Technical Writing For Engineers

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“Prophets, poets, and thinkers of every age have proclaimed love as the highest of all the virtues. But Zion cannot be established by the lower forms of love…it requires charity (agape), that pure love of Christ “bestowed” as a gift upon all who will submit to the covenants and the powers of the atonement. It was this kind of love that sustained a Zion society for four generations among the Nephites who experienced “no contention … because of the love of God which did dwell in the hearts of the people.”

…The entire gospel plan and program of the Church is to engender in us this quintessential quality—love. The pure love of Christ is a sanctifying and cleansing power—the only force powerful enough to make us “THE PURE IN HEART.”

…One cannot belong to the Church for long without learning that service is central to the entire workings of the kingdom.

Quinn Gardner
Why Write?

- Develops perhaps the single most important skill in your career.
  - Engineers must be excellent technical writers
- Conveys important ideas in a lasting way that will preserve your work.
- Hones your thinking
  - Careful thought
  - Critical analysis
  - Others’ point of view
Rule #1 of Good Writing

- Revision, revision, revision!!!!
- “There is no such thing as good writing, only good re-writing.”
An Effective Report is Logical

- Technical report logic begins at the word level and extends through the document level.

- **Document Level**
  - Easy to follow (sectioning and structure)
  - Professional appearance (neat, organized)

- **Paragraph Level**
  - Coherence in thought (paragraph construction)
  - Makes points quickly (concise)

- **Word/Sentence Level**
  - Professional Language (spelling, grammar)
  - Unambiguous wording (precise language)

Good technical writing conveys the ideas in such a way that the reader can easily and quickly understand and is convinced.
Document Level Logic

SECTIONING AND STRUCTURE
Full/Complete Reports

- Abstract (for the very busy reader)
  - Includes major details of the report.
  - This is the first place you convince the audience.

- Introduction (what is this all about?)
  - Problem statement (how did it all start?)
  - Objectives (what needed to be accomplished?)
  - DO NOT discuss methods or results here
Full/Complete Report (continued)

- Theoretical/Analytical Background (what principles apply?)
  - How can the answer be determined?
  - Assumptions!!!

- Methods (what did you do?)

- Results/Analysis/Discussion (what did you get, and what does it mean?)
  - Establish the validity of your results
    - Compare to theory, published data, etc.
    - Error Analysis

- Summary/Conclusions (tie it all together)
  - Draw and support your conclusions
Memo Reports

- Most communication done in industry are short!
  - Email
  - 1-2 page memo reports (may be longer)
- Memo reports contain many of the same elements as longer reports, but the purpose is to give the reader the most important information (results, discussion, conclusions) quickly.
- Several sections of a full reports are often combined in memo reports
Sections of Memo Reports

- Heading
  - To:
  - From:
  - Subject:

- Introduction/Objective
- Methods/Apparatus/Procedures
- Results/Discussion
- Conclusions/Recommendations

- **Main focus**
- Very abbreviated
- May not be needed
Proposals

- Common in industry and academia.
- A document that offers to provide service or a product (for money).
- Usually written in response to a request for work.
- Outlines the plans to accomplish the requested work.
- Seeks to persuade the reader to choose the submitting person/company to perform the work.
Sections of a Proposal

- Different organizations will have different requirements.
  - It is very important to adhere to the requirements.
- In general, proposals have the following elements.
  - Summary
  - Project Description (Technical proposal)
  - Personnel (Management proposal)
  - Budget (Cost proposal)
Proposals in ChEn 475

- Before beginning any experiment, you are required to submit a proposal, in memo format, outlining your plans.
- This is a very important part of the process.
  - Think through all the details.
  - Communicate a clear plan to the entire group.
  - Work out most the analysis problems before you begin.
Sections of Proposals in ChEn 475

- **Overview/Objective (Introduction)**
  - Explain the problem background.
  - Clearly define the objectives.

- **Theoretical Analysis**
  - Explain the design equations

- **Experimental Methods**
  - **Apparatus**
  - Details on replicates, conditions,

- **Expected Outcomes**
  - Estimate ranges of expected measurements
  - Perform *a full sample calculation* using estimates
Progress Report

- Brief update on progress to your boss or sponsor in the middle of your project
- Very common in industry and academia

Components:
- One paragraph by email
- One PowerPoint slide attached

Content
- Progress
- Challenges
- Needs
- Preliminary results
CONSTRUCTING GOOD PARAGRAPHS

Paragraph Level Logic

Adapted from http://owl.english.purdue.edu/owl/resource/606/1/ and http://english.byu.edu/writingcenter/handouts/OrganizationStructure/paragraphunity.htm
### What is a paragraph?

<table>
<thead>
<tr>
<th>Definition</th>
<th>Basic Rules</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A paragraph is a collection of related sentences dealing with a single topic.</td>
<td>Keep one idea to one paragraph.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If you begin to transition into a new idea, begin a new paragraph.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If a single paragraph becomes long, consider elaborating on each point in separate paragraphs.</td>
<td></td>
</tr>
</tbody>
</table>
Saner, Wisconsin is the snow-mobile capital of the world. The buzzing of the engines fills the air, and their tank-like tracks crisscross the snow. The snow reminds me of Mom's mashed potatoes, covered with furrows I would draw with my fork. Mom's mashed potatoes usually made me sick; that's why I was playing with them. I like to make a hole in the middle of the potatoes and fill it with melted butter. This behavior has been the subject of long chats with my analyst.
Elements of a Paragraph

In addition to being restricted to one topic, effective paragraphs should contain each of the following:

◦ A Topic Sentence
◦ Adequate Development
◦ Coherence
A Topic Sentence

- Every paragraph should have a topic sentence.
- The topic sentence explains, in a general way, what the paragraph is about.
- The best way to make sure your reader understands is to make the first sentence the topic sentence.
Adequate Development

- The topic of the paragraph should be fully discussed.
- Beware of paragraphs with only two or three sentences.
- Method to create well-developed paragraphs
  - Use examples/illustrations
  - Cite data
  - Define terms
  - Compare/Contrast
  - Evaluate causes and reasons
  - Examine effects
  - Analyze the topic
Coherence

- Coherence is the trait that makes the paragraph easily understandable.
- This is often referred to as “flow.”
Example-Non Coherent

The means by which Asian companies have sought to compete with American products in market segments in the Western Pacific region will constitute the objective of the first phase of our study. The labor costs of our Asian competitors and their ability to introduce new products quickly are the main issues to be examined in detail. A plan that will demonstrate how American industry can restructure its operations so that it can better exploit unexpected market opportunities, particularly in the Pacific Rim, will be developed from this study.

A study it being done, but what is being studied and what is expected?
In the first phase of our study, we will examine *market segments* in the Western Pacific region to determine how *Asian companies* have competed with *American* products. The *study* will examine, in detail, *labor costs* and the ability of *Asian competitors* to introduce new products quickly. By *studying* these elements, we will develop a plan that will demonstrate how *American industry* can restructure its operations so that it can better exploit unexpected *market opportunities*, particularly in the *Pacific Rim*. 
Tips For Writing Coherent Paragraphs

- **Repetition of words**
  - *study, market, Asian, American* are repeated multiple times

- **Related words**
  - *Asian companies* ➔ *Asian competitors*
  - *market segments* ➔ *labor costs*
Tips – Transitional Words

- Use transitional words to link ideas from different sentences.

- Transitions (found in bold in this paragraph) are functional words or word groups, even whole paragraphs, that connect and show relationships between ideas in a piece of writing. Moreover, they show on paper that writers are aware that a reader can't read their minds. Anything that does this job, then, is a transition—even if it is a punctuation mark, such as a dash, colon, or semicolon; if it connects or shows relationships, it is a transition.
Experiments show that important tasks can be accomplished with a hand axe. *Homo erectus* possessed other tools suitable for some purposes. The hand axe was costly to produce in terms of time, labor, and skill, and required larger blocks of fine-grained, faultless stone. Flint and basalt are fine-grained, faultless stones. The hand axe presented a hazard.
Experiments show that this important task can be accomplished with a hand axe. But *Homo erectus* possessed other tools suitable for that purpose. Compared with these, the hand axe was costly to produce in terms of time, labor, and skill, and required larger blocks of fine-grained, faultless stone, such as flint or basalt. The hand axe also presented a hazard.
Problems with “Linking”

A memo was received September 1 requesting this information. The objective of this report is to present the best method for delivery of an equimolar mixture of carbon dioxide and argon to purge oxygen out of the welding environment in the MIG welding process. The compressibility of carbon dioxide and the equimolar mixture is given at 25°C for a range of pressures from 100 to 750 psia.

By isothermally increasing the volume by a set amount and measuring the new pressures compressibility factors were able to be determined.
Word/Sentence Level Logic

GRAMMAR TIPS
Agreement in Number

- Inconsistency in number is possibly the single most common error of capable writers.
  - ☹ This data was used in the analysis.
  - ☺ These data were used in the analysis.
  - ☹ Everyone please take their seat.
  - ☺ Everyone please take his or her seat.
  - ☹ Each of the valves opened at their designated times.
  - ☺ Each of the valves opened at its designated time.
Hyphens

- The high-temperature tank ruptured.
- The twenty-five-meter pipe.
- The blue-green fluid leaked. (compound adjective in this case)
  OR
  The leaking fluid was blue green. (predicate modifier in this case and is not hyphenated)
- The six- or eight-bit A/D converter.
- The *in situ* analysis indicates poor mixing. (no hyphen)
Units

- Abbreviated units that derive from people’s names are capitalized (but spelled out units are not).
  - V, K, and kg; volt, kelvin, and kilogram but degrees Celsius

- Temperature
  - Celsius not centigrade
  - 45 °C, not 45° C, 68 °F, 512 °R, 325 K
  - 45° is an angle, not a temperature.

- Values and units are not hyphenated when used as adjectives unless they are spelled out.
  - 3 mm tube or three-millimeter tube, but not 3-mm tube.

- Use superscripts to be precise in units
  - \( J \cdot mol^{-1} \cdot K^{-1} \) not \( J/mol/K \)
  - Can use \( J/mol \)
Case and Tense Matter

- The assignment came to me and my partner (not my partner and I).
- My instructor told me he was most impressed.
- The two major contributors were my partner and I (not me and my partner).
  - My partner and I were ….
- The author of this report was I (not me).
  - I was the author ….
- The data fit a straight line and are consistent with first-order kinetics.
Dangling Constructions

- Ensure the subject of introductory sentences agrees with that of the remainder of the sentence.
  - Having studied the costs, several questions arise.
  - Having studied the costs, we posed the following questions.

- To obtain more precise data, surrogate chemicals were used.
  - To obtain more precise data, investigators used surrogate chemicals.
Avoid Split Infinitives

😊 The coal was able to barely burn.
😊 The coal was barely able to burn.
😊 The tank was too cold for the reaction to significantly proceed.
😊 The tank was too cold for the reaction to proceed significantly.
Subject Verb Agreement

- Subject-verb agreement requires attention, particularly when the subject and verb are separated by other words.
  - The thermocouples wired to the A/D board indicate reactor status.
- Compound subjects linked by and generally require plural verbs.
  - Temperature and, for non-ideal gases, pressure influence gas enthalpy.
- Compound subjects linked by or generally require verbs matching the closest noun.
  - A higher reflux ratio or two additional stages produce column performance within specifications.
  - Two additional stages or a higher reflux ratio produces column performance within specifications.
- Indefinite pronouns generally require singular verbs.
  - Each of the experiments requires 10 kg of solvent.
  - But: Some of the experiments require hours to conduct.
  - Some of the reagent reacts with the air (similar with all, and any).
**Active vs. Passive Voice**

- Active voice should be used when possible.
  - 😞 A loose connection was responsible for voltage spikes that melted the power supply.
  - 😊 A loose connection generated voltage spikes, melting the power supply.

- Don’t avoid passive voice altogether.
  - 😊 The pressure was measured using a mercury manometer.
  - 😞 A mercury manometer measured the pressure.
  - or
  - 😞 We measured the pressure using a mercury manometer.
Verbs

• Subject-verb agreement – with intervening words, match verb to subject, not the closest noun

😊 High levels of air pollution damage the respiratory tract.

😊 A full set of weights costs five-hundred dollars.

😊 The reaction rate expression, together with its parameters, appears in Table 1. (similarly, phrases beginning with as well as, in addition to, accompanied by, and along with do not make a singular noun plural).
Capitalization

- Names of specific items generally are capitalized.
  - The Constitution (if US constitution is implied) describes three branches of government.
  - The constitution (if any generic constitution is implied) describes elections of officers campus organizations.
  - Figure 7 illustrates model predictions based on Equation 9.
  - The figure illustrates model predictions based on this equation.
Word/Sentence Level Logic

UNAMBIGUOUS LANGUAGE (WRITING PRECISELY)
Writing Precisely

- Be Specific
- Words like “big,” “better,” “slightly,” etc. leave the reader guessing

- Replace
  - a tall spray dryer
  - a long, thin pipe
  - results agreed fairly well with predictions
  - efficiency was low

- With
  - a 40 foot tall spray dryer
  - an 85 ft long, 3 inch diameter pipe
  - results fell within 7% of predictions
  - efficiency was 41%
YOU’LL NEVER DO ANY GOOD WITH A SIGN LIKE THAT...YOU HAVE TO BE MORE SPECIFIC.
HELP STAMP OUT THINGS THAT NEED STAMPING OUT!
Corporate Spy at Chemical Plant

You wouldn’t believe how big the storage tanks are. And there are horizontal pipes and vertical pipes and valves all over the place.
Abstract

This report has been prepared to discuss the results of experimental efforts to determine the conditions for transition from laminar to turbulent flow for water flowing in a cylindrical horizontal tube. In addition, the report will compare the consistency of experimental data used to determine the flow rate from integrating velocity profiles with that obtained from theoretical correlations. (Appendix 1)

Summary

It was observed that the transition from laminar flow occurred at approximately $Re = 1250$, where $Re = Reynold’s$ Number. The flow rates obtained from the velocity profiles were within 14% of those obtained experimentally. Results are in fairly good agreement, but it is recommended that certain changes be made in the experimental apparatus to obtain better results.
Summary

The radial finned tube had the highest heat transfer per foot and the highest fin efficiency of the finned tubes. The greatest heat transfer was found at the highest flow rate available with our pump (6.7 gpm).

The heat transfer coefficients were internally consistent. The radial and longitudinal fins deviated by only 2% in their coefficients, but the value of the bare pipe might be high. The rusted fins are infeasible even at one third the cost because of the low amount of transfer. Rusted surfaces have a thermal conductivity of about 1 BTU/hr ft F compared to 119 BTU/hr ft F for aluminum. The bare pipe had a rather high heat transfer coefficient but the surface area was so small that not enough transfer took place.
VI. CONCLUSIONS AND RECOMMENDATIONS

1) Standard heat transfer equations predict the temperature profiles in rods within 10%.

2) The values for thermal conductivity in the literature are accurate.
Paragraph Level Logic

WRITING CONCISELY
Writing Concisely

- Look for unnecessary words
- Go over it many times

- **Replace**
  - during the course of the experiment
  - corrosion which was there because of the acid
  - We were able to measure . . .
  - We found out that the flowrate was...
  - Our biggest problem was . . .
  - This report has been prepared to discuss the results of experimental efforts to determine the conditions for transition from laminar to turbulent flow

- **With**
  - during the experiment
  - acid-induced corrosion
  - We measured . . .
  - The flowrate was . . .
  - [nothing]
  - The transition from laminar to turbulent flow was experimentally determined to be . . .
Writing concisely takes time

From Abraham Lincoln (reported in the book *Lincoln*, by Russell Freedman)

“One of the beauties of his speeches was their eloquent brevity. He agonized over his speeches, revising and cutting and polishing until the moment he mounted the podium. He couldn’t stand folks who were long-winded. Referring to one such person, Lincoln said, ‘That man can compress the most words in the fewest ideas of anyone I ever knew.’”
Conciseness Tips

• Useless phrases.
  ☹ There was an increase in temperature.
  ☺ The temperature increased from 75 °C to 100 °C.

• Redundant words.
  ☹ The time-temperature history of the particle appears in the figure.
  ☺ The particle temperature history appears in the figure.
Conciseness Tips

• Non-essential Relative Clauses
  ☹ The wires that come from the thermocouple that is in the distillation column require rerouting.
  ☺ The distillation column thermocouple leads require rerouting.

• Unnecessary Prepositions
  ☹ The reading of the temperature meter for the hot tank was 214 °C.
  ☺ The hot-tank temperature meter read 214 °C.
Conciseness Tips

- Minimize prepositions
  - ☹️ The temperature of the fluid increased rapidly.
  - 😊 The fluid temperature increased rapidly.

- Especially avoid preposition strings
  - ☹️ The concentration of benzene in the fluid outside of the tank exceeded EPA limits.
  - 😊 The benzene concentration in the external fluid exceeded EPA limits.
  - 😊 The external-fluid benzene concentration exceeded EPA limits.
Conciseness Tips

- Empty Prepositional Phrases
  - ☹ Students are required by the university to make payments of their fees at the time of registration.
  - ☺ The university requires students to pay registration fees.

- Vagueness
  - ☹ Many students feel anxiety stress when they find themselves in a testing situation.
  - ☺ Exams make many students nervous (or anxious).
Conciseness Tips

- Unnecessary qualifiers
  - 😞 It should be noted that the reactor was hot.
  - ☺ The reactor was hot.

- Indirect references
  - 😞 The professor in my section of the Unit Operations Laboratory class graded the report.
  - ☺ Dr. Memmott graded the report.
The conclusion drawn was that the limiting factor in the experiment was the pH probe. The reaction was much faster at 40°C and the probe was very sluggish. The reaction seemed to proceed faster than the probe could read accurately.

Thus, at 40°C the reaction proceeded faster than the slow-response probe could monitor the OH⁻ concentration.
APPARATUS and PROCEDURE (131 words)
The holding tank was filled with 300 gallons of water. A fitting or valve was then placed between the manometer leads. Next the pump was turned on and the two pressure gauges on either side of the pump were read to determine the total static pump head (Hp). The water flow rate was varied to give different Hp’s and the pressure drop across the fitting or valve was measured with the manometer. The hose that discharged the water into the holding tank was then placed in the weighing tank. The Hp was varied again and flow rates were measured by using the weighing scale. After measuring the flow rate the water was returned to the holding tank. A new fitting or valve was put into place and the procedure was repeated.

BETTER (65 words)
Water from a 300-gallon holding tank was pumped via a Model VIP pump through 3/4 inch schedule 40 steel pipe with the test valve or fitting attached. Pressure gauges at the pump inlet and outlet provided pump head data. As the pump head was varied, the pressure drop was measured using a manometer, and the flow rate was determined by weighing the water in the collecting tank.
At the measuring station, ink was injected into the stream at various distances from the pipe wall via a thin, variable-position needle. The velocity of the ink was determined by measuring the travel time between markers along the pipe, and a velocity profile was then determined.
Plagiarism Examples

- Direct Plagiarism—The verbatim copying of an original source without acknowledging the source.
- Paraphrased Plagiarism—The paraphrasing, without acknowledgment, of ideas from another that the reader might mistake for your own.
- Plagiarism Mosaic—The borrowing of words, ideas, or data from an original source and blending this original material with one's own without acknowledging the source.
- Insufficient Acknowledgment—The partial or incomplete attribution of words, ideas, or data from an original source.

source: http://catalog.byu.edu/policy/academic-honesty, downloaded April 14, 2017
Paraphrasing is essential in academic writing, especially when reviewing the literature.

A proper paraphrase generally is shorter, less complex, and more focused on the point you are discussing than the original document. It is written

- in your own words, not the direct or rearranged words of the author – if the author uses a term or phrase you feel is essential, it should be in quotes,
- usually in combination with other work,
- in the context of a logical structure or argument you are discussing.
Consequences at BYU

- Oral or written reprimand
- Redoing work
- Lower assignment or course grade
- Removal from course
- Dismissal from college
- Probation, suspension, or dismissal from the university
- Legal action

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Professional Consequences

- All of the following are recorded responses to employees who plagiarize materials in order of increasing negative severity
  - Reward
  - No consequence
  - Loss of personal respect and trust
  - Compromised relationships
  - Loss of institutional respect and trust
  - Job reassignment
  - Loss of job
  - Prosecution
  - Loss of career
  - Failure of company
Avoiding Plagiarism

- Cite sources correctly
- Cite original source, not a subsequent citation
- Quote direct phrases
- Paraphrase correctly and include citations
THAT'S IT!