Getting It Write

Tips for Effective Communication

As scientists and engineers, we need to write and speak frequently about our work, but are we doing it as well as we can? It is critical that we communicate well to convey clear ideas to an engaged audience. In this column, I offer some tips and advice to help young scientists be their best at technical writing, public speaking, and peer reviewing. And while I treat these as separate topics, the interested reader will see the many synergies among them. For example, writing a great document and speaking about it are related skills. Similarly, the ability to critically review a paper is a useful skill to acquire before attempting to write one.

PRECISE, CONCISE, AND WELL-STRUCTURED WRITING

Writing is key to developing, clarifying, and polishing your ideas; it demonstrates knowledge, skill, and creativity. Writing is an art form, albeit constrained by the rules of the English language and guidelines for technical writing. My favorite quotes on writing are all about simplicity—its importance, difficulty, and relationship with the content.

- "Simplicity is the ultimate sophistication," Leonardo Da Vinci
- "The easiest reading is damned hard writing," Thomas Hood
- "If you can't explain it simply, you don't understand it well enough," Albert Einstein.

Jefferson Bates [1] praises precision and brevity as key requirements for technical writing (see also [2]). The way to achieve precision and brevity is through careful thinking and relentless editing. Avoid vagueness and ambiguity. Use simple words and avoid jargon. Choose common, logical, and memorable terminology. Be concise. Maximize the signal-to-noise ratio. Use short sentences. Here is an example of how to edit for brevity:

- *Bad*: There are various conditions proposed in the consensus literature that quantify the convergence rate.
- *Good*: Various conditions in the consensus literature quantify the convergence rate.

Here is an example of how to edit a mathematical sentence for precision:

- *Bad*: Assume that A is a row-stochastic matrix. Show that, for all vectors x, equation (1) holds.
- *Good*: Show that any row-stochastic matrix A and vector x satisfy equation (1).

Dimitri Bertsekas [3] suggests ten rules for constructing a mathematical document. The fundamental unit is a stand-alone segment, such as a section containing preliminary concepts, a theorem and its proof, or several related remarks. Segments should contain a proper amount of material, neither too much nor too little. They should focus on their main message and consist of related ideas and organized and interconnected for simplicity and clarity.

I recommend the freely available lecture notes by Donald Knuth, Tracy Larrabee, and Paul Roberts [4]. This booklet is a rich source of insight, anecdotes, examples, and memorable quotes, including the following warning: "Mathematicians who merely think great theorems have no more done their job than painters who merely think great paintings" [4].

To elaborate on this warning, writing is an integral part of thinking, not an afterthought. The elements that make for good writing—precision, brevity, and good structure—are also prerequisites for sound thinking.

PRESENTATIONS ON POINT

The following points were inspired by [5] and [6] by Dennis Bernstein and Tammy Kolda.

- *Focus on the ideas, not on the details*. Cover all the basics ideas: the problem, its importance, the state of the art, the results, and their novelty.
- *Tell a captivating story.* Organize your work as a developing narrative with an orderly progression. That is, start from diverse examples and get to a general rule. Alternatively, start with a problem, unravel ingenious evidence, and get to the solution. Put another way, take known ideas and connect them in surprising ways. Stick to your story.
- *Treat your audience as your customer.* Imagine yourself in the minds of your audience and manage their experience. Tailor your talk to their background. Look at them (not at your slides). Ensure that they can hear you, see you, and see your slides.
- *Speak clearly.* Speak at the right speed and volume. Be enthusiastic and not nervous. Use simple terms, especially when introducing important concepts. Do not wave your pointer randomly at your slides or the audience.

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- *Avoid cluttered slides.* Prepare uncluttered slides, and then fill in the details in your talk. Do not use small fonts or have more than a few lines per slide. Do not overdo frame-by-frame animation. Use color and special effects judiciously.
- *Use few clear symbols.* Introduce as few symbols and with as clear a meaning as possible. Adopt natural, common symbols. Do not let notation distract from the content.
- *Use figures, pictures, diagrams, and tables.* Envision giving the presentation with only figures and then introduce the minimum necessary symbols, equations, and text.
- *Manage your time properly.* Make a top-down decision on how to allocate your time (where will you be halfway through?). End your talk on time. It is pointless and ironic to complain that "there isn't enough time."
- *Be respectful.* Introduce yourself and acknowledge coauthors, organizers, session chairs, and audience. Have a slide on references. Watch your demeanor. Bring business cards, copies of your paper, or letter-size printouts of your poster.
- *Practice.* Practice, practice, and then practice some more.

The CSS Online Lecture Library, at http://www.ieeecss-oll.org/, contains numerous examples of outstanding presentations, starting with the absolute classic "Respect the Unstable" by Gunter Stein, the inaugural 1989 Bode lecture.

READING, REVIEWING, AND FIGHTING A PAPER

> Don't just read it; fight it! Ask your own questions, look for your own examples, discover your own proofs. Is the hypothesis necessary? Is the converse true? What happens in the classical special case? What about the degenerate cases? Where does the proof use the hypothesis?
>
> —Paul Halmos

A comprehensive and thoughtful guide on reviewing computer science papers is provided by Ian Parberry [7]. Among other concepts, [7] explains how the reviewer should be objective, fair, quick, professional, confidential, honest, and courteous. Lofty goals indeed! To help you achieve them, here is a list of questions [7], [8] to ask yourself as you read and review a paper.

1) Is the problem clearly described and well posed? Is the problem well motivated?
2) Is the relevant literature clearly reviewed and explained? Does the paper demonstrate an understanding of the field?
3) Do the abstract and the introduction clearly state the contributions? Do the contributions claimed in the abstract and introduction correspond to the result in the article body?
4) Are the contributions sufficiently significant and useful?
5) Are the contributions sufficiently original and different from previous work?
6) Is the approach technically sound? Are the results correct? Is the treatment technically complete?
7) Does the document present the overall work in a clear manner? Is it well organized and well written in clear, proper English?

Here are some practical bits of advice on how to write a professional review.

1) Focus exclusively on the document, and do not criticize the authors.
2) Do not disclose your identity directly or indirectly by including identifying information.
3) If you believe the results are "simple" or "obvious," articulate why and be as specific.
4) If you find a technical problem, clarify whether you believe that only the proof is incorrect or the result itself. Find a counterexample and/or suggest a solution.
5) If you believe the results are previously known, list the relevant peer-reviewed references. Do not cite your own papers in all but the most extreme cases. Note that a result cannot be both known and wrong (with remarkable exceptions, of course).
6) If you believe the paper is not well written, explain what is disorganized, what is being obfuscated, and what is not concise. Give constructive suggestions.
7) Help the authors make the document more accessible to nonspecialists by pointing out unnecessary jargon.

FINAL REMARK

This column is only a beginning, of course. I encourage you to read further on the subject and develop your own style. More importantly, I urge you to practice and seek feedback on what you create. As always, I am at your disposal for comments and suggestions. My e-mail is bullo@ucsb.edu.

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