Technical Writing For Engineers

Thomas A. Knotts Thomas H. Fletcher N. Stanley Harding

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With help from: Ken A. Solen Larry L. Baxter Richard L. Rowley Randy L. Lewis



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
 - I-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





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

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.
 - <u>These data were</u> used in the analysis.
 - Everyone please take <u>their</u> seat.
 - Service please take <u>his</u> or <u>her</u> seat.
 - Each of the valves opened at <u>their</u> designated <u>times</u>.
 - ⊙ 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
 - \circ 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).
- O My instructor told me he was most impressed.
- The two major contributors were my partner and <u>I</u> (not me and my partner).

⊙ My partner and I were

 \odot The author of this report was <u>I</u> (not me).

⊙ I was the author

 The <u>data</u> <u>fit</u> a straight line and <u>are</u> 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 <u>thermocouples</u> wired to the A/D board <u>indicate</u> reactor status.
- Compound subjects linked by and generally require plural verbs.
 <u>Temperature and</u>, for non-ideal gases, <u>pressure influence</u> gas enthalpy.
- Compound subjects linked by or generally require verbs matching the closest noun.
 - O A higher reflux <u>ratio</u> or two additional <u>stages produce</u> column performance within specifications.
 - Two additional <u>stages</u> or a higher reflux <u>ratio produces</u> column performance within specifications.
- Indefinite pronouns generally require singular verbs.
 - ⊙ Each of the experiments <u>requires</u> 10 kg of solvent.
 - ③ But: <u>Some</u> of the <u>experiments</u> <u>require</u> hours to conduct.
 - ⊙ <u>Some</u> of the <u>reagent</u> <u>reacts</u> 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.

We measured the pressure using a mercury manometer.



Verbs

- Subject-verb agreement with intervening words, match verb to subject, not the closest noun
 - Output: High <u>levels</u> of air pollution <u>damage</u> the respiratory tract.
 - ⊙ A full <u>set</u> of weights <u>costs</u> five-hundred dollars.
 - The reaction rate <u>expression</u>, together with its parameters, <u>appears</u> 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 <u>Constitution</u> (if US constitution is implied) describes three branches of government.
 - The <u>constitution</u> (if any generic constitution is implied) describes elections of officers campus organizations.
 - Figure 7 illustrates model predictions base on Equation 9.
 - The <u>figure</u> illustrates model predictions based on this <u>equation</u>.

Word/Sentence Level Logic

UNAMBIGUOUS LANGUAGE (WRITING PRECISELY)

Writing Precisely

Be Specific

Words like "big," "better," "slightly," etc. leave the reader guessing

<u>Replace</u>

11 annoss dasson

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

• <u>With</u>

- a 40 foot tall spray dryer
- an 85 ft long, 3 inch diameter pipe
- results fell within 7% of predictions
- efficiency was 41%







Corporate Spy at Chemical Plant



Vague

<u>Abstract</u>

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 I)

<u>Summary</u>

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.

Vague

<u>Summary</u>

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 I BTU/hr ft F compared to II9 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.

Vague

VI. CONCLUSIONS AND RECOMMENDATIONS

 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

<u>Replace</u>

- 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

- <u>With</u>
 - 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 <u>Lincoln</u>, 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.'"

- Useless phrases.
 - Carte There was an increase in temperature.
 - ⊙ The temperature increased from 75 °C to 100 °C.
- Redundant words.
 - The <u>time</u>-temperature <u>history</u> of the particle appears in the figure.
 - The particle temperature history appears in the figure.

- 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.

 \odot The hot-tank temperature meter read 214 °C.

- Minimize prepositions
 - The <u>temperature of the fluid</u> increased rapidly.
 - ⊙ The <u>fluid temperature</u> increased rapidly.
- Especially avoid preposition strings
 - The concentration of benzene in the fluid outside of the tank exceeded EPA limits.
 - The <u>benzene</u> <u>concentration in the external fluid</u> exceeded EPA limits.
 - The external-fluid <u>benzene</u> <u>concentration</u> exceeded EPA limits.

- 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.

Stams make many students nervous (or anxious).

- 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.
 - Or. Rowley graded the report.

Wordy (40 words)

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.

Better (16 words)

Thus, at 40° C the reaction proceeded faster than the slow-response probe could monitor the OH⁻ concentration.

Wordy

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 flowrate was determined by weighing the water in the collecting tank.

Wordy (96 words) (also note problems with tense)

At the measuring station, ink is injected into the stream from a thin needle. The position of the needle in the pipe is adjustable, so ink can be injected at different distances from the pipe wall. A distance was marked along the pipe wall so a stopwatch could be used to time the ink flow over the distance. The velocity of the stream at the position of needle tip could be calculated from the distance, and the elapsed time. By determining the velocity at positions across the pipe radius, a velocity profile could be generated.

Better (46 words)

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.

• THAT'S IT!