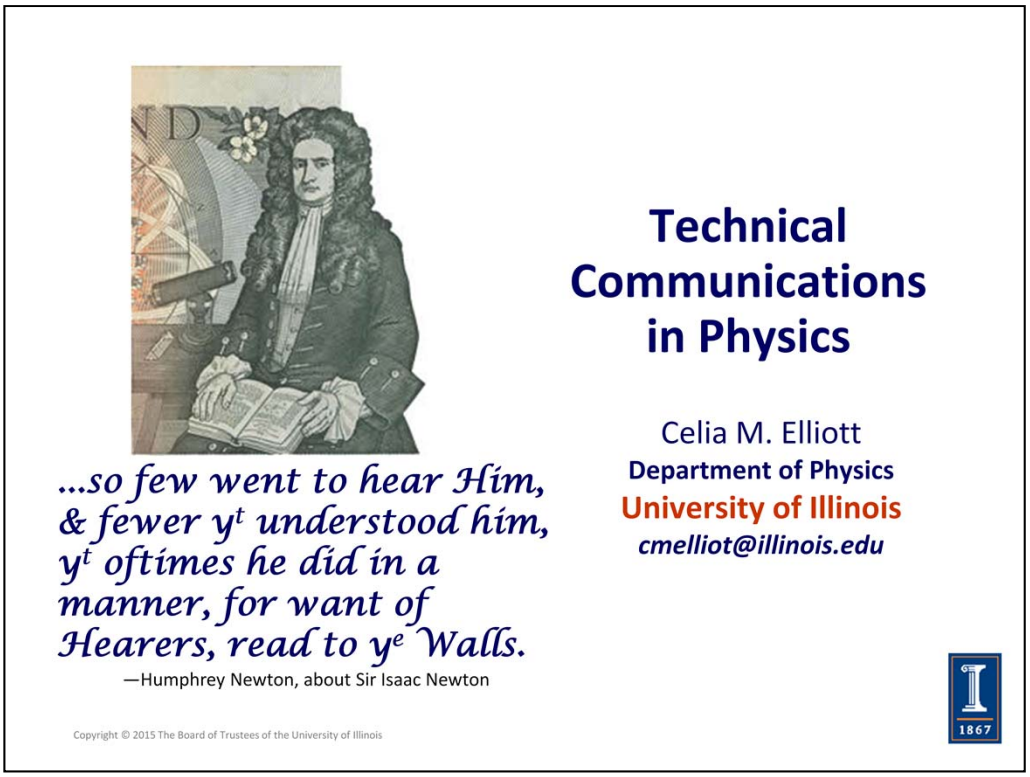
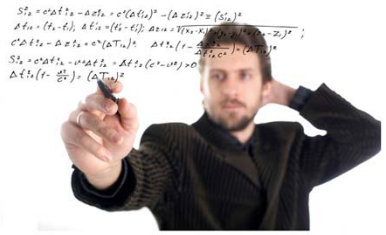


If you're the next Isaac Newton, you could probably get by with "reading to the walls." If you're not, you must learn how to communicate effectively in science if you're going to be successful.

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

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



Increasingly, physicists work in teams; good teamwork depends on good communications

Promotion depends on good communications skills; executives and professors spend most of their time communicating—supervising, delegating, evaluating, clarifying, leading—all of which require clear, precise writing

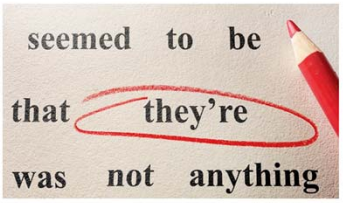
Funding depends on good communications skills

2) I'm too busy…

Good communication skills save time and increase efficiency by eliminating mistakes and misunderstandings

Good communication skills cut down on revising and editing time

3) My word processor will correct my missteaks



Electronic checkers do not "read" your work; they look for suspect patterns based on algorithms

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

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

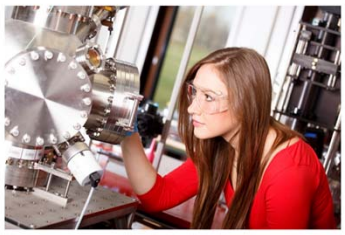
4) Copy editors will correct my papers

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

Copy editors won't see the slides for your talks, your proposals, your reports to funders, your internal memos….

Your reputation is in <u>your</u> hands and dependent on <u>your</u> communication skills

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



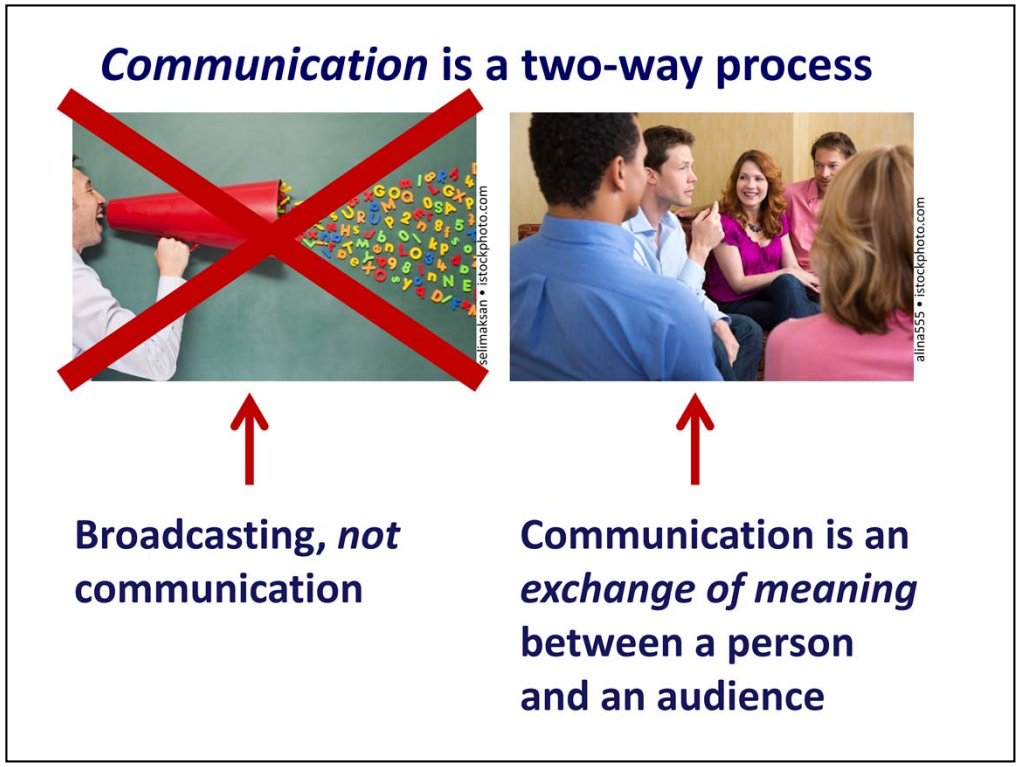
Writing and speaking well is a *craft*, not a talent

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

Like everything else in physics, it requires instruction and practice

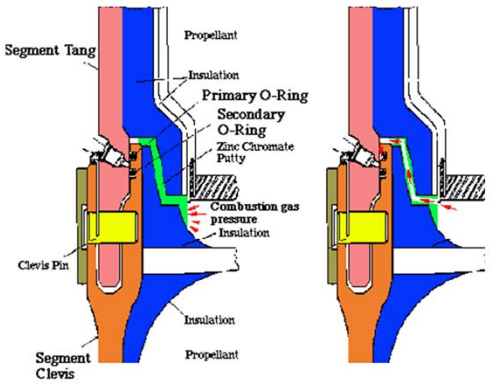
As a scientist, you will communicate your ideas in all of the following venues:

- 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.***

Explaining the *Challenger* disaster



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

© Marilynn K. Yee, NYT Pictures

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.”

“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.

You must provide explanations that are understandable and meaningful to your audience if you’re going to succeed as a science communicator.

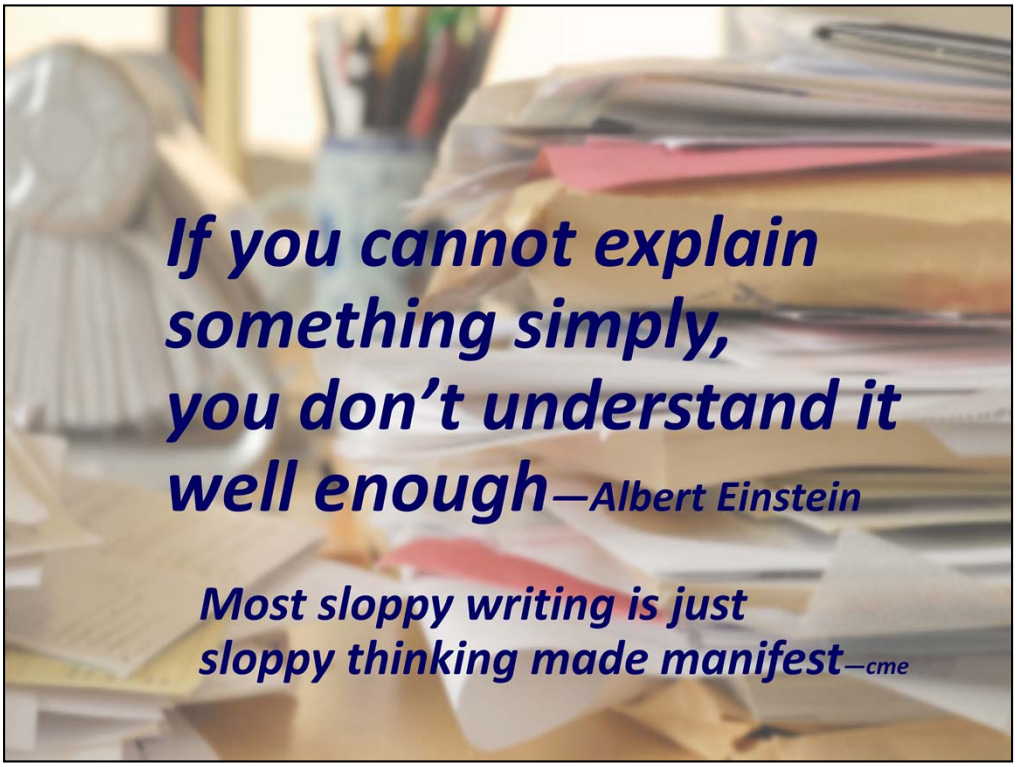
Communication occurs in eight steps

1. You have an idea and an audience that you want to convey it to
2. You select a medium to transmit the idea
3. You encode the idea for the medium in a message
4. You transmit the message
5. Your audience receives the message
6. The audience decodes it (assigns meaning)
7. The audience transmits a message back to you about how they interpreted the message (feedback)
8. You confirm that the message has been understood as you intended

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).

Some common problems in novices' scientific writing:

- Inappropriate scope or emphasis.
- Lack of logical organization, cohesion, transitions.
- Organizing narratives chronologically.
- Wordiness and superfluous information.
- Use of imprecise or ambiguous language.
- Failure to adhere to scientific writing conventions.
- Poor use of graphics or presentation of data.
- "Mechanical" errors—in grammar, usage, spelling, punctuation.
- Underestimating the time needed to write, revise, and proofread.

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).

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).

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

The "photographs" did not ***contain*** any "particles" (other than in the sense that they were made of matter).

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

There is a huge gap between saying "I have a photograph of some weird-looking tracks" and "I have a photograph of Sasquatch."

Write precisely!

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).