

Revising Technical Manuscripts to Improve Coherence, Clarity & Conciseness



With thanks to the fabulous Physics faculty at the University of Illinois
© 2016 The Board of Trustees of the University of Illinois
All rights reserved.

Celia M. Elliott
University of Illinois
cm Elliott@illinois.edu




Three disclaimers:

- I am not a scientist—I'm a science writer and technical editor. The author trumps the editor every time. (But you really *should* listen to us; we have your best interests at heart. We really do.)
- All of my experience has been in nuclear engineering and physics. I think the ideas I'm going to share with you today are applicable to all science and engineering communications, but your mileage may differ.
- The opinions expressed are solely those of the speaker and are not necessarily shared by the University of Illinois. (But they should be.)

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

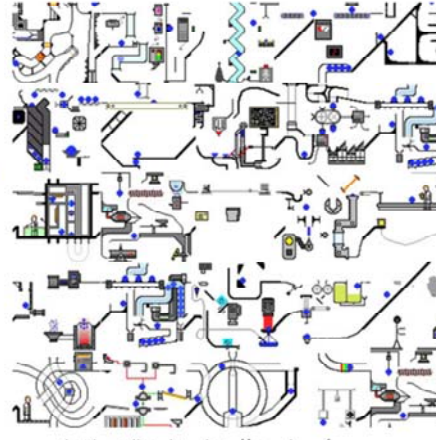
“The act of composition disciplines the mind; writing is one way to go about thinking, and the practice and habit of writing not only drain the mind, but supply it too.” Strunk and White, *The Elements of Style*, 3rd ed., p. 70.

“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*.

Will Strunk put it another way:

“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.”



The Blue Ball Machine, <http://ytmnd.com/>

Quotation from W. Strunk Jr. and E.B. White, *Elements of Style*, 3rd ed. (Needham Heights, MA, Allyn & Bacon, 1979), p. 23.

In 2011, *Time* magazine listed *The Elements of Style* as “one of the 100 best and most influential books written in English since 1923.”

Every person who calls himself or herself a writer should have a copy of Strunk & White within arms-reach.—*cme* *

**No promotional consideration was provided by Allyn & Bacon for this heartfelt endorsement.*

Effective editing incorporates four distinct elements

- **Clarifying the selection and presentation of ideas, tailored to the audience**
- **Organizing the narrative logically**
http://people.physics.illinois.edu/Celia/SciWriter_Advice.pdf
- **Using language precisely and concisely**
- **Correcting “mechanical” errors that detract from a professional presentation**

Editing should proceed in three separate steps



1. Reading for content (the science)
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.

In this talk, I'm going to concentrate on Step 2, because that's where I think I can help you the most.

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 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 a level appropriate for the audience and the purpose?

Is the narrative arranged in a logical, coherent structure?

Do figures and tables support and *clarify* the main points of your paper?

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

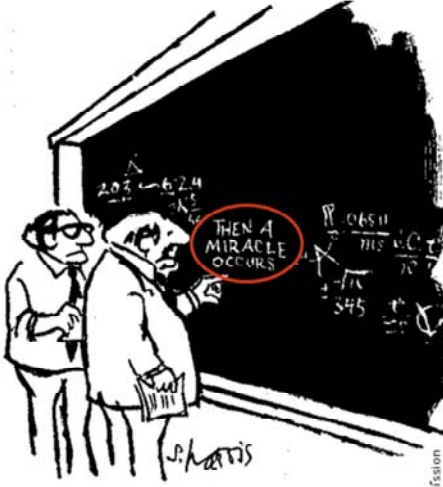
- Are the main points clearly identifiable and given appropriate emphasis?
- Do figures and tables support and enhance the main points?
- Is the narrative coherent—is there a clearly defined progression from background to hypothesis to method to results to conclusions?

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.

Organize the ms. so that the reader can grasp the main points immediately

Provide a descriptive, memorable title

Include an effective abstract (scientific paper) or executive summary (report) and key words

Preview important points in subheadings

Use graphical highlighting (bold**, *italic*, **color**) to make your main points pop off the page**

Use figures to illustrate and emphasize key concepts

Summarize important points at the end of each section

Tip: remember how scientists read papers

Scientists don't read papers by starting with the first word of the title and reading all the way to the last word of the references. Most scan a list of titles first and pick out the most likely looking paper. Then they read the abstract, leaf through the paper, read the section headings and look at the figures and captions, skim the conclusions, and then go back and read the whole paper if they've decided it's worth their time.

For some tips on how to write effective titles, see <http://people.physics.illinois.edu/Celia/EffectiveTitles.pdf>.

For some tips on how to write effective abstracts, see <http://people.physics.illinois.edu/Celia/Abstracts.pdf>.

Use descriptive headings to guide the reader through the text

“New Mechanisms for Regulating Bone Formation”¹

Section headings:

**Mutations Help Pinpoint Function
Narrowing Down the Possibilities
Building Better Bones**

Running head: *Regulating Bone Growth*

Key words: evolutionarily conserved region (ECR), gene regulation, genome, knockout mice, microscale computed tomography, osteoblast, osteoclast, osteocyte, osteoporosis, sclerosteosis, sclerostin (Sost), Van Buchem’s disease, Wnt signaling

¹R. Hanson, *Science & Technology Review*, UCRL-TR-52000-13-3 (March 2013), pp. 18–20.

If the journal allows it, replace the generic “Introduction,” “Methods,” “Results,” “Discussion,” “Conclusions” section headings with content-rich, meaningful, memorable phrases that will capture the reader’s attention and provide sign posts to guide him or her through the manuscript.

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 following 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 ^{178m}Hf ... Some estimates suggested that, with accelerated decay, 1 g of 100-percent isomeric ^{178m}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/drnl-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 verb phrases

<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** (section) 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



But don't rely on jargon!

13

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

- to a physicist—the effect that the wavelength at which a black body radiates the most energy is inversely proportional to its absolute temperature
- to a mechanical engineer—the volume moved by the stroke of a piston
- to a seismologist—a geological fault
- to a marine engineer—the weight of the water displaced by a vessel floating in it
- to a pharmacist—percolation
- to a botanist—abnormality in the position or form of a leaf or organ
- to a psychologist—a defense mechanism in which an emotion is transferred to another, more acceptable object

“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**

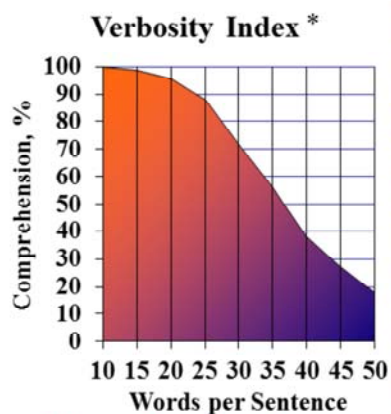
As defined by Ernest Gowers and quoted by Bryan Garner in *Garner’s Modern American Usage*, *abstractitis* is writing that is so abstruse that even the writer does not know what he or she is trying to say. Here’s a description of the phenomenon:

“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.)

Use *short* sentences, ≤ 25 words

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...



...and control your modifiers

Avoid long strings of nouns used as adjectives
mean field anisotropic superconducting reverse
bias toroid magnet

Get your modifiers in the right place

The initial focus will be on several super-
conductors where unconventional behavior has
been suggested by other methods, *including*
high-temperature superconductors such as
YBa₂CuO₇.

Write short sentences—less than 25 words.

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

Follow 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, who first introduced me to the three-preposition rule.

What's wrong with this sentence?

“The development of the theory of convection began some 85 years ago with Lord Rayleigh’s analysis of instability in fluids heated from below, but it was not easy for geoscientists to accept that a mechanism applicable to a fluid like water could also be relevant to understanding the behavior of the solid mantle composed of silicates.”

It's impossible to understand the meaning of this long, convoluted sentence on the first reading. Even if you're a native English speaker.

Even if you're a geophysicist.

What's wrong with this sentence?

“The *development of* the theory of convection began some 85 years ago with Lord Rayleigh’s analysis of instability in fluids heated from below, but *it was not easy* for geoscientists *to accept* that a mechanism applicable to a fluid like water could also *be* relevant *to understanding* the behavior of the solid mantle *composed of* silicates.”

It’s too long—56 words!

It uses noun-ified verbs (*development of*)

It uses “to be” verbs and indirect construction

It uses infinitives and gerunds instead of active verbs

It violates the three-preposition rule* (10 preps)

One of the easiest ways to improve your writing is to write short (<25 words) declarative sentences using active verbs. If you routinely write sentences containing more than 25 words, you likely have long strings of prepositional phrases, weak verbs, misplaced modifiers, and indefinite pronoun references—all leading to difficulty in interpreting your meaning.

Refer to Ms. P on “like,” which is used incorrectly in the example, but that’s a rant for another day. (q.v. <http://people.physics.illinois.edu/Celia/MsP/Like.pdf>)

*More on the three-preposition rule (3PR) next semester—stay tuned!

Here's how to fix it:

“Convection theory began some 85 years ago, with Lord Rayleigh’s analysis of instabilities in fluids heated from below. While convection clearly explained the behavior of fluids, geoscientists were reluctant to apply the theory to movement in the Earth’s solid silicate mantle.”

Two sentences of ≈20 words each

Subjects come first

Verbs are verbs

Concise and direct

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.*

**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.

Data to demonstrate linear scaling of output with current were inconclusive.

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.

Avoid beginning sentences with “There are...”—use the passive voice and plunge right in

- ❖ ~~“There are~~ several methods to produce thin metal substrates—hot stamping, cold rolling, and cleaving.”
- ❖ “Thin metal substrates may be produced by several methods—hot stamping, cold rolling, and cleaving.”

This rewrite has the added advantage of putting the important part of the sentence (“thin metal substrates”) first and the examples directly after “methods,” where they belong.

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...



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.

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

on the order of

in the near future

a very limited number of cases

it appears to be indicated that

in spite of the fact that

subsequent to

at the present time

in consequence of this fact

as compared with

in combination with

because

about

soon

few

apparently

although, despite

after

now

thus

versus

with

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)

A numerical approach was devised that enables the fast and efficient determination of the ternary diagrams associated with our Gibbs free energy. (22 words)

A new numerical approach quickly and efficiently determines the ternary diagrams associated with Gibbs free energy. (16 words, more direct)

32

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*—

Spelling

Grammar

Punctuation

U.S. English usage

Scientific writing conventions

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: 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

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 justified lines

Position graphics strategically

Select an attractive page layout

Adequate white space

Clean, uncluttered appearance

To recap:

Distill, distill, distill...

Focus on important ideas,
logical structure,
precise language,
“mechanical errors”



Editing should proceed in three steps:
content, style, proofreading

Pay attention to transitions and reader cues

Make your own editing checklist and use it

cmelliot@illinois.edu

<http://physics.illinois.edu/People/Celia>