

Revising Technical Manuscripts to Improve Coherence, Clarity & Conciseness



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Today we are going to look at techniques to revise and polish technical manuscripts.

The goal of the scientific writer:
clarity, coherence, conciseness

“Perfection is achieved, not when there is nothing left to add, but when there is nothing left to take away.”



Distill, distill, distill...

—Antoine-Marie-Roger de Saint-Exupery

Because we think in words, the act of expressing observation in language—of distilling amorphous thoughts into words—is a powerful tool for clarifying your thinking.

Translating your thoughts into words so that you can communicate them to someone else forces you

- to question your assumptions.
- to look for holes.
- to fill in gaps in your thinking.

“The act of composition disciplines the mind; writing is one way to go about thinking, and the practice and habit of writing not only drain the mind, but supply it too.” Strunk and White, *The Elements of Style*, 3rd ed., p. 70.

“It’s also through writing that we learn to articulate our thoughts clearly; our critical thinking is strengthened and clarified by our expression of it in writing.” J.L. Craig, “Writing strategies for graduate students,” *Proc. ASEE Ann. Conf. & Exposition* (Nashville, TN, ASEE, 2005).

Antoine Marie Jean-Baptiste Roger, comte de Saint Exupéry, *Mort pour la France*, was a French aristocrat, writer, poet, and pioneering aviator. He became a laureate of several of France's highest literary awards and also won the U.S. National Book Award. He is best remembered for his novella *The Little Prince* (*Le Petit Prince*) and for his lyrical aviation writings, including *Wind, Sand and Stars* and *Night Flight*.

Plan for time to reflect and revise

You should allow as much time for revision as you do for writing your paper in the first place

Revising concentrates on four elements

- 1. Clarifying the selection and presentation of ideas, tailored to the audience**
- 2. Organizing the narrative logically**
- 3. Evaluating the use of language (emphasis, tone, vocabulary)**
- 4. Proofreading for mechanical errors**



Rewriting often takes more time than writing. As you are planning your timeline for completing your paper, build in sufficient time for getting feedback from others and revising the manuscript.

The probability that a first-draft paper, ripped off the printer 30 ns before the deadline, will be acceptable work approaches 0.

Editing should proceed in three steps

1. Reading for content and logical organization
2. Editing for style (language, tone, emphasis)
3. Proofreading for mechanics (spelling, punctuation, and grammar)

Allow sufficient time for each step!

(it will always take longer than expected)

The Elliott editing equations:

$$t = 4h + \epsilon \quad [1]$$

$$t = 5(h + a) + \epsilon \quad [2]$$

Think of the process as zooming in on the manuscript.

I have learned that you can talk and talk and talk to physicists, but if you really want to get their attention, show them an equation. Hence the Elliott editing equations given above.

In Eq. 1, t is the time it actually takes to edit a manuscript, h is the number of hours you think any idiot should be able to do it in, and ϵ is not necessarily trivial.

Equation 2 is the expression for the time it takes to edit a paper that has multiple authors, where t is the time it actually takes, h is the number of hours you think it should take, a is the number of authors, and ϵ , again, is not necessarily trivial.

1. Look at the science first (macroscopic scale)

Is the information valid, significant, timely, and complete?

Is the context clear? What is new and different? What have you contributed?

Is the information presented at an appropriate level for the audience and the purpose?

Is the narrative arranged in a logical, coherent structure?

Do figures, equations, and tables support, emphasize, and *clarify* the main points?

The first pass is from the **macroscopic** (section) level—look at the **science**.

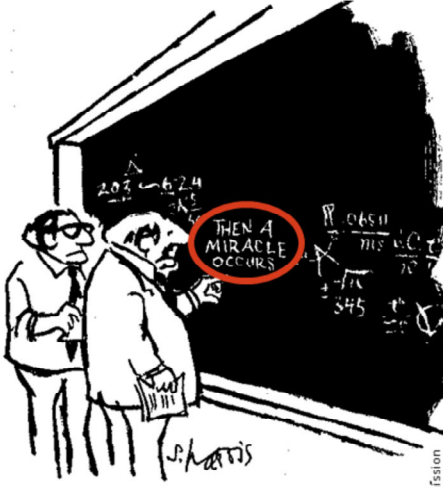
- Are the main points clearly identifiable and given appropriate emphasis?
- Do figures and tables support and enhance the main points?
- Is the narrative coherent—is there a clearly defined progression from background to hypothesis to method to results to conclusions?

TIP: Cut and paste the first sentence of each paragraph into a new document. Read it aloud. Does it adequately tell your story? Are there gaps or omissions?

See <http://people.physics.illinois.edu/Celia/Lectures/Paragraphs.pdf> for tips on how to build effective paragraphs to incorporate an organic, logical structure in your writing.

- Have you supplied sufficient background so that the reader can understand the significance of your work? Have you provided appropriate context through adequate referencing of prior work?
- Have you made your case? Have you justified your assumptions, anticipated reader questions and objections, and supported your arguments?
- Is it clear what you have contributed?

Narrative must be clear and logical



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Used with permission

- Reveal the underlying relationships of ideas and data**
- State assumptions and inferences explicitly and provide supporting evidence**
- Avoid gaps in logic or unwritten assumptions**

Scientists and engineers tend to be highly skeptical about “miracles.”

Provide transitional statements to tie ideas together.

State assumptions and inferences explicitly and provide supporting detail.

Add authority to your arguments by citing previous work.

Arrange your narrative in a logical structure.

Provide logical transitions

One section ends with:

*“... **Improved sensitivity** is important because amplifiers and signal processors are nonlinear and thus can mix signals that lie outside the desired band; the mixing generates signals with frequencies that appear as in-band noise.”*

Begin the next section with:

*“To **achieve the improved filter performance**, high-quality epitaxial films of YBCO have been...”*

The logical connection between the two sections is made clear by repeating the idea of **improving performance**

If you've followed my outlining and paragraph-building advice (http://people.physics.illinois.edu/Celia/SciWriter_Advice.pdf), you'll already have an organically organized, logical narrative line. Reinforce that underlying structure by using transitional statements to tie paragraphs and sections together.

Include **summary statements**

“Testing the physics of nuclear isomers”²

Problem statement (first page):

“Research in the late 1990s indicated x rays could be used to trigger the release of energy from $^{178\text{m}}\text{Hf}$... Some estimates suggested that, with accelerated decay, 1 g of 100-percent isomeric $^{178\text{m}}\text{Hf}$ could release more energy than the detonation of 200 kg of TNT.”

Summary statement (last page):

“These findings can allay DOE’s concern about potential applications of the purported isomer energy source. X-ray induced decay of the Hf isomer does not present a new concern for national security. It also is not a viable alternative as a stand-alone energy source.”

²Maurina Sherman, <http://www.eurekaalert.org/features/doe/2005-08/dmnl-ttp082205.php>

Provide summary statements at the end of each major section of the paper.

The old speaker’s rule is “Tell them what you’re going to tell them. Tell them. Tell them what you told them.” That advice is just as valid for paper and reports. Take it from a mother—telling somebody something important three times is *not* overkill.

2. Focus on the “style” (mesoscopic scale)



Use precise, unambiguous language

Avoid gratuitous jargon

**Use straightforward, declarative sentences
and keep them short (<25 words)**

**Use strong, action verbs, not weak verbs of
being**

<http://people.physics.illinois.edu/Celia/Verbs.pdf>

Eliminate fluffy stuff

<http://people.physics.illinois.edu/Celia/Lectures/Fluff.pdf>

Next, zoom in to the **mesoscopic** (intermediate) level—look at the **words**.

- Is the language clear and unambiguous?
- Have you defined all acronyms and technical jargon that may be unfamiliar to your audience?
- Have you used the simplest word to unambiguously convey your meaning?

Semantics and syntax control clear communication

**“Semantics” is the meaning of words;
you must have a vocabulary adequate to
describe things precisely**



The difference between the right word and the *almost*-right word is the difference between *lightning* and *lightning bug*.
—*Mark Twain*



**Scale your use of jargon to
the intended audience**

Note that words have connotations (overtones of associated ideas or emotions) beyond their literal dictionary meanings, which also affect the appropriateness of word choice.

Example: dis·place·ment [dis'plāsmənt]

- $\Delta x = x_f - x_o$ (physicist)
- the volume moved by the stroke of a piston (mechanical engineer)
- a geological fault (seismologist)
- the volume of water displaced by a vessel floating in it (marine engineer)
- percolation (pharmacist)
- abnormality in the position or form of a leaf or organ (botanist)
- a defense mechanism in which an emotion is transferred to another, more acceptable object (psychologist)

Semantics—the indirect relation between words and meaning; note that words have different meanings in different contexts; e.g. “displacement”

“Syntax” is the way words are put together to form sentences

Sloppy syntax can lead to confusion:

“Two months later, in late January of 1957, Bob wrote down the wave function *for the superconducting state on a New York subway train.*”



s-wave



d-wave



p-wave



Subway trains in New York are *superconducting*?

One way to avoid sloppy syntax is to write shorter sentences. We'll see how and why in a minute...

Avoid “*abstractitis*”

“writing that is so abstruse that even the *writer* does not know what he or she is trying to say” —*Sir Ernest Gowers, GCB*

- 1. Clarify—replace jargon with accessible terminology; use simple subjects and direct action verbs; de-convolute syntax**
- 2. Quantify—replace wimpy, qualitative adjectives with quantitative descriptors**
- 3. Objectify—give concrete examples; use analogies**

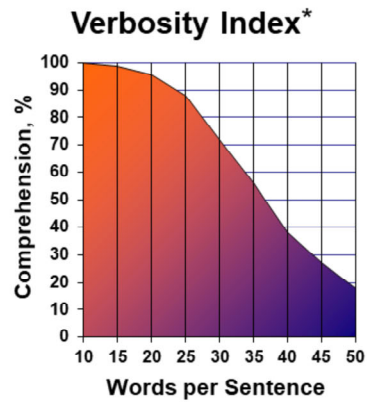
As defined by Ernest Gowers and quoted by Bryan Garner in *Garner’s Modern American Usage*, *abstractitis* is writing that is so abstruse that even the writer does not know what he or she is trying to say. Here’s a description of the phenomenon:

“The words ...dance before my eyes in a meaningless procession: cross-reference to cross-reference, exception upon exception—couched in abstract terms that offer no handle to seize hold of—leave in my mind only a confused sense of some vitally important, but successfully concealed, purport, which it is my duty to extract, but which is within my power, if at all, only after the most inordinate expenditure of time.” (*Yale L.J.* **167**, 169 [1947]).

While Gowers in this case was talking about the U.S. Internal Revenue Code, he could easily have been describing many physics papers.

Gowers’ use of a 68-word sentence is a rant for another day.

Use these techniques to revise for clarity and conciseness



***Illustration only, does not represent actual data. (But it could.)**

Write shorter sentences

Limit the number of modifying clauses & prepositional phrases

Keep verbs close to nouns

Express ideas in positives, not negatives

Avoid indirect constructions; put the subject first

Eliminate unnecessary words

De-nounify verbs

We'll look at how to apply each of these editing techniques next.

Write shorter sentences (<25 words)

The following sentence (63 words), while grammatically correct, is impossible to understand on the first reading



“A program of chemical analysis and receptor modeling is proposed in which samples obtained at the EB ENTEK sites will be used to estimate the sources and/or source regions of trace elemental deposition into the area and the effects of specific urban areas on the airborne particulate matter compositions and thus, their potential contribution to the contamination of the area’s water supplies.”

Avoid long strings of nouns used as adjectives, too
mean field anisotropic superconducting reverse bias
toroid magnet <sigh>

Write short sentences—fewer than 25 words.

Avoid long strings of nouns used as adjectives—“mean field anisotropic superconducting reverse bias toroid magnet” (or MASRBTM, to its fans)

Observe the “three preposition” rule.* If you have a sentence that contains more than three prepositions, rewrite it before it wanders off to die.

Writing shorter paragraphs will also help your reader follow the logic of your narrative. For more information on how to write strong paragraphs, see

<http://people.physics.illinois.edu/Celia/Lectures/Paragraphs.pdf>.

*With thanks to Stephanie Teich-McGoldrick of Sandia National Laboratories, who first introduced me to the three-preposition rule.

Keep verbs **close to their nouns**

Several schemes ranging from minimal computational cost and poor accuracy to high computational cost and high accuracy **can be employed**.

*Several schemes **can be employed**, ranging from minimal computational cost and poor accuracy to high computational cost and great accuracy.*

A program to be used in conjunction with a PC data acquisition card **was written**.

*A program **was written** for use with a PC data acquisition card.*

One of the pitfalls of using the passive voice is the tendency by amateurs to maroon the verb at the end of the sentence. Avoid this practice.

**Recast *negative expressions*—
a positive is easier to understand
and is usually more concise**

Although some data supported the hypothesis, it could not be concluded that output scaled linearly with current.

Output appeared to scale nonlinearly with current.

Arcing under high-current operation could not be avoided without the use of the insulated feedthrough.

The insulated feedthrough prevented arcing, even during high-current operation.

Ideas expressed as positives are almost always easier to process and grasp quickly. Readers have to undergo a second step of deciphering ideas presented as negatives; they have to backtrack to figure out what something *is*, if you tell them what it is *not*. Don't make your readers work this hard.

Avoid beginning clauses with “There are...” or “It is...—put the subject first and plunge right in

“Aside from the point defect corresponding to the cone’s vertex, there is a ‘focal’ set consisting of the two parabolic segments $x^2 = b|y| + b^2/4$.”

“In addition to the point defect corresponding to the cone’s vertex, a ‘focal’ set occurs that consists of the two parabolic segments $x^2 = b|y| + b^2/4$.”

Train yourself to spot “There is...” and “There are...” sentences and rewrite them in the passive voice, which puts the important point first in the sentence (“front loads”).

Make sure *indefinite pronouns* refer to the correct antecedent

Non-commutative geometry is obtained when the latter equation fails and is replaced by another equation, as in the case of the quantum Hall system. The interpretation of this effect in superstrings is startling, however, because *it* is a fundamental theory of spacetime, and *it* means that we cannot think of spacetime in terms of ordinary smooth geometry, as in general relativity.

or *any* antecedent...



Ideally, a pronoun should refer to the noun immediately preceding it. Don't make the reader go back several sentences to determine what "it" you mean. By the same token, you may not use a pronoun until you have first used the noun to which the pronoun refers.

Avoid the big A's—amphibologies and anthropomorphism

Beware of words with multiple meanings

A sintered mixture for the experimental heating rod was prepared from martensitic steel and 5% nickel. *This element* proved to be unsatisfactory.

A subtle but important *point* about the series of *points* generated is that they are not statistically independent *points*.

Don't give human traits to inanimate objects

The substrate *tells* the YBCO how to align during growth.

The dial *needs* to be set at ...

Be sure to use the right word

Alternate or alternative?

Ability, capacity, capability?

Affect or effect?

Principle or principal?

Optimal or optimum?

Biannual or biennial?

Compliment or complement?

Bryan A. Garner, *Garner's Modern American Usage*
(New York, Oxford University Press, 2003)

Theodore Bernstein, *The Careful Writer*
(New York, Atheneum, 1965)



Ms. Particular's Micro-Lectures on Style and Usage
(<http://people.physics.illinois.edu/Celia/MsP/MsParticular.htm>)

Eliminate commonly abused **FLWs***

“only”

The linear relationship in the plots at $T \geq 1340$ K **only** agreed with experimental data when $t \leq 10$ ns.

“with”

We show that solitons undergo a strong blueshift in fibers **with** a dispersion landscape that varies along the direction of propagation.

“etc.”

~~It is well known that~~ localized magnetic moments and the couplings between them are two indispensable factors to induce long-range spin ordering in solids, exhibiting ferromagnetism (FM), antiferromagnetism (AFM), ferrimagnetism, **etc.**

*<http://people.physics.illinois.edu/Celia/MsP/FLWs.pdf>

No more naked “*this*”es—just don’t

In some pellet designs, the average ionic charge, Z , and the laser intensity, I , are large enough that the distribution function is predicted to be non-Maxwellian (flat-topped). **This** has important consequences: reduction of the absorption rate, electron flux, and modification of the continuum x-ray emission rates.

A certain amount of energy is required to cause an electron to spin flip when it is beside another electron. Thus, the energy required is double **this** and is provided by the incident photons.

“This means that...”  *i.e., or thus*

Eliminate fluff


**Redundancies and
wordy expressions**

Pointless modifiers

Tautologies

**Generalities that sound important
but contain zero meaningful content**

<http://people.physics.illinois.edu/Celia/Lectures/Fluff.pdf>



“Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts.” W. Strunk Jr. and E.B. White, *Elements of Style*, 3rd ed. (Needham Heights, MA, Allyn & Bacon, 1979), p. 23.

Eliminate *unnecessary* words

the results *tend to* suggest
they are *both* identical
estimated to be about 0.75 mg
such as copper, iron, *and etc.*
divided into two equal halves
bright yellow *in color* and elliptical *in shape*
 $\Lambda = \lambda/2\theta$, *and vice versa*
given *the fact that* $\tau_\alpha = \sigma q_\alpha \int n(s) ds$
were reexamined *in order* to confirm the presence
It is known that nanocrystallites can form shear bands

“A phrase such as “*it is interesting to note that*”
adds no information and only delays getting to
the point of the sentence.” *Scientific Style and Format*

Replace *wordy expressions*

due to the fact that	<i>because</i>
in the near future	<i>soon</i>
a very limited number of cases	<i>few</i>
it appears to be indicated that	<i>apparently</i>
in spite of the fact that	<i>although, despite</i>
subsequent to	<i>after</i>
at the present time	<i>now</i>
in consequence of this fact	<i>thus</i>
as compared with	<i>versus</i>
in combination with	<i>with</i>

Change nouns ending in *-tion*, *-ment*, and *-ance* back into verbs

The most common use for Raman spectroscopy is for the observation of phonons. (13 words)

Raman spectroscopy is most commonly used to observe phonons. (9 words)

We proceeded to make an arrangement of the superconducting islands on the substrate with the STM tip. (17 words)

We arranged the superconducting islands on the substrate using the STM tip. (12 words)

The superconducting islands were arranged on the substrate using the STM tip. (Better?)

Many English words derived from Latin change verbs into the nominative form by adding *-tion*, *-ment*, and *-ance* suffixes to the verbs. Thus *act* (v.) becomes *action* (n.), *arrange* (v.) becomes *arrangement* (n.), and *perform* (v.) becomes *performance*.

An easy way to improve the conciseness and vigor of your writing is to be on the alert for these nouns and change them back into the verbs they came from.

3. Now for proofreading (microscopic scale)

Editing concentrates on ideas and expression

Proofing concentrates on mechanics

The importance of *proofreading* cannot be overstated

VOLUME 76, NUMBER 17

PHYSICAL REVIEW LETTERS

22 APRIL 1996

**Effect of Filamentation of Brillouin Scattering in Large Underdense Plasmas Irradiated
by Incoherent Laser Light
[Phys. Rev. Lett. 75, 4413 (1995)]**

T. Afshar-rad, L. A. Gizzi, M. Desselberger, and O. Willi

We regret that in the printed version of the manuscript, Figs. 2(a)–2(c) were interchanged with Figs. 3(a)–3(c). In addition, the published Fig. 3(d) was incorrect. As the principal conclusion of the article was based upon a comparison of Figs. 2(a) and 2(b) to Figs. 3(a) and 3(b), this error may have prevented many readers from comprehending the Letter. We are therefore reprinting it correctly below.

You do not want to be these authors. Believe me.

Proofreading examines the manuscript one word at a time

Acronyms, mathematical symbols, and special characters are defined at first usage

Format and typography are consistent and conform to manuscript preparation rules

Technical writing conventions are observed

Grammar and usage are flawless

Punctuation and spelling are *perfect*



TIP 1: Always proofread from a hard copy

TIP 2: Start at the bottom right-hand corner and read backwards and up

Maintain witless consistency throughout the text

**Terminology—always call the same things by
the same names**

Typography—use of italics and boldface

Expression of numbers

Definitions of symbols or special characters

Legends in figures

Style of subheadings, captions, table titles

Use of color



People expect a change to *mean* something!

If you talk for four pages about a “solar collector” and suddenly introduce a “solar absorber” on Page 5, a careful reader will wonder if something qualitatively different is being described.

Present a professional-looking document

Select an appropriate font and size

Use no more than two font styles

Automatically hyphenate the document to avoid annoying white spaces in fully justified lines

Position graphics strategically

Select an attractive page layout

Adequate white space

Clean, uncluttered appearance

Responding to reviewers' comments

Include a letter to the editor with your revised ms

Thank the reviewers for their time

Explicitly tell the editor what you've changed

1. In response to R1, we have redrawn the plot in Fig. 3.
2. In response to R2, we have added references on tunneling to the introduction.
3. We do not agree with R2 about the significance of the annealing time. We have elaborated on assumptions about annealing in the methods section.
4. We have added a discussion on quenching.
5. We have added Fig. 9, an AFM image of the terraces observed in the unannealed samples.



Ask the editor to accept your ms for publication

To recap:

**Focus on important ideas,
logical structure,
precise language,
“mechanical errors”
—in this order**



Eliminate digressions and redundancies

Pay attention to transitions and reader cues

Proofread from a hard copy

Distill, distill, distill...



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Notes: