

Academic Writing in Engineering and Science

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Why do we write?

Science must be publicly-available, systematically-conducted and objective. It also must provide new knowledge in a reproducible and cumulative manner. A peer-reviewed published article allows these characteristics to exist. For instance:

Your article must be reproducible. This means you must provide every detail needed for someone in Tanzania or Australia to repeat your work identically without ever needing to contact you.

Your article should be cumulative. This means it should clearly explain what knowledge base it relies on.

Your article must be objective. This means you must clearly state all assumptions and potential pitfalls of your study/method.

When you first start writing...

I suggest:

- Start writing as soon as you start your research! From the first day!
- You start with a title, abstract and outline. Each of these will probably change quite a bit by the time you are done, but they will be your guiding star until then.
- Start populating each section within the outline. It is a good practice to not spend too much time on the introduction at first. It will most likely be rewritten when the paper gets close to being done.
- A typical outline includes: introduction, background, methodology, results, conclusion, references.

When identifying a target journal:

- Decide as early as possible. Shortly after the title, abstract and outline are ready. Definitely before the first draft of the paper is ready.
- Find 3-4 journals that have published work similar to yours. Look at their impact-factors and reputations. For instance, some open-access journals these days are not reputable.
- Assess their back-log. Does it take 3 years for an accepted paper to be published? If so, avoid that journal.
- Consider journals that have published work you cite. This is the easiest way to justify submitting a paper to a journal.
- If you have a hard time choosing among 2 options, writing a quick email to the editor of the journal is a good idea.

Once a target journal is selected:

- Read the instructions to authors on the journal website before starting to prepare your paper.
- Determine the minimum/ maximum length of articles the journal allows.
- Determine the minimum/ maximum length of abstract the journal allows.
- Does the journal have a template for articles? If so, use it.
- Determine if the journal has the guidelines regarding writing style. If so, follow them.
- Determine if the journal has restrictions regarding the number of figures and tables. What format are these figures to be uploaded? Tiff? Jpeg?
- In what format should references appear?

Once a target journal is selected:

The best advice I can give:

Find a recently published paper in your target journal and use it as a reference...keep it on your bedside.

When your first draft is done...

I suggest:

- You put your paper aside for 72 hours and let your brain forget about it. Then go back and read it over.
- Revise it as many different forms as possible: print copies, electronic copies, reading out loud to yourself and etc.
- Do not give anyone your first draft to read – it is likely to cause frustration for both sides. Rule of thumb: revise three times yourself before letting anyone see your draft.
- Write and revise every day – even as little as 30 minutes. As your research makes progress, your write-up should be making progress at the same pace.

When writing:

Pay attention to:

- Writing technically **CORRECT STATEMENTS**. I consider writing incorrect statements as the **biggest sin**. So, think twice or thrice about every sentence's technical content before you write it down.
- Writing grammatically correct statements. Use all the help you can get available on campus to improve your English.

When writing:

Pay attention to:

- Writing brief, concise, right-to-the point sentences. Avoid unnecessary words at all cost.
- Don't repeat yourself. Avoid redundancy.
- Don't switch tenses out of the blue! Everything YOU have done and are reporting should be in the **present tense**. Everything OTHERS have done (in your literature review) should be in the **past tense**.

When writing:

FLOW is everything:

- Pay attention to the flow of ideas from **one sentence to the next.**

Feel free to use connecting phrases: therefore, hence, thus, furthermore, moreover, nevertheless, however and etc. Also you use common words between two sentences to link.

- Pay attention to the flow of ideas from **one paragraph to the next.**

The last sentence of the first paragraph and the first sentence of the second paragraph should ensure the flow.

- Pay attention to the flow of ideas from **one section to the next.**

This is a little harder sometimes. But the flow from section to section should make 'technical sense'. You do not need the last or first sentences of each section to accomplish this. A proper outline typically takes care of it.

Flow between sentences:

Original Introduction

The symmetrically spiraled curve program was designed and written to compute the basic characteristics of a symmetrically spiraled circular curve. In addition to those characteristics, the program will also compute the deflection angles required to set stakes at quarter stations (every 25 feet) along the curve.

*borrowed from Tom Lang

Flow between sentences:

Revised Introduction

Symmetrically spiraled curves accommodate the natural driving path of the motorist. Properly designed, these curves produce a more comfortable ride. However, engineers have hesitated to use these curves because of the difficulty in calculating them. In this study, the symmetrically spiraled curve program was written to compute the basic characteristics of the curve more easily. This paper explains how to arrange the necessary data sets on computer cards so that highway engineers can use the symmetrically spiraled curve program to design a curve.

*revised from Tom Lang

In engineering (technical) writing:

Your reader should not have any freedom for interpretation. Hence, you must avoid:

- Subjective statements
- Metaphors
- Abstraction

Instead, you must achieve accurate and precise communication through charts, graphs, equations and factual statements. Hundred different people reading your sentences should get the same message.

When writing:

Here are some good writing practices:

- Use active voice as much as possible, but if you need to use passive voice it is OK as well.
- Use as little abbreviations as possible. My personal rule of thumb: if an abbreviation is not used more than 5 times throughout the text, do not introduce it. It makes it harder for the reader to follow.
- Once you use an acronym, use it consistently throughout the rest of the document. Don't stop using it out of the blue.
- Adjust the use of jargon depending on your audience. Too much jargon might turn off unfamiliar readers.

When writing:

- Avoid indefinite and weak statements and the use of probable terms (i.e. may and maybe).
- Avoid vague statements (i.e. good agreement), quantify your results with meaningful metrics (i.e. 5% difference in mean values).

When writing:

- Write simply! Your readers are usually global and with different native languages. It is distracting for a reader that struggles to understand not only the concept, but also the language.
- Avoid writing like a diary! You should only specify the necessary steps needed for your proposed study or approach.
- If you are using MS Word, use the Readability Statistics to test your document's readability score and other metrics ([Click here for tutorial](#)).

When writing:

- Put appropriate punctuation between sentences such as commas, semicolons and colons.
- Use only one space between sentences.
- Capitalize the first word after using a colon.
- Instead of overusing commas, break the sentence.
- This is a quick read if you want to know about punctuation: <http://grammar.ccc.commnet.edu/grammar/index.htm>

When writing:

Define a new term immediately after the first time it is used. Italicize unfamiliar terms if needed.

- Formulating an overly complex model calibration campaign would lead to models with inferior predictive capability in that reducing the *fitting error* (error in model predictions at the settings of the calibration experiments) results in an increase in the *prediction error* (error in model predictions at untested settings).
- This trade-off relationship is due to the model being overly flexible to fit to noise in the measurements (a concept also known as overfitting), seemingly improving the goodness-of-fit while degrading the generalizability (see Figure 2). Here, the generalizability is defined as the ability of a model to represent the reality of interest at all settings of the domain, including the settings where experiments are not available (Jaafar & Han, 2012).

When writing:

State the most important information in the main clause:

- Not good:** Despite being useful, the results have uncertainty.
Better: Despite having uncertainty, the results are still useful.
Best: The results are useful, despite having uncertainty.

Combine two short, overlapping sentences into one:

- Not good:** The results indicate that the maturity levels are high. Maturity level is calculated using the PCI metric.
Better: The results indicate that the maturity levels, calculated using the PCI metric, are high.

When writing:

Avoid abstract nouns and

Not good: The existing nature of Fort Sumter's behavior was handled through the applied use of computer modeling capabilities.

What do you mean by 'existing nature'? What does 'behavior' mean? How is it 'handled'? What does 'applied use' mean?

Better: With finite element tools, we modeled the dynamic behavior of Fort Sumter's casemates.

When writing:

Avoid ambiguity:

The dynamic behavior of the stadium changed as the crowd started to fill the stadium.

What caused the change in the behavior of the stadium?

The dynamic behavior of the stadium changed because the crowd started to fill the stadium.

The crowd caused the change in the behavior of the stadium.

When writing:

Avoid unnecessary words

(already) existing

never (before)

at (the) present (time)

none (at all)

(basic) fundamentals

now (at this time)

(completely) eliminate

period (of time)

(continue to) remain

(private) industry

currently (being)

(separate) entities

(currently) underway

start (out)

(empty) space

write (out)

had done (previously)

(still) persists

introduced (a new)

mix (together)

whether (or not)

When writing:

Avoid unnecessary words:

stands to show	→	shows
make arrangements for	→	arrange
make the decision	→	decide
perform the measurement of	→	measure
achieve the development of	→	develop
due to the fact that	→	because

When writing:

Avoid unnecessary words:

In actual fact	→	actually
at the time that; at the time when	→	when
In excess of	→	more than, over
In regarding to	→	about, regarding, concerning
Previous to	→	before
Prior to	→	before, until
Subsequent to	→	after
A majority of	→	most
By means of	→	by, with

When writing:

Avoid pronouns

It, this, they, its, their....etc.

Not good: Because the sensor was influenced by the cable, it was secured on the side of the frame.

What is it? The cable or the sensor?

Better: Because the sensor was influenced by the cable, the cable was secured on the side of the frame.

When deciding keywords:

Keywords are used by search engines (Google, Compendex and etc.) to locate your article (along with the title and abstract).

Use as many keywords as you are allowed to, but do not repeat the words that are already in the **abstract** or **title**.

Select the keywords that will maximize the chances of your paper being found by someone interested in the topic.

When preparing figures:

Make sure:

- Use your ink sparingly. Do not include a line if it does not communicate information to your reader.
- Keep the font size and type the same as your narrative text. Keep the actual printing size of the figure in mind when determining the font size. How big is it going to be in the published paper (3.5 or 7in)?
- Prepare your figure such that if someone prints it in black and white, it is still readable. Use different line styles or symbols to differentiate between different data sets.
- Every figure must be referenced in the text. If you do not discuss a paper or refer to it, then it is probably not needed.

When referencing:

- When completing a literature review or using published work to support your discussions, always give priority to peer-reviewed journal articles, instead of conference proceedings.
- Never use websites as a reference (unless you absolutely have to). If you do, mention the date of access and save the webpage on your computer. The website may not be available after 10 years.
- When compiling your bibliography, remember: every cited paper in the text must be listed in the bibliography AND every paper listed in the bibliography must be cited in the text.

When referencing:

- References should be given as: (LASTNAME, YYYY) or (LASTNAME and LASTNAME, YYYY).
- In the end of the paper, references must be organized in alphabetical order. Make sure the format of each citation is *identical*.
- When you have multiple references in a single parenthesis, list them in chronological order.
- If there are 3 or more authors, then use the last name of the first author only: (LASTNAME ET AL., YYYY).
- If there are more than one paper cited from the same first author in the same year, use a,b,c to differentiate them: (LASTNAME ET AL., YYYYa).

When submitting your paper to the journal:

- Read the instructions to authors on the journal website once again before starting to prepare your paper for submission.
- Oftentimes, you will need a cover letter, manuscript, and separate image for each figure. Some journals ask you to prepare a separate doc file for each figure and table.
- While preparing your cover letter, modify an existing cover letter (ask someone of your research group). You will need a brief paragraph explaining the importance of your work and why it fits to that particular journal's scope.

Long story short.....

- Good technical writing doesn't happen overnight, but it is a skill that can be cultivated.
- *Writing a first-class document requires outlining, drafting, rereading, revising, editing, collecting feedback AND doing all of these activities over and over.*
- *Improving your writing skills requires self-review, peer-review, subject-matter expert feedback, and practice...practice...and more practice...*

...and most importantly, assume responsibility in writing about your own research (paper, thesis and/or dissertation) and don't expect somebody else to do it for you.