization), US Environmental Protection Agency, Michigan Department of Environmental Quality. Include adequate information for the reader to locate each reference. If retrieved from a website, include the access date. Specific examples are provided below.

State of Michigan. Michigan Legislature. "Michigan Compiles Laws, Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, Act 451 of 1994, as amended"). Retrieved January 18, 2007, [www.legislature.mi.gov/\(S\(hdzekx55hemtgi45fdul5xmz\)\)/mileg.aspx?page=getobject&objectname=mcl-451-1994-ii-2-soil-conservation-erosion-and-sedimentation-control-91&highlight=](http://www.legislature.mi.gov/(S(hdzekx55hemtgi45fdul5xmz))/mileg.aspx?page=getobject&objectname=mcl-451-1994-ii-2-soil-conservation-erosion-and-sedimentation-control-91&highlight=) (accessed March 3, 2007).

State of Michigan. State Office of Administrative Hearings and Rules. "Michigan Administrative Code, Part 2, Air Use Approval, Air Pollution Control", promulgated by the Michigan Department of Environmental Quality, administered by the Air Quality Division. Retrieved January 18, 2007, www.state.mi.us/orr/emi/admincode.asp?AdminCode=Single&Admin_Num=33601201&Dpt=EQ&RngHigh= (accessed February 13, 2007).

Wikipedia. 2007. High Performance Liquid Chromatography. <http://en.wikipedia.org/wiki/HLPC> (accessed January 21, 2007).-1898 USA, 2003.

NCCLS. Blood Collection on Filer Paper for Newborn Screening Programs; Approved Standard—Fourth Edition. NCCLS document LA4-A4[ISBN 1-56238-503-8]. NCCLS, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087

When citing unpublished data or information from an expert through a personal conversation or written correspondence, give the person credit in the body of the report by providing their last name and the year of personal contact, for example (Jones, 2007). Include the person's name, title, and company and information to reestablish contact if needed, as shown below.

Jones, Susan. Associate Professor, Michigan State University, Department Animal Husbandry, jones@msu.edu, 517-432-8888. Personal communication, January 22, 2007.

4.3. APPENDICES

Include material that is in support of the work but not pertinent to the understanding of the report in the appendix. This includes figures or tables referred to in the results section; material such as raw data, sample, intermediate, or lengthy calculations; long derivatives; and detailed information that might interest only certain readers.

Each step in the design must include a sample calculation. All steps and unit conversions must be shown. This includes calculations used in computer spreadsheets and programs.

Identify all appendix material within the body of the report. When using multiple appendices, place them in the order referenced in the report and label them with capital letters (A, B, ...) followed by a descriptive name (e.g., Appendix A: Rheology Data). List each Appendix in the Table of Contents and number each appendix page with the corresponding capital letter followed by Arabic numerals in the bottom center of each page (A1, A2, A3..., B1, B2, B3...). This requires inserting "*section breaks/next page*" between appendices.

5. FORMS OF COMMUNICATION

The professional world uses a variety of written forms of communication. Be ready to learn new techniques and listen to experienced managers. Adjust for particular needs and be flexible to adapt to changing situations and formats. This section provides guidance for preparing e-mail, resumes, letters, progress reports, presentations.

5.1. E-MAIL

E-mail has become the most common form of written communication. It is important to scrutinize both e-mail received and returned. Mistakes signify either carelessness or a lack of knowledge. Be discreet; e-mail is a permanent record and is retrievable as court testimony. Follow these rules:

1. Write a complete subject line and include the needed action.
2. Be brief and include the most important information at the beginning of the message.
3. Use correct spelling, grammar, and parallel sentence structure. Proofread and make sure the text says what is intended. Always spell check e-mails before sending.
4. ALL CAPS implies yelling.
5. Make sure the tone of the message is not too abrupt or offensive, especially for those who have a tendency to be direct.
6. Include a signature line that provides alternative contact information (cell phone and mailing address).
7. When replying to a request, provide enough context to ensure that the response is clear.
8. To save the reader time, include information in the body of the message rather than as an attachment. If attachments are included, make sure the reader has the appropriate software to view the content.
9. When using e-mail to send a cover letter and resume to a potential employer, compose the e-mail, let it sit for an hour or so, have a friend read it, and then re-read it aloud before sending it. Make sure to keep a copy and note promised follow-up dates on your calendar.
10. E-mail content is subject to disclosure and is often forwarded beyond the intended recipient. Never e-mail content that is not appropriate for a resume. Most corporate systems retain a backup of all e-mail traffic. This backup is retained after e-mail has been deleted from your system.

E-mail is a tool, but it carries with it some strong responsibilities and possibly damaging consequences. Never use it when a face-to-face dialog is needed. Do not use it when a formal document is required; it does not carry the status of a formal report.

5.2. RESUMES

The Biosystems Engineering Resume Book is published each year and placed on the Department of Biosystems and Agricultural Engineering website. It is also distributed to industry representatives who routinely hire our students for internships, three or six month co-op experiences, and fulltime positions. View the most current version at <http://www.egr.msu.edu/age/> by clicking on Resume Book for ideas and format. Then gather personal information for use in preparing a resume. Include education, work experience, honors, skills, activities, and professional affiliations. When describing work experience, list specific accomplishments that demonstrate skills that are important to employers.

The ultimate goal is to fit the content on one page with one-inch top, bottom, and side margins using a font no smaller than 10.5 pt. Do not use automated templates; instead, create a personal format. For assistance with professionally formatting Microsoft documents, review Appendix C. Become familiar with using the horizontal ruler to set margins, indents, and tabs, and learn how to use Microsoft Word “styles” to format section headings, which provides readily adjustable document spacing vertically on the page.

Use the Resume Checklist provided in Appendix A to review; then edit as necessary. E-mail a draft resume to the Biosystems Engineering Career Resource Center Coordinator and request an appointment to review the content, and, if necessary, assist with prioritization of the information if it does not fit on one page. Use this opportunity to discuss your interests in acquiring part-time engineering related employment on and off campus, summer or six-month internships, undergraduate and graduate research opportunities, and full-time job placement upon graduation.

Additional resources are available on the MSU Career Services and Placement website at: www.csp.msu.edu and in “The Center” located in room 1340 of the Engineering Building. The Center also provides assistance with resume writing and mock interviews.

See “Focus Your Resume on Results” at <http://resume.monster.com/articles/results/> and “Your Resume Objective: How to Write a Career Summary” at <http://resume.monster.com/articles/profilesummary/> for additional information and ideas.

The MSU Alumni Association offers job placement services for alumni and has excellent resume writing resources on their website: www.msualum.com.

Also, visit <http://hotjobs.yahoo.com/resume> for recommendations of words to include (teamwork, flexibility, detail-oriented, self-motivated) and vague terms that weaken your resume (assist, support, contribute).

5.3. LETTERS

Create an attractive and professional personal letterhead. Include your name, mailing address, phone number and e-mail address. Varying the font size and adding a horizontal line are techniques that will set the letterhead apart from the remainder of the page. For a uniform look, consider replicating your letterhead as the heading on your resume.

5.3.1. Business Letter

Letters must be clearly written, to the point, and positive. When used to transmit a work product, use the letter as an opportunity to thank the client and or recipient as this may be the only contact. Clearly specify actions needed by the recipient along with required due dates. Remember, a letter sent to a

potential client, prospective employer, or funding agency may or may not be answered simply because of its quality.

5.3.2. Resume Cover Letter

The cover letter that accompanies a resume and transcript functions as an introduction to a prospective employer. It is an opportunity to summarize clearly technical and communications skills, experiences, and accomplishments that would benefit the employer. If they do not like what they read, you may never get the chance to talk to them in person.

The cover letter should use personalized letterhead that includes your name, address, phone number, and e-mail address. When preparing the letter reflect your overall goals and include:

Date of the letter

Contact person's name, company name, mailing address and telephone number followed by a blank line and then a salutation, for example, Dear Ms. Smith.

The first paragraph contains the reason for the letter, the source of information about the employer, and what you prefer to do in the future. Consider including your willingness or desire to work internationally or within a particular region of the country.

In the next paragraph, summarize the main points of your resume that will interest the employer. Remember that the employer has a copy of your resume, so be brief, and include new information that is not in your resume (e.g., current coursework, research, or completion of activities).

The closing paragraph provides a thank you to the employer in consideration and review of your resume and cover letter. Offer your cell phone number so you can be reached, and inform the employer that you will call the company to confirm receipt of the letter or to check on interview schedules.

Spend adequate time to perfect the letter quality. Have others read your letter and provide editorial comments. Make sure that your letter presents a positive impression!

5.3.3. Thank-You Letter after an Interview

Remember to obtain names, addresses, and phone numbers during your interview so that you can follow-up in writing.

After interviewing for a position, send a thank-you letter within 24 hours to the individuals who interviewed you. This courtesy may put you ahead of the competition. Make it businesslike and concise.

Include your name, mailing address, phone number, and e-mail address in the letterhead. Balance the content on the page. Include the date, followed by one or more blank lines, then the interviewer's name, company name, and mailing address.

In the first paragraph, thank the interviewer for the interview and clearly signify your interest in working for the company if the job is "right" for you. If the job is not for you, thank the interviewer and briefly indicate that the job does not fit your interests. Be careful making this decision, because you cannot professionally change your mind.

In the second paragraph, mention again your qualifications and include any positive qualities that you may have forgotten to mention at the interview.

Close the letter with a final thank you and express your interest in hearing from the interviewer and the company. Provide the interviewer with your phone number and e-mail address. If you prefer to have

more control of the communication, notify the interviewer/company of a specific time when you will follow your letter with a phone call.

Remember to make each thank-you letter a separate entity. Do not use form letters. Personalize the letter, so that the reader will get a positive feeling from the text. If you get a rejection, follow the above procedure. The positive value of your response may open up new doors to employment.

In cover letters, thank-you letters, and resumes, it is best to use the same kind and color of paper.

Send a similar thank-you letter to your employer after finalizing your plans for an internship, co-operative position, or full-time employment.

5.3.4. Follow-up Letter after an Initial Contact

Include your name, mailing address, phone number and e-mail address in the letterhead. Include the date, followed by one or more blank lines, then the recommended contact person's name, company name, and mailing address. Limit the content to one page and center it vertically.

Use "Dear" followed by Mr. or Ms. and then the recommended contact person's name as the salutation. If uncertain about the person's gender, use RE: followed by the subject of the correspondence instead of addressing the letter to a specific person, for example: "RE: Advertised Design Engineer Position in your Detroit Office."

In the opening paragraph, refer to the initial contact and express your appreciation for this contact. Mention what was discussed and what interested you. Be specific, giving examples that are professional and will make you distinctive. Use employer terminology and customize the letter to fit the job description. Use action verbs, write clearly and concisely, and use the pronoun "I" selectively. Be honest and positive. Include your degree and graduation date or the date you are available for employment.

In the second paragraph, summarize your skills and strengths, especially those that piqued the interest of the company contact person. Give details of your conversation that are relevant to the company's needs. Remember that your resume is attached, so limit this paragraph to additional skills and accomplishments or those experiences that are unique to this position or the company. Descriptions of actions and experiences that demonstrate your skills are more effective than generalizations. For example, "Last semester I traveled to Costa Rica to study Food Safety. While I was there, I assisted an engineering professors with the installation of water treatment systems at schools and healthcare facilities in rural areas that did not have electricity."

Make the closing paragraph active by taking the initiative to contact the company. Indicate a date that you will follow-up. Remember, you have two contact names to follow-up with, your initial contact and the recipient of this letter.

Close the letter using "Sincerely," followed by four blank lines, and then your name. Sign the letter just above your printed name.

Type "c:" followed by your initial contact person's name. This signifies that this person has been sent a copy of this letter, so remember to do so.

Type the word "Enclosure" if you have enclosed your resume or other documents.

5.4. PROGRESS REPORTS

The ability to provide a concise, well written, progress report is an essential communication skill needed in the work environment, whether it is government, industry, or consulting. Progress reports provide a status of tasks outlined in the project management plan. Include the date and address the memo to the technical advisor with a copy to course instructors and others that are interested in the project status (peers, clients). Provide the assignment name (I-PR3) on the subject line and summarize in the body of the memo the following.

1. Individual (or group) accomplishments that support the objectives and tasks in the project management plan. Include the status of tasks that are ahead or behind schedule. Provide an explanation if a task is behind schedule.
2. Planned accomplishments for the next work period. Be explicit and provide adequate detail for the readers' comprehension and to assist with prioritizing and completing these tasks. Identify critical tasks that need immediate action. Document equipment and or materials needed.
3. Project related technical difficulties or concerns that need assistance with resolving and additional resources needed for success.
4. Other professional project related issues as needed.

Update the project management plan as tasks are completed and add or adjust tasks and due dates as required. Attach a copy of the updated project management plan to the progress report.

5.5. PRESENTATIONS

Prepare an outline of key points, not sentences, using concrete terms the audience will understand. Prepare and arrange visuals that assist with telling a logically organized story. Start by providing needed background information and then describe the problem and specific objectives and the importance and relevance to other related work.

Maintain focus by including only data that support the objectives. Prepare simplified report figures and tables to enable the audience to grasp the content quickly from a distance; round and justify numbers as needed. Integrate professional organizational charts, flow diagrams, illustrations, schematics, bar and pie charts, line graphs, and photographs that summarize or emphasize findings, show trends in data, describe a process or illustrate a design. Unnecessarily fancy and flashy materials subtract from the message. Incorporate color to add interest, incorporating shading, symbols, and line types distinguishable by colorblind viewers.

Frequently review the objective and the relation of the current material to the objectives, both visually and verbally. Present data and arguments objectively and explain shortcomings so the audience will understand. Summarize conclusions and recommendations including suggestions for further work.

Practice the presentation using the visual aids as talking points, looking at them only as necessary. Do not read the presentation, and avoid using notes. Maintain eye contact with people throughout the audience. Speak with certainty and at a volume adequate to carry the room. Avoid raising the tone of voice at the end of sentences. If a line is muddled—DON'T PANIC! Take a breath and regroup. Be aware of, and try to avoid, speaking idiosyncrasies (you know, uh, like). Use humor sparingly and appropriate for the audience; too much is not funny.

Adjust content to meet the allotted time and the presentation goals, allowing time for questions. Review for grammar, spelling, and consistency, ensuring parallel structure is maintained on each visual.

Do not be afraid of being nervous; if you care about the impression you will leave, you will be nervous. Repeatedly practice the presentation standing with good posture. Use visuals as prompts. Be prepared to defend the conclusions with data and give thoughtful answers to questions, even if it requires hesitation before answering. If unable to answer a question, offer to obtain the information.

Dress professionally, and when not speaking, stand with good posture and direct attention to the person speaking.

Appendix A provides a Technical Presentation Checklist to assist with finalizing your presentation.

5.6. ABSTRACTS

An abstract is published alone and therefore must be self-contained and concise yet comprehensive. Although similar to a technical report executive summary, an abstract is written to interest an audience in the hopes of publishing the paper and possibly presenting the work at a conference; therefore, the first sentence must entice the reader. To enable the text to stand alone, acronyms or abbreviations or bibliographic, figure, or table references are not used. The abstract is written in past tense since the work has already been completed. Generally it is single-spaced and one or two paragraphs (250 words maximum).

Like the executive summary, the abstract summarizes the principle objectives, scope of investigation, methodologies used, and principal results, conclusions, and implications voiced. It allows the reader to compare the results to the initial hypotheses in familiar language that is comprehensible and convincing.

6. REFERENCES

- Davis, Martha. 2002. *Scientific Papers and Presentations*. San Diego, CA: Academic Press.
- Day, Robert A. 1998. *How to Write and Publish a Scientific Paper, 5th Edition*. Phoenix, AZ: Oryx Press
- Efiok, Bassey J.S. 1993. Basic Calculations for Chemical & Biological Analyses, 2nd Edition. AOAC International (editor). Gaithersburg, MD. pg 104 – 107.
- Merriam-Webster, Inc. 2006. *Merriam-Webster On-line Dictionary*. www.m-w.com/dictionary. (accessed October 25, 2006.)
- Purdue University, 2007. *The Owl at Purdue*. <http://owl.english.purdue.edu>. (accessed August 25, 2007).
- Rubens, Philip (editor). 2001. *Science & Technical Writing: A Manual of Style*, 2nd Edition. New York, NY: Routledge.
- Texas A&M University, 2007. *Chemistry Department*, www.chem.tamu.edu/class/fyp/mathrev/mr-sigfg.html (accessed September 15, 2007).

APPENDIX A: CHECKLISTS

TECHNICAL WRITING CHECKLIST

Content Guidelines
<ul style="list-style-type: none"> <input type="checkbox"/> Organize logically (tell a story). <input type="checkbox"/> Provide adequate background. <input type="checkbox"/> Clearly state the objectives. <input type="checkbox"/> Provide adequate content to meet objectives. <input type="checkbox"/> Limit information to that which supports the objectives. <input type="checkbox"/> Place important data in the body of the report, if applicable. <input type="checkbox"/> Describe and/or properly refer to all methods and modifications. <input type="checkbox"/> Include a quality analysis of the data that support the conclusions. <input type="checkbox"/> Understand the purpose of every sentence. <input type="checkbox"/> Reference all unoriginal materials, both in the text and in the References section. <input type="checkbox"/> If applicable, include the name of the sample and the date it was collected and analyzed.
Technical Writing
<p><i>Figures and Tables</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Provide clear and complete titles to enable use when removed from the document. <input type="checkbox"/> Develop adequate contrast and distinguishable line types for printing in black and white. <input type="checkbox"/> Center figures and tables horizontally within the report margins. <input type="checkbox"/> Cross-reference in the text. Use tables if there will be more than 3 to 4 entries. <input type="checkbox"/> Use the correct number of significant figures (or round as appropriate for comprehension).
<p><i>Consistency</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Correctly and uniformly spell, capitalize, abbreviate, hyphenate, bold, and italicize text. <input type="checkbox"/> Precede a number with a value less than one with a zero (0.5). <input type="checkbox"/> Provide uniform white space: margins, before and after headings, line spacing, spaces between sentences. <input type="checkbox"/> Keep on the same line of text: number/units, salutation/name, figure/number, and table/number. <input type="checkbox"/> Reserve underlining for hyperlinks.
<p><i>Appropriate Language</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Eliminate contractions, personal pronouns, colloquialisms, jargon, clichés, and sexist language. <input type="checkbox"/> Use active voice. Reword to the positive <input type="checkbox"/> Avoid saying the same thing twice. Rewrite sentences to prevent using the same key words in one sentence. <input type="checkbox"/> Provide certainty: avoid auxiliaries such as would, should, could, may, etc. <input type="checkbox"/> Replace complex words with simple terms if they convey the same meaning. <input type="checkbox"/> Begin sequential sentences with different words. Replace vague or ambiguous terms with precise text. <input type="checkbox"/> Replace verb-preposition combinations with high quality action verbs (talk about → discuss, written up → compose).
<p><i>Text Flow</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Provide descriptive headings and subheadings. <input type="checkbox"/> Compose clear and concise text: avoid using more words than the idea or concept deserves. <input type="checkbox"/> Eliminate irrelevant information, emotion, unsupported opinions, and judgments. <input type="checkbox"/> Place sentences in logical order and incorporate transitional words. <input type="checkbox"/> Limit paragraphs to one idea. Use sentence variety. Avoid very long (run-on) and very short sentences. <input type="checkbox"/> Combine sentences when it improves text flow. <input type="checkbox"/> Define acronyms and initialisms. Evaluate the need to define and use an acronym if not referred to again.
<p><i>Grammar and Punctuation</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Use correct spelling, grammar, and punctuation. Maintain parallel structure in sentences and lists. <input type="checkbox"/> Use “that” (defines and restricts) and “which” (generally unrestrictive) correctly. <input type="checkbox"/> Use active voice to create concise, energetic text. Minimize the use of past tense.
<p><i>Appendices</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Include material such as calculations, raw data, and lab sheets. <input type="checkbox"/> Provide a clear and complete title for each appendix (Appendix A: Rheological Data) <input type="checkbox"/> Refer to each appendix in the text (Appendix A). <input type="checkbox"/> Sequentially label each appendix in the order they appear in the text. <input type="checkbox"/> Precede table or figure numbers within each appendix by its corresponding letter (Table A1).
<ul style="list-style-type: none"> <input type="checkbox"/> Proofread for correctly spelled but incorrectly used words (from/form, there/their, manor/manner). <input type="checkbox"/> Number pages; for reports verify that the front matter, text, and appendix pages are correctly numbered. <input type="checkbox"/> Sign individual and group work products, signifying agreement with the entire document.

TECHNICAL PRESENTATION CHECKLIST

Format Guidelines
<input type="checkbox"/> Match format to presentation type (public, peers, administrators, etc.).
<input type="checkbox"/> Minimize the number of words by using clues to help tell a story.
<input type="checkbox"/> Express data in simplified graphs or charts when possible.
<input type="checkbox"/> Integrate schematics and photographs to add interest.
<input type="checkbox"/> Round numbers so the audience to grasp the content quickly.
<input type="checkbox"/> Provide headings and subheadings as needed, avoiding unnecessary bullets.
<input type="checkbox"/> Prepare professional visual materials that are legible from a distance and by colorblind viewers.
<input type="checkbox"/> Use humor sparingly and appropriate for the audience.
Content Guidelines
<input type="checkbox"/> Present a logically organized story in concrete terms the audience will understand.
<input type="checkbox"/> Clearly state the objectives.
<input type="checkbox"/> Present and show only data that supports the objectives.
<input type="checkbox"/> Remain focused and avoid tangents.
<input type="checkbox"/> Frequently review the objective and the relation of the current material to the objective.
<input type="checkbox"/> Present data and arguments objectively and explain shortcomings.
<input type="checkbox"/> Summarize conclusions and recommendations.
<input type="checkbox"/> Stay within allotted time, saving adequate time for questions.
Style Guidelines
<input type="checkbox"/> Meet the Technical Writing Checklist.
<input type="checkbox"/> Avoid overcrowding visual material. Delete unnecessary words. Use bullets with parallel structure.
<input type="checkbox"/> Provide visual material that is clear and legible from a distance.
<input type="checkbox"/> Speak clearly and at a volume appropriate for the room.
<input type="checkbox"/> Maintain eye contact with the audience.
<input type="checkbox"/> Use visuals as prompts -- do not read a presentation, and avoid referring to notes.
<input type="checkbox"/> Give thoughtful answers to questions, even if it requires hesitation before answering. If unable to answer a question, offer to obtain the information.
<input type="checkbox"/> Be aware of, and try to avoid, speaking idiosyncrasies (you know, uh, like).
<input type="checkbox"/> Be professional and organized, clearly present the material, and be prepared to defend the conclusions with data.
<input type="checkbox"/> Practice, edit, and practice again.

RESUME CRITIQUE CHECKLIST

First Impression
<input type="checkbox"/> Does it make a prospective employer want to read it and offer an interview?
Professional Layout
<input type="checkbox"/> Does the resume fit on one page with a one-inch margin on all four sides?
<input type="checkbox"/> Are font sizes and text styles for headings and paragraphs consistent?
<input type="checkbox"/> Is adequate space provided between work experiences to set them apart?
Writing
<input type="checkbox"/> Text meet standards of correctness (spelling, grammar, and punctuation)?
<input type="checkbox"/> Do items within sentences and bulleted lists use consistent verb tenses?
<input type="checkbox"/> Do statements use specific action verbs that show strength and reflect the qualities of a person who takes action? (See Appendix G for a list of action verbs)
<input type="checkbox"/> Is past tense used for previous employment?
<input type="checkbox"/> Are formal English, direct language, and simple terms used?
<input type="checkbox"/> Are the correct key words, scientific terms, and conventions for your profession used? This is critical with the increasing use of electronic keyword searches by employers
<input type="checkbox"/> Is the writing style clear and concise?
Experience
<input type="checkbox"/> Does the <i>Objective</i> or <i>Skills Summary</i> clearly and concisely state your career goals (short-term for underclass students) and the type of position you are interested in?
<input type="checkbox"/> Is the university name, city, and state included?
<input type="checkbox"/> Are the degree (i.e., Bachelor of Science in Biosystems Engineering) and date of graduation listed?
<input type="checkbox"/> Are consistent significant figures used to document a grade point average (i.e., 3.44/4.00)?
<input type="checkbox"/> Is the area of specialization described in a way that will be familiar to an employer?
<input type="checkbox"/> Are key words in bold font for emphasis?
<input type="checkbox"/> Is the most recent work experience listed first (reverse chronological order)?
<input type="checkbox"/> Are all time frames recorded? An employer will flag a lapse in activity.
<input type="checkbox"/> If volunteer work experiences or activities are listed, are they applicable to the <i>Objective</i> ?
<input type="checkbox"/> Do work experience descriptions stress accomplishments and special skills rather than job requirements and duties?
<input type="checkbox"/> Are unique qualifications, strengths, and attributes identified?
<input type="checkbox"/> Are problem solving abilities and competencies presented in a way to interest an employer?

Source: Adapted from the Michigan State University, Career Services and Placement website.

APPENDIX B: STYLE GUIDE RESOURCES

1. A classic reference book on composition.
Strunk, William. 1999. *Elements of Style*. Ithaca, N.Y.: Priv. print. [Geneva, N.Y.: Press of W.P. Humphrey], 1918; Bartleby.com, www.bartleby.com/141/. (Accessed October 27, 2006).
2. A compiled list of online university style guides maintained by Western Michigan University.
College and university online style guides: <http://www.wmich.edu/wmu/writing/others/>
3. A list of Chicago Press books related to style and a list of questions and answers to clarify and add to the 15th edition.
The Chicago Manual of Style and Related Books:
http://www.press.uchicago.edu/Subjects/virtual_guide.html
4. An on-line source when a full volume style guide is not at your fingertips.
The University of Colorado at Boulder Style Guide:
<http://www.colorado.edu/Publications/styleguide/index.html>
5. Provides general information on copyrights and includes pending copyright legislation.
United States Copyright Office: The Library of Congress: <http://www.copyright.gov/>
6. Provides guidance on letter writing.
Iowa State University: <http://www.eng.iastate.edu/ecs/students/LetterWriting.html#checklist>
7. University of California Berkeley Library Style Guides:
www.lib.berkeley.edu/TeachingLib/Guides/Internet/Style.html
8. The Chicago Manual of Style Guide:
www.chicagomanualofstyle.org/tools_citationguide.html
9. Modern Language Association (MLA) recommendations on documenting website sources
http://www.mla.org/publications/style/style_faq/style_faq4
10. Citing Net Sources - Quick Guide
<http://gateway.lib.ohio-state.edu/tutor/les7/guide.html>
11. Action Verbs -- By Skills Category
<http://www.quintcareers.com/research>
12. The Owl at Purdue provides online handouts covering writing, research, grammar, and MLA and APA style
<http://owl.english.purdue.edu>

APPENDIX C: MICROSOFT OFFICE

Microsoft Word offers automated features to assist with formatting technical documents. Take the time to learn some of the features; the rewards will save time and provide consistent and professionally formatted documents. At a minimum learn how to:

1. Use the horizontal ruler to set margins, indents, and tabs.
2. Insert “breaks” to divide a document into several unique sections. This is required when numbering report pages for front matter (i, ii), report text (1, 2), and appendices (A1, A2).
3. Create unique “styles” for consistent automated formatting of headings, sub-headings, body text, table and figure captions, tables, and references. Save these settings as a report “template” for later use.
4. Add a set amount of space before and after unique “styles” to provide uniform white space throughout the document.
5. Create referenced figure and table headings and cross-reference them in the text so they are automatically renumbered when a table or figure is added, deleted, or moved. Then generate or update a List of Figures and a List of Tables using the automated features.
6. Insert and format page numbers using the “Header and Footer” toolbar. This toolbar appears when *View/Header and Footer* is selected.

MICROSOFT TUTORIALS

Measure up with the horizontal ruler: Set margins, indents, and tabs

<http://office.microsoft.com/en-us/assistance/HA011226861033.aspx>

Tips for Understanding Styles in Word 2002

www.microsoft.com/office/previous/xp/columns/column14.asp

11 Tips for Creating Tables in Word 2002

<http://www.microsoft.com/office/previous/xp/columns/column13.asp>

Visit the Microsoft website for numerous other tutorials.

HELPFUL HINTS

1. Insert a page break: CTRL+SPACEBAR.
2. Insert a tab within a Word table or Excel worksheet: CTRL+TAB.
3. Keep proper names, titles or dimensions and units from splitting between lines: Highlight the space between and then SHIFT+CTRL+SPACEBAR, for example Mr. Smith, Table 1, Appendix A, 5 feet. Hyphenated words are similarly kept together SHIFT+CTRL+HYPHEN.
4. Insert a section break to divide a document into unique sections for formatting purposes:
Insert/Break/ Section Break Types: Next Page.
5. Center page content vertically: *File/Page Setup, Layout, Vertical Alignment: Center. Apply to: This section, This page forward or Whole document.*
6. Set header and footer margins for the entire document: *File/Page Setup, Layout, From Edge Header=0.5, Footer=0.5. – Apply to: Whole Document.*

7. Add and format page numbers to report sections:
 - First insert section breaks between front matter, report text, and appendices.
 - Insert page numbers by using *View/Header and Footer* (a toolbar will appear).
 - Click on the *Switch between header and footer* toolbar button to move to the footer. Then click on the *Same as previous* toolbar button (toggle switch). This will make the footer of section two unique allowing unique footers for each section.
 - Click on the *Insert Page Number* button. Then use the *Format Page Number* button to format the page number (i, ii, iii or 1, 2, 3 or A1, A2, A3). Count the title page, but do not number it. Select the *Center* button on the formatting toolbar to center the page number.
8. Using “styles” format main headings as “Heading 1” and sub-headings as “Heading 2.” Next, create the Table of Contents by selecting *Insert/Reference/Index and Tables/Table of Contents*. Adjust heading indents using the horizontal ruler. Manually delete the tab and page number that follows the *List of Appendices* in the *Table of Contents*. Manually add the Appendix letter (A, B) before each page “1” (i.e., A1, B1).
9. Provide uniform space before and after figure and table captions: *Format/Paragraph/Spacing -- Before: 6 pt -- After: 12 pt*. Reference the captions of each using *Insert/Reference/Index and Tables/Table of Figures*. Select *Caption Label* (either figure or table).
10. Cross-reference tables and figure captions with their reference within the document using *Insert/Reference/Cross-reference*. Then select *Reference Type* and *For which numbered item*.
11. Create List of Tables: *Insert/Reference/Index and Tables: Table of Figures: Caption Label: select Table*
12. Add a black line around a picture or graphic: Right clicking on a picture and select *Format Object/Colors and Lines/* then select line type.
13. To remove all of the formatting from a Word document, select the whole document by pressing CTRL+A (or select a portion of the document) then press CTRL+SHIFT+N.

READABILITY TOOL

Microsoft Word has a *Readability Statistics* tool that evaluates how easy or difficult your text will be for readers to comprehend. Follow the procedure below to check your document for readability.

Under *Tools*, select *Options* click the *Spelling and Grammar* tab. Select both: *Check grammar as you type* and *Show readability statistics* and then choose the *Writing Style* you wish Word to use. Next click the *Settings tab* and choose how Word will review the document, then click *OK*.

Highlight the text of interest and then click spell check (shift-F7). It will first check for spelling and grammar and then provide the readability statistics. Maintain an average of 20-25 words per sentence (15-20 for e-mail messages). Limit passive sentences to 10-15% of the document (5% in e-mail).

The Flesch Reading Ease scale goes from 0 (the most difficult to read) to 100 (the easiest). Depending on your document, aim for a total score of at least 35. The executive summary should score at least 40. Most e-mail should score between 40 and 60, depending on the information in the message.

The Flesch Kincaid Grade Level relates to American schooling. Depending on the document, aim for between 8th and 12th grade. Most reports and proposals should score between a 10th and 12th grade reading level. Executive Summaries should score between a 10th and 11th grade reading levels, if possible.

The final step gives the statistics to measure the document readability.

EQUATION EDITOR

Two useful Web-based tutorials include:

<http://ist.uwaterloo.ca/ec/equations/equation.html>.

<http://callcentre.education.ed.ac.uk/downloads/quickguides/word/WordEquationEditor.pdf#search=%22equation%20editor%20Word%20tutorials%22>

ROUND VALUES USING EXCEL

Use Microsoft Excel functions to format data for comprehension and focus on the relevant features when used in reports and presentations. In the example below the ROUND function is used to display financial numbers to the nearest dollar with a maximum of two significant figures.

Row/Column	Value	Rounded Value
	A	B
1	\$341,394,176.88	\$340,000,000
2	\$48,848,003.70	\$49,000,000
3	\$2,561,121.22	\$2,600,000
4	\$172,899.38	\$170,000
5	\$46,074.35	\$46,000
6	\$7,227.62	\$7,200
7	\$798.95	\$800
8	\$4.35	\$4
=ROUND(A2, -1*(LEN(TEXT(INT(A2+0.5),"general"))-2))		

To automatically round numbers in Excel, such as dollar figures, use a negative number of decimal places (-2 rounds to the nearest 100).

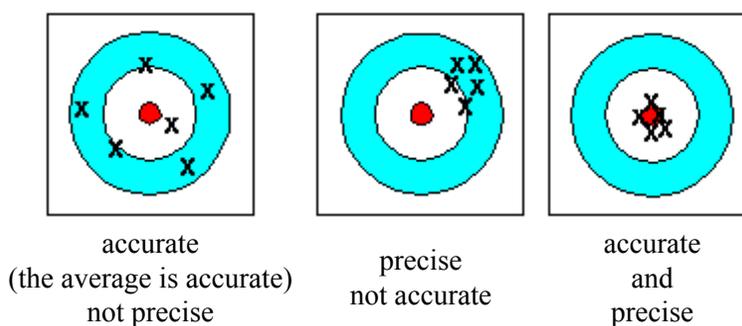
APPENDIX D: SIGNIFICANT FIGURES

Credit for the majority of the following content is given to Texas A&M University Chemistry Department Website, which is found at: <http://www.chem.tamu.edu/class/fyp/mathrev/mr-sigfg.html>.

EXACT AND INEXACT NUMBERS

Exact numbers represent items that are counted. For example, there are exactly 12 ears of corn in a dozen or most people have exactly 10 toes and 10 fingers. Inexact numbers are measured values.

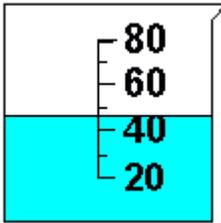
When making measurements, it is important to understand the difference between accuracy and precision. Accuracy refers to how closely a measured value agrees with the correct value. Precision relates to how closely individual measurements agree with each other.

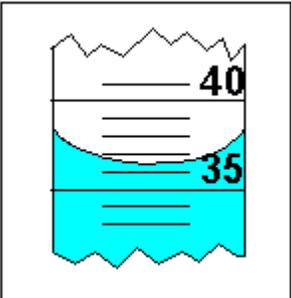
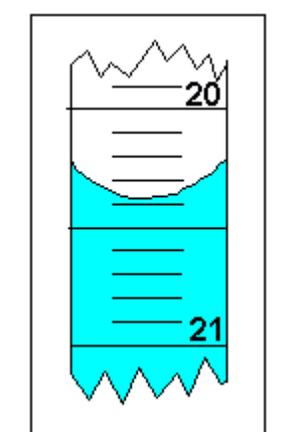


www.chem.tamu.edu/class/fyp/mathrev/mr-sigfg.html

The number of significant figures represents the number of digits believed to be correct by the person taking a measurement and includes one estimated digit. When making a measurement, record to 1/10 or 0.1 of the smallest division. This results in a reading error of $\pm 1/10$ or 0.1 of the smallest division. When less sure, 1/5 or 0.2 of the smallest division is read.

For example, compare the precision of a volume measurement using a beaker, graduated cylinder, or buret.

Beaker		<p>The smallest division is 10 mL, so the volume to $\pm 1/10$ of 10 mL or ± 1 mL can be read. Therefore, the volume read from the beaker has a reading error of ± 1 mL.</p> <p>The volume in this beaker is 47 ± 1 mL. One might read 46 mL; another might read the volume as 48 mL. All the answers are correct within the reading error of ± 1 mL.</p> <p>The measurement has 2 significant figures. The "4" is known for sure and the "7" is an estimate.</p>
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Graduated Cylinder		<p>First, note that the surface of the liquid is curved. This is called the meniscus. This phenomenon is caused by the fact that water molecules are more attracted to glass than to each other (adhesive forces are stronger than cohesive forces). The volume is read at the BOTTOM of the meniscus.</p> <p>The smallest division of this graduated cylinder is 1 mL. Therefore, the reading error is ± 0.1 mL or 1/10 of the smallest division. An appropriate reading of the volume is 36.5 ± 0.1 mL. An equally precise value would be 36.6 mL or 36.4 mL.</p> <p>The measurement has 3 significant figures. The "3" and the "6" are known for sure and the "5" is an estimate.</p>
Buret		<p>The smallest division in this buret is 0.1 mL. Therefore, the reading error is ± 0.01 mL. A good volume reading is 20.38 ± 0.01 mL. An equally precise answer would be 20.39 mL or 20.37 mL.</p> <p>The measurement has 4 significant figures. The "2", "0", and "3" are known and the "8" is an estimate.</p> <p>** Note that the numbers get bigger as you go down a buret because the liquid leaves from the bottom.</p>

www.chem.tamu.edu/class/fyp/mathrev/mr-sigfg.html

Therefore, the concept of significant figures in a measurement deals with precision only.

Consider measuring the length of a metal rod several times with a ruler. Essentially the same measurement is repeatedly made with a small reading error equal to about 1/10 of the smallest division on the ruler. The length has been determined with high precision. However, what is the accuracy of the ruler to begin with? Perhaps it was a plastic ruler left in the hot Texas sun and was stretched. The accuracy of your measuring device is unknown unless it is calibrated, i.e. compared against a ruler of known accuracy. Note: in the laboratory, a good analytical chemist always calibrates the volumetric glassware before using it by weighing a known volume of liquid dispensed from the glassware. The actual volume is determined by dividing the mass of the liquid by its density, hence the accuracy of the glassware.

SIGNIFICANT FIGURE RULES

1. Leading zeros are never significant.
2. Imbedded zeros are always significant.
3. Trailing zeros are significant only if the decimal point is specified.

Hint: Change the number to scientific notation. It is easier to see.

Example	Number of Significant Figures	Scientific Notation	
0.00682	3	6.82×10^{-3}	Leading zeros are not significant.
1.072	4	1.072×10^0	Imbedded zeros are always significant.
300	1	3×10^2	Trailing zeros are significant only if the decimal point is specified.
300.	3	3.00×10^2	
300.0	4	3.000×10^2	

Addition and Subtraction: When a calculation is limited to addition and subtraction, report the final result to as many decimal places (not significant digits) as there are in the term with the least number of decimal places. In other words, the last digit retained is set by the first doubtful digit. For example:

Addition

$$\begin{array}{r}
 4.7832 \\
 1.234 \\
 + 2.02 \\
 \hline
 8.0372 \\
 \Downarrow \text{rounding} \\
 8.04
 \end{array}$$

Even though a calculator gives an answer of 8.0372 the number must be rounded to 8.04 (two decimal places) because the answer must only contain one doubtful digit. Note that the doubtful digits are underlined.

Subtraction

$$\begin{array}{r}
 1.0236 \\
 - 0.97268 \\
 \hline
 0.05092 \\
 \Downarrow \text{rounding} \\
 0.0509
 \end{array}$$

Subtraction is interesting when concerned with significant figures. Even though both numbers involved in the subtraction have 5 significant figures, the answer has 4 decimal places, resulting in an answer with only has 3 significant figures when rounded correctly. Remember, the answer must only have 1 doubtful digit.

Multiplication, Division, and Trigonometric Functions: When calculations involve division, multiplication, and/or trigonometric functions only, report the answer with no more significant figures than the least accurately known number. For example:

Multiplication

$$\begin{array}{r} 2.8723 \\ \times 1.6 \\ \hline 4.59568 \\ \Downarrow \text{rounding} \\ 4.6 \end{array}$$

Round the answer to 2 significant figures, since 1.6 only has 2 significant figures.

Division

$$\begin{array}{r} 45.2 \\ \div 6.3578 \\ \hline 7.1093775 \\ \Downarrow \text{rounding} \\ 7.11 \end{array}$$

Round the answer to 3 significant figures, since 45.2 has only 3 significant figures.

Intermediate Calculations: When computing multi-step calculations, keep one or more significant digits then required in your final answer to prevent a small, but sometimes non-negligible, truncation or round-off error.

Rounding:

When rounding numbers to a certain number of significant figures, do so to the nearest value.

- Example: Round to 3 significant figures: 2.3467×10^4 (Answer: 2.35×10^4)
- Example: Round to 2 significant figures: 1.612×10^3 (Answer: 1.6×10^3)

However, when there is a 5, round up if the number before the 5 is odd and let it be when the number before the 5 is even. This results in balancing rounding errors for a series of calculations.

- Example: Round to 2 significant figures: 2.35×10^2 (Answer: 2.4×10^2)
- Example: Round to 2 significant figures: 2.45×10^2 (Answer: 2.4×10^2)

It is acceptable to round to fewer significant digits when conveying numbers to an audience if the full information is not useful. For example if a revised test procedure takes 3 hours and 52 minutes, it would be acceptable to say 4 hours, even though this is less precise.

QUIZ

Question 1 Give the correct number of significant figures for **4500, 4500., 0.0032, 0.04050**

Question 2 Give the answer to the correct number of significant figures: **$4503 + 34.90 + 550 = ?$**

Question 3 Give the answer to the correct number of significant figures: **$1.367 - 1.34 = ?$**

Question 4 Give the answer to the correct number of significant figures: **$(1.3 \times 10^3)(5.724 \times 10^4) = ?$**

Question 5 Give the answer to the correct number of significant figures: **$(6305)/(0.010) = ?$**

Answers: (1) 2, 4, 2, 4 **(2)** 5090 (3 significant figures - round to the tens place - set by 550)

(3) 0.03 (1 significant figure - round to hundredths place)

(4) 7.4×10^7 (2 significant figures - set by 1.3×10^3)

(5) 6.3×10^5 (2 significant figures - set by 0.010)

APPENDIX E: COMMONLY MISUSED WORDS

Accept/Except

“Accept” means to take or receive something.

He *accepted* his diploma with a smile.

“Except” means to exclude or leave out. Also used the same as the word “but.”

We have all of the chemicals *except* the chorine.

Affect/Effect

"Affect" when used as a verb, means to have an influence on something.

The temperature of the room *affects* the quality of the ice cream.

The faculty was able to positively *affect* the students' technical writing ability.

"Effect" is most often used as a noun and means the result or consequence.

The high quality presentations had a positive effect on the students' confidence.

"Effect" when used as a verb, means to create or bring about.

We are confident that an improved program will effect a positive change in attendance.

"Effective" is an adjective, which means having the right effect.

The professional agenda proved to be effective in increasing club membership.

Generally speaking, **affect** is the **act**, and **effect** is the **result**.

Among/Between

“Among” refers to being surrounded by (usually more than two things).

She was *among* relatives.

“Between” refers to the space separating things or places.

The cost was split *between* the three of them.

Amount of/Number of

“Amount of” refers to things that are measured.

We could not measure the *amount of* heat coming out of the oven.

“Number of” refers to things that can be counted.

The *number of* books that were missing was recorded.

As per

This is not good form. Write “per your request” or “as you requested.”

Assure/Ensure/Insure

“Assure” means to declare earnestly or confidently; give someone confidence.

She assured us that the money will be secure.

“Ensure” means to make sure or certain.

We will ensure that the reports will be delivered on time.

“Insure” means to guarantee or secure indemnity against loss or harm.

They insure employees for loss of a limb of life while on the job.

Comprise/Compose

“Comprise” means to include, contain, or consist of.

The class is comprised of Biosystems Engineering students.

“Compose” means to be made of parts.

Ice cream is composed of many ingredients.

Could/Would

“Could” is the past tense of “can” and means to have the ability to do something.

Could a biosensor be used to detect pathogenic contamination in food, water, and the environment?

“Would” is the past tense of “will” and is used to ask someone to commit to an action.

Would you call me when you have finished the experiment?

Datum/Data

A “datum” is singular; “data” is the plural form of “datum.”

The datum appeared to be in error.

The data were collected in the laboratory.

Due to/Because/Since

“Due to” means “caused by.”

She lost her job due to her lack of effort.

“Because” shows reason by cause or effect

He missed his appointment because he overslept.

“Since” is relative to time, before the present time, or after a time in the past.

The department has hired three new faculty *since* last semester.

e.g./et al./i.e.

“e.g.” is the abbreviation for the Latin term “*exempli gratia*” and means “*for example*.” A period follows each letter, then a comma, which is followed by the example given.

They were selling summer vegetables (e.g., carrots, corn, tomatoes) along the roadside.

“et al.” is the abbreviation for the Latin term “*et alii*” and means “and others.”

Jones *et al.* were responsible for the entertainment.

“i.e.” is the abbreviation for the Latin term “*id est*” and means “*that is*,” “*therefore*,” or “*in other words*.”

Previously derived and readily available analytical results can be quoted with suitable reference; i.e., equations from a text.

Fewer/Less

“Fewer” is used in relation to a number of items.

He needs a *fewer* number of jars than anticipated.

“Less” is used to define to a smaller extent or to show a lower importance.

The heat required was *less* than we expected.

Further/Farther

“Further” indicates progression to a greater extent or degree.

The team is *further* along in their research and experimental design than expected.

“Farther” indicates more physical distance in space or time.

The team ran over 100 miles, which was *farther* than anticipated.

Historic/Historical

“Historic” refers to being well-known or important in history.

“Historical” refers to being in the past.

Its/It’s

“Its” is possessive without using an apostrophe, like theirs, ours, yours, his and hers.

The deer stopped in *its* tracks.

“It’s” is a contraction for “it is.”

The tuition did not increase this semester, but *it’s* going to next fall.

Oppress/Repress

“Oppress” indicates persecution, whereas “repress” means to restrain.

The new government promised to alleviate the oppression felt by the northerners.

She had long repressed her desire to scream.

Since/Sense

“Since” is relative to time, before the present time, or after a time in the past.

The student has been here *since* the beginning of class.

“Sense” is an awareness or appreciation of something

The experimental results made sense.

“Sense” also refers to a specialized function (e.g., sight, hearing, smell, taste).

He used his senses to alert the audience of the dangers.

Use/Utilize

“Use” means to put into service. (Use is generally preferred over utilize)

The students *use* the computer lab daily.

“Utilize” refers to the necessary conversion of something to make it useful.

Turkey litter is *utilized* to heat the greenhouse.

Who/Whom

In most cases, the following steps will be useful in determining whether to use who or whom in a clause within a sentence:

Isolate the clause, starting with the who, whoever, whom, or whomever pronoun.

He did not tell me (*who, whom*) Mr. Smith has selected.

Be courteous to (*whoever, whomever*) telephones you.

Identify the verb in the clause. If a noun appears between the verb and the choice (who, whom), choose whom because it is in the objective case.

He did not tell me *whom* Mr. Smith has selected. (object--noun--verb)

If there is no noun between the verb and the choice, choose who because it is in the nominative case.

Be courteous to *whoever* telephones you. (object--verb)

APPENDIX F: CONCISE TEXT

Wordy Text	Concise Alternative
a considerable amount of	much
a considerable number of	many
a decreased amount of	less
a decreased number of, fewer in number	fewer
a lot of	many
a majority of	most
a small number of	few
absolutely essential	essential
after the determination of	determine
along the lines of	like
an innumerable number of tiny veins	innumerable tiny veins
an order of magnitude faster	ten times faster
are of the same opinion	agree
as a consequence of, based on or because of the fact that	because
as well as	and
as a matter of fact	in fact
as confirmation of	confirmed
at a later date	later
at a rapid rate	rapidly
at no time	never
at the conclusion of	after
at the present time	now
at this point in time	now, at that time
bright green in color	bright green
call a halt	stop
cognizant of	aware of
conducted an analysis	analyzed
consensus of opinion	consensus
crystal clear	clear
for the reason that	because, since
despite the fact that	although
due to the fact that, as the result of	because
due to the reasons that	due to
during the time that, during the course of	while, during
employ	use
following	after
for the reason that	because, since
from the point of view, on behalf of	for
give an account of	describe
goes under the name of	is called
had occasion to be	was
has been engaged in a study of	has studied
has resulted in	resulted
if conditions are such that	if
important essentials	essentials
in light of	because, since

Wordy Text	Concise Alternative
in the event that	if
in the not-too-distant future	soon
in the vast majority of circumstances	in most circumstances
is defined as	is
is desirous of	wants
it is apparent that	apparently
it is clear that	clearly
it is often the case that	often
it is possible that the cause is	the cause may be
it would appear that	apparently
join together	join
lack of ability to	couldn't
large in size	large
make a decision	decided
met with	met
no later than	by
on a monthly basis	monthly
on no occasion	never
on two separate occasions	twice
oval in shape	oval
perform	do
performed an assessment	assessed
prior to	before
referred to as	called
regarding	about
regardless of the fact that	even though
serious crisis	crisis
settle on	decide
subsequent to	after
take a look	look
take into consideration	consider
terminate	end
the cause may be	because
the tube that has a length of 3m	the tube, 3m long
through the use of	by, with
transpire	happen
until such time as	until
utilize, utilization	use
very unusual, very unique	unusual, unique
was of the opinion that	believed
we conducted inoculation experiments on	we inoculated
with the possible exception that	except
with the result that	so that
within the realm of possibility	possible

Adapted from Day 1998.

APPENDIX G: ACTION VERBS

Improve the interest and accuracy of text by selecting action verbs from the following list. Proofread the text and replace verb-preposition phrases (also known as “cheap verbs”) with action verbs. A few examples include look up (find), take over (assume), check out (investigate), turn in (submit), run into (meet, encounter), go with (select), go over (review), come across (discover, impress), give up (surrender, forego), put up with (tolerate), head off (divert, avoid), bring about (cause), etc.

accelerate	assist	commission	delegate
acclimate	assume	commit	deliver
accompany	attain	communicate	demonstrate
accomplish	attract	compare	depreciate
achieve	audit	compile	describe
acquire	augment	complete	designate
act	author	comply	design
activate	authorize	compose	determine
actuate	automate	compute	develop
adapt	award	conceive	devise
add			devote
address	balance	conceptualize	diagnose
adhere	bargain	conclude	diagram
adjust	borrow	condense	direct
administer	broaden	conduct	disclose
admit	budget	confer	discount
advance	build	consolidate	discover
advertise		construct	dispatch
advise	calculate	consult	display
advocate	canvas	contract	dissemble
affect	capitalize	contrast	distinguish
aid	catalogue	contribute	distribute
air	centralize	control	diversify
allocate	chair	convert	divest
alter	challenge	convince	document
amend	change	coordinate	double
amplify	channel	correct	draft
analyze	chart	correspond	
anticipate	check	counsel	earn
apply	chose	create	ease
appoint	circulate	critique	edit
appraise	clarify	cultivate	educate
approach	classify	cut	effect
approve	clear		elect
arbitrate	close	debate	eliminate
arrange	coach	debug	employ
ascertain	co-author	decide	empower
assemble	collaborate	decrease	enable
assess	collect	defer	encourage
assign	combine	define	endorse

enforce	generate	judge	oversee
engage	govern	launch	
engineer	grade	learn	participate
enhance	grant	lecture	pass
enlarge	group	led	pattern
enlist	guard	lighten	pay
enrich	guide	liquidate	penalize
enter	handle	listen	perceive
entertain	head	litigate	perform
establish	help	lobby	permit
estimate	hire	localize	persuade
evaluate	host	locate	pinpoint
examine	identify	maintain	pioneer
exceed	illuminate	manage	place
exchange	illustrate	map	plan
execute	implement	market	poll
exempt	improve	maximize	prepare
exercise	improvise	measure	present
expand	inaugurate	mechanize	preserve
expedite	increase	mediate	preside
explain	incur	memorize	prevent
expose	index	merge	price
extend	indoctrinate	meet	print
extract	induce	minimize	prioritize
extrapolate	influence	model	probe
	inform	moderate	process
facilitate	initiate	modernize	procure
familiarize	innovate	modify	produce
fashion	inquire	modulate	profile
field	inspect	monitor	program
figure	inspire	motivate	project
finalize	install	mold	prompt
finance	instigate	move	propose
find	instill	multiply	prove
fit	institute	name	provide
focus	instruct	narrate	publicize
forecast	insure	negotiate	publish
foresee	integrate	notice	purchase
formalize	interface	nurture	pursue
form	interpret	observe	
formulate	interview	obtain	quantify
fortify	introduce	offer	question
foster	invent	offset	quote
frame	inventory	open	
fulfill	invest	operate	raise
function	investigate	order	rank
furnish	involve	organize	rate
gain	isolate	orient	react
gather	issued	originate	receive
gauge	joined	overhaul	recognize

recommend	secure	tailor
reconcile	segment	target
record	select	teach
recover	sell	tend
recruit	send	terminate
rectify	separate	test
redesign	serve	tighten
reduce	service	trace
refer	settle	trade
refine	shape	train
regain	shorten	transact
regulate	showy	transfer
rehabilitate	sign	transform
reinforce	simplify	translate
reinstate	simulate	transport
reject	solve	travel
relate	sort	treat
release	speak	triple
remedy	specify	
remodel	speculate	uncover
render	spread	undertake
renegotiate	stabilize	unify
renovated	staff	unite
reorganize	stage	update
repair	standardize	upgrade
replace	steer	use
report	stimulate	
represent	strategize	validate
request	streamline	value
research	strengthen	verify
resolve	stress	view
respond	structure	visit
restore	study	
restructure	submit	weigh
retain	substantiate	welcome
retrieve	substitute	widen
revamp	succeed	win
reveal	suggest	witness
reverse	summarize	work
review	supersede	write
revise	supervise	
revitalize	supply	
reward	support	
route	surpass	
	survey	
safeguard	synchronize	
salvage	synthesize	
save	systematize	
schedule		
screen	tabulated	

APPENDIX H: EDITORIAL MARKS

To assist with incorporating group or reviewer comments, use the following common editorial marks to note needed revisions.

Delete	
Delete space	
Insert space	#
Begin new paragraph	
Align horizontally	=
Align vertically	
Transpose	
Spell out	Sp
Insert here	^
Insert comma	
Insert period	
Insert semicolon	;
Insert colon	:
Insert hyphen	=
Insert parentheses	()