...so few went to hear Him, & fewer yᵗ understood him, yᵗ oftimes he did in a manner, for want of Hearers, read to yᵉ Walls.

—Humphrey Newton, about Sir Isaac Newton

Technical Communications in Physics

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If you're the next Isaac Newton, you could probably get by with "reading to the walls." If you're not, you must learn how to communicate effectively in science if you're going to be successful.

This semester, I’ll do my best to disabuse you of these “reasons.”

1) I'm a physicist; I do math, not prose...

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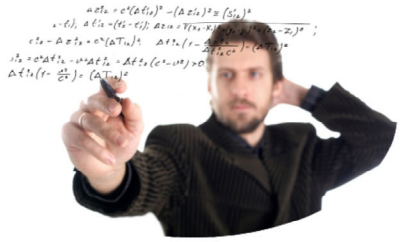
Show me a physicist who cannot communicate effectively, and I'll show you a physicist who cannot get papers published, cannot get proposals funded, isn't invited to give talks at meetings, cannot get hired, doesn't get promoted...

1) I'm a physicist; I do math, not prose...



Increasingly, physicists work in collaborations; good communications skills are essential

Getting hired and getting promoted depend on good communications skills

Getting recognized for your scientific contributions depends on good communication skills

Funding depends on good communications skills

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Executives and professors spend most of their time communicating—supervising, delegating, evaluating, clarifying, leading—all of which require clear, precise writing and speaking

2) I'm too busy…

Good communication skills save time and increase efficiency by anticipating readers' interpretations and eliminating mistakes

Good communication skills reduce time spent in revising and editing

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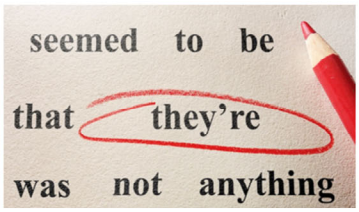
3) My word processor will correct my missteaks



Electronic checkers do not "read" your work; they are only as good as their algorithms, which are geared for business writing

The best grammar checkers cannot help you with organization, emphasis, or tone

The best spell checkers cannot distinguish between "assess" and "asses"

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4) Copy editors will correct my papers

Copy editors are a nearly extinct species at most journals nowadays; authors submit text that is usually published "as is"—mistakes and all

Copy editors won't see the slides for your talks, your proposals, your reports to funders, your email to collaborators or your supervisor

Your reputation and success is in your hands and dependent on your communication skills

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5) I'm just not a good writer or speaker

Writing and speaking well are *crafts*, not innate talents

The same aptitudes that make you a good physicist (logic, rigor, attention to detail, pattern recognition) are *exactly* what you need to be a good scientific communicator

Like everything else in physics, communication skills require instruction and practice

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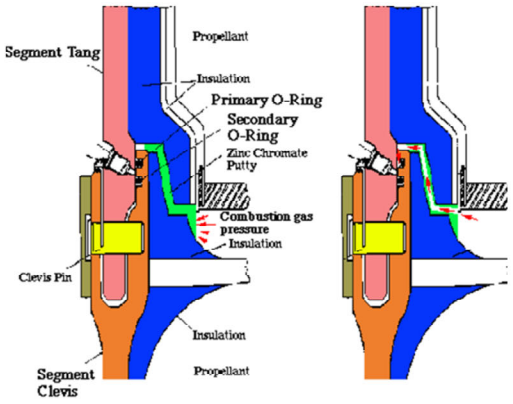
As a scientist, you will communicate your ideas in all of the following venues:

- Presentations at group meetings, work shops, conferences, and job interviews.
- Publications in journals.
- Teaching and training.
- Grant proposals.
- Reviews of other people's manuscripts and proposals.
- Applications and nominations.
- Evaluations and recommendations.
- Websites and electronic media.

Communication is not broadcasting—it is successful only when the receiver understands the content of a message ***as the sender intended it.***

When communication fails—

January 28, 1986--Space Shuttle Challenger broke apart 73 seconds into its flight, killing all seven crew members aboard.



Report of the Presidential Commission on Space Shuttle Challenger Accident, 1986

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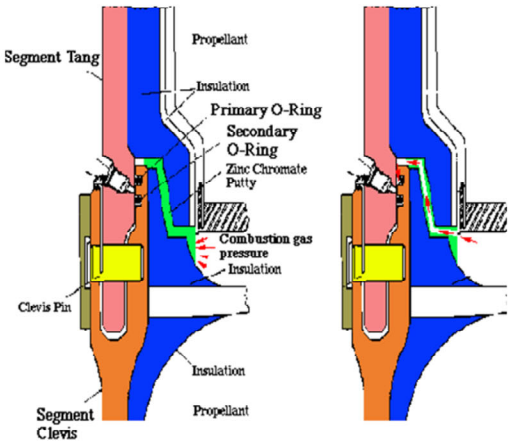
The U.S. space program was brought to its knees on January 28, 1986, when the space shuttle *Challenger* exploded 73 s after launch.

President Ronald Reagan appointed a blue-ribbon commission of scientists and engineers to investigate the accident and report to the Congress and the American people what went wrong.

The commission concluded that the solid rocket booster O-rings failed to seal properly, allowing flames from combustion gases to burn through the external fuel tank. Faulty design of the solid rocket boosters, insufficient low-temperature testing of the O-ring material, and **failure of communication** between different levels of NASA management were determined to be the cause of the disaster.[1]

1. https://onlineethics.org/cases/engineering-ethics-cases-texas-am/space-shuttle-challenger-disaster

Explaining the *Challenger* disaster



NASA's explanation

© Marilynn K. Yee, NYT Pictures

Richard Feynman's explanation

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An enormous gulf divides "talking" or "writing" and effective communication.

On the left is NASA's explanation for the Challenger accident. On the right is Richard Feynman's admittedly flawed experiment that galvanized the American public.

"I took this stuff I got out of your [O-ring] seal and I put it in ice water, and I discovered that when you put some pressure on it for a while and then undo it, it doesn't stretch back. It stays the same dimension. In other words, for a few seconds at least, and more seconds than that, there is no resilience in this particular material when it is at a temperature of 32 degrees. I believe that has some significance for our problem."[2]

You must provide explanations that are <u>understandable</u> and <u>meaningful</u> to your audience if you're going to succeed as a science communicator.

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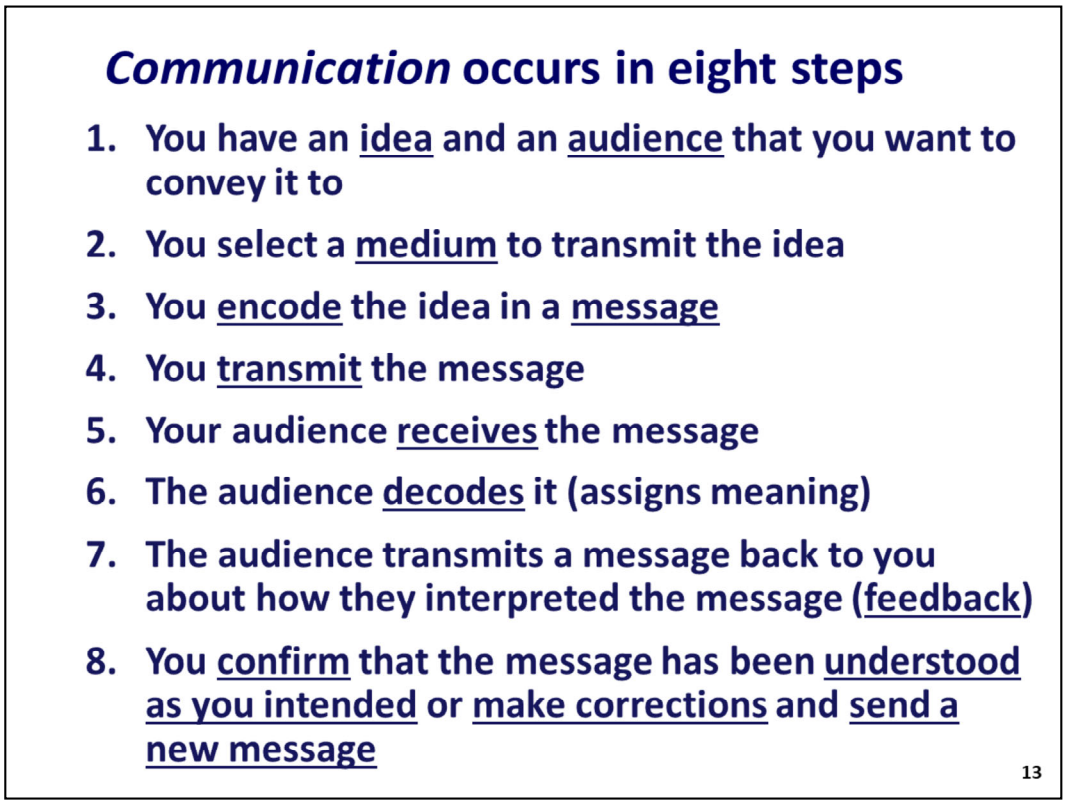
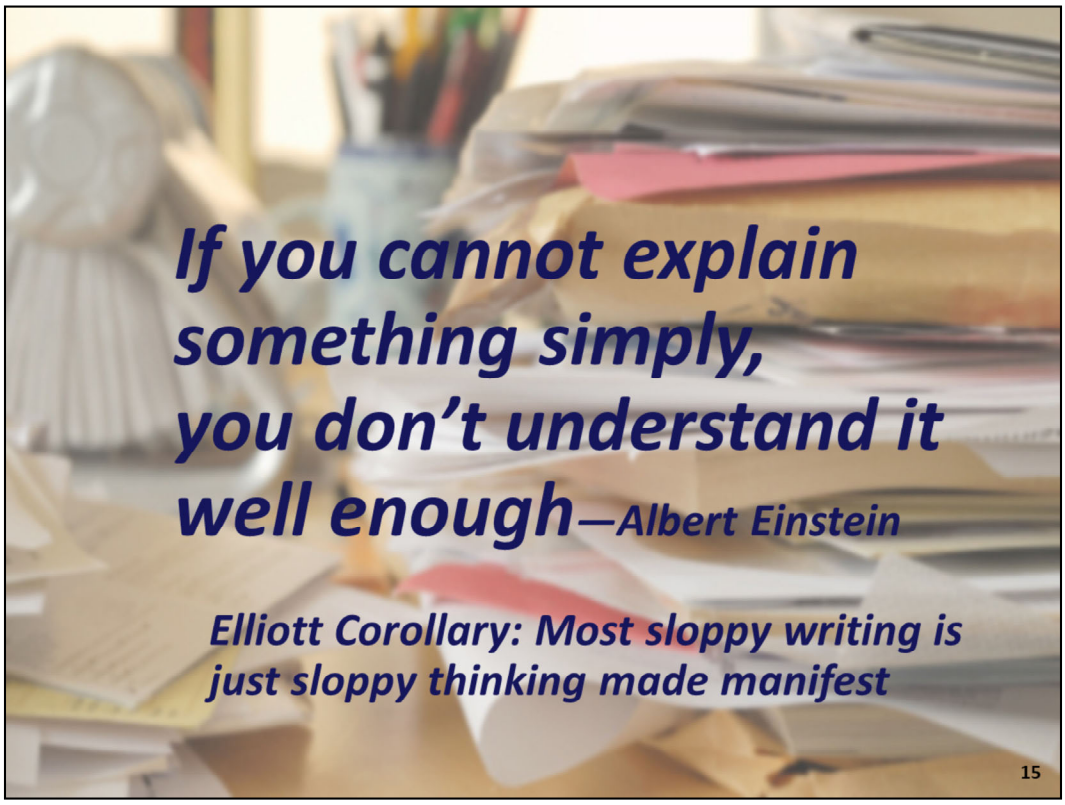
2. "What Do You Care What Other People Think?" Further Adventures of a Curious Character, Richard P. Feynman, as told to Ralph Leighton (W.W. Norton and Company, New York, 1988), pp. 151–153.



Some scientific communications (particularly written communications), have no mechanism for Steps 7 and 8. Consequently, writers must be particularly careful that the meaning they seek to convey is encoded precisely and unambiguously and in words that the receiver can understand.

Writing and speaking are practice-based skills; you learn how to do them by doing them.

There's no substitute for practice.

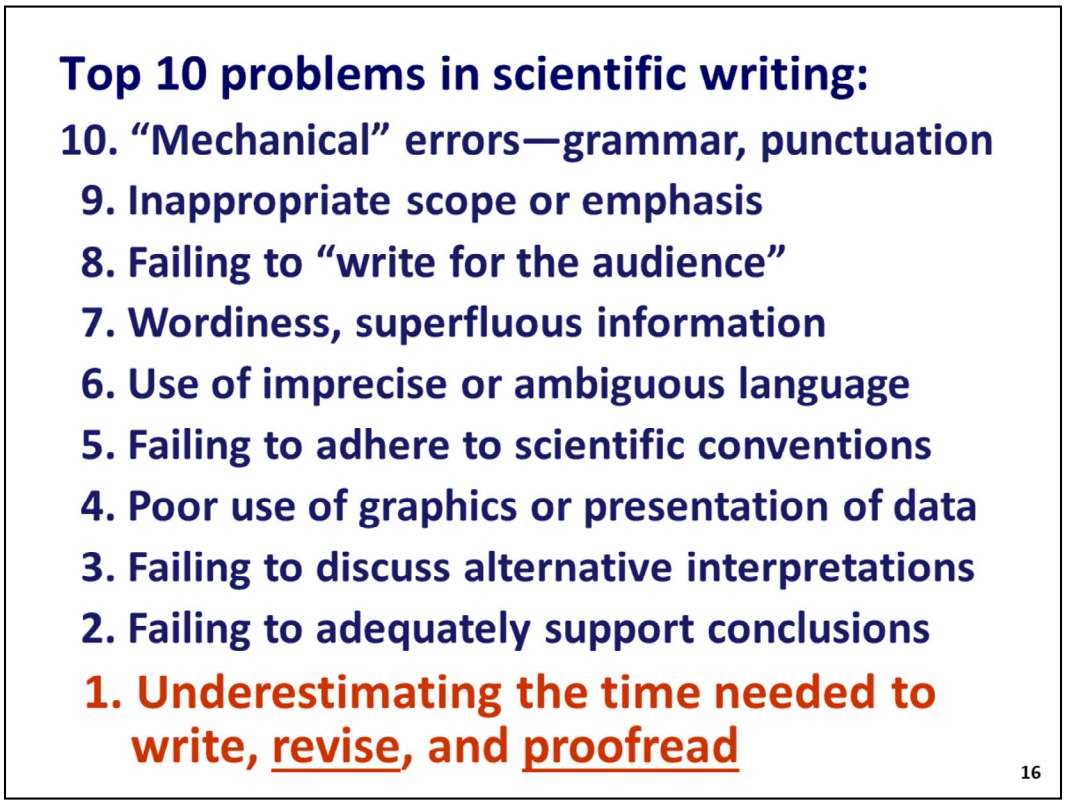


Because we think in words, the act of expressing observation in language—of distilling amorphous thoughts into words—is a powerful tool for clarifying your thinking.

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).



During this semester, we'll concentrate on helping you to overcome these common problems in science writing.

Here's a famous paper that has a writing flaw...can you spot it?

"Evidence of a positively charged electron was found in cosmic ray tracks produced in a vertical Wilson chamber. Of 1300 photographs, 15 were found to contain this unexplained particle. Analysis of the tracks indicates a particle of positive charge, having a magnitude comparable to that of an electron."

Carl D. Anderson, "The Positive Electron," *Phys. Rev.* **43**, 491–494 (1933).

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This paragraph was taken from a paper published in 1933, announcing the discovery of the positron, for which Carl Anderson shared the 1936 Nobel Prize in Physics.

Now, admittedly, Carl Anderson won a Nobel Prize and I didn't. But I still think this paragraph could (should) have been written more carefully.

Can you spot the problem?

"Evidence of a positively charged electron was found in cosmic ray tracks produced in a vertical Wilson chamber. **Of 1300 photographs, 15 were found to contain this unexplained particle.** Analysis of the tracks indicates a particle of positive charge, having a magnitude comparable to that of an electron."

Carl D. Anderson, "The Positive Electron," *Phys. Rev.* **43**, 491–494 (1933).

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Patterson-Gimlin film, Frame 352
https://en.wikipedia.org/wiki/Bigfoot#/media/File:Patterson–Gimlin_film_frame_352.jpg

"Of 1300 photographs, 15 were found to contain this unexplained particle."

The "photographs" did not *contain* any "particles"

Tracks recorded on the photographic film could not be explained by the behavior of any known particles

A huge logical chasm exists between stating "I have a photo of some weird-looking tracks" and "My photo contains Bigfoot!"

Patterson-Gimlin film, Frame 352
https://en.wikipedia.org/wiki/Bigfoot#/media/File:Patterson–Gimlin_film_frame_352.jpg

Write precisely!

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They require having an adequate vocabulary and a sensitivity to words' nuances.
They require practice and iteration.
They require constructive criticism from experts and peers.
Train yourself to recognize excellence and emulate it.
Seize every opportunity that presents itself to improve your skills.
Your investment in improving them *will* affect your future success.

Practice may not make "perfect," but it definitely makes "better."

For good advice and further reading:

W. Strunk and E.B. White, *The Elements of Style*, 3rd ed. (Allyn & Bacon, Boston, 1979).

V. Booth, *Communicating in Science*, 2nd ed. (CUP, Cambridge, 1993).

H.B. Michaelson, *How to Write and Publish Engineering Papers and Reports,* 3rd ed. (Oryx Press, Phoenix, 1990).

S.L. Montgomery, *The Chicago Guide to Communicating Science* (University of Chicago Press, Chicago, 2003).

Michael Alley, *The Craft of Scientific Writing*, 3rd ed. (Springer, New York, 1996).

E. Tufte, *The Visual Display of Quantitative Information*, 2nd ed. (Graphics Press, Cheshire, CT, 2003).