

Technical Writing

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Getting ahead

- **Success in research** = good results + good communication about your results
- **Success in business** = good ideas + good follow-through + good communication about your work
- **Good communication** =
 - “Elevator pitch” for professional conversations
 - Good presentations
 - Good writing
 - Conferences, journals, proposals, reports, opinion pieces, etc.

Writing Stuff

- Writing technical papers
 - Conference
 - Journal
 - (Thesis)
- Writing NSF research proposals
- Writing Op-eds

Writing Basics

Writing exists in a cultural context. Know your professional culture and how it communicates. Your writing should be in the same style as others in your group and be optimized for your reader.

- **Who is the audience?**
- **What is your story?**
 - Why is it worthy of your audience's attention?
 - Is your story compelling enough to keep your audience engaged?
- **How credible is your story?**
 - Building your credibility as an expert
- **Why does your story matter?**

Heilmeier's Catechism (from Wikipedia)

George Heilmeier was former Director of DARPA (Defense Advanced Research Projects Agency), former CTO of Texas Instruments, former President of Bellcore, and former CEO of SAIC. **Heilmeier's Catechism** is a set of questions credited to Heilmeier that anyone proposing a research project or product development effort should be able to answer:

- **What** are you trying to do? Articulate your objectives using absolutely no jargon.
- **How** is it done today, and what are the limits of current practice?
- **What's new** in your approach and why do you think it will be successful?
- **Who cares?**
- If you're successful, **what difference will it make?**
- What are the **risks and the payoffs?**
- How much will it **cost?**
- **How long** will it take?
- What are the midterm and final "exams" to check for success? (**metrics of success**)

Writing is a skill you can keep getting better at

- If you don't get accepted ... DON'T GIVE UP
- “Bounce”/improve the work!
 - Get over it, look at the reviews and improve the piece
 - Get more results if needed
 - Send it somewhere else (or for another round)
- Not getting accepted doesn't mean the work is bad (original pagerank paper rejected from SIGIR in 1998 ...)

Writing Conference Papers

- **Who is your audience:** Specialists in your general area (e.g. programming languages, data mining, HPC)
- Review committees:
 - **Have a lot of papers to read in a short period of time**
 - Make your results compelling and clear on the first page
 - Make your paper easy to skim (graphics, organization, line spacing, font)
 - **Are looking for new results that advance the state of the art**
 - Make the innovative aspects of your paper clear up front
 - **Are looking for “hot” topics**
 - Can you relate your results to a community / national priority or new area?

Writing Conference Papers – Organization

- Organization of your paper is dependent on conference and area. Read “best papers” from your target conference as a model. (Best papers in many conferences at http://jeffhuang.com/best_paper_awards.html)
- **Generic format**
 - Introduction
 - Related work
 - Approach
 - Results
 - Conclusion

Current / next generation conference papers may expect you to **cite your data**.

Get in the habit of doing it now.

Writing Conference Papers – More Detail

1. Abstract

- 1-2 paragraphs summarizing the paper and results. Should be broadly understandable.

2. Introduction

- ~1 page – should tell reviewer everything they need to know about what you are doing and why it is important

3. Related work

- generously include work that's relevant, especially from likely reviewers
- Diplomatically describe why their work doesn't solve your problem (“Berman's work focused on networks in which communication costs are zero. Our focuses on networks in which communications costs are positive and vary dynamically”)
- Related work sometimes after Approach

4. Approach

- Clearly describe the problem you're solving and your approach to solve it: methods, experiments, theorems, etc.
- Provide enough detail to make your approach credible

5. Results

- Graphs and visuals (tables, etc.) are always great
- Be able to discuss the trends in your data and what they imply with respect to the problem and the area

6. Conclusion

- .5 page? Should be as self-contained as possible, compelling, and less than a page: What did you do, how did you do it, what are the results, why should we care.

7. Acknowledgements

- People who helped who are not authors

Writing Journal Papers

- **Journal papers are the archival record of your work.** This is the place for **really careful detail** and **thorough description** of what you have done.
- **Who is your audience:** Specialists in your specific area (e.g. exascale programming environments) and in the general area (e.g. HPC)
- **Journal papers**
 - Should include enough details so that results could conceivably be reproduced
 - Should provide detailed methodology and charts and graphs
 - Should include data citations so paper is “self-contained”
 - Should stand up if read “with a fine toothed comb”

Writing Journal Papers – Organization

- Organization of the paper is dependent on journal and area. Read other papers from the journal as a guide.

- **Generic format**

- Introduction
- Related work
- Approach
- Results
- Conclusion

Journals are beginning to expect that accompanying data will be available, but don't necessarily provide repositories.

- **Provide a publicly accessible place for your data** – ingesting your data in a public or institutional repository is best
- **Give you data a DOI** and create a citation for your data
- Get in the habit of doing this for all publications

Writing Journal Papers – More Detail

- **Introduction**

- Introduce the problem and why it is important
- Describe your approach and why it is important

- **Related work**

- generously include work that's relevant, especially from likely reviewers
- Diplomatically describe why their work doesn't solve your problem (see conf. papers)

- **Approach**

- Clearly describe the problem you're solving and your approach to solve it : methods, experiments, theorems, data,etc.
- Provide enough detail to make your results reproducible and your approach

credible

- **Results**

- Graphs and visuals (tables, etc.) should be provided with sufficient detail to place your results in the context with other work in the area
- Be able to discuss the trends in your data and what they imply with respect to the problem and the area

- **Conclusion**

- Should be as self-contained as possible, compelling, and less than a page: What did you do, how did you do it, what are the results, why should we care.

General Conference and Journal Tips

- **Make the paper easy / fun to read**
 - Use graphics to compellingly convey the message
 - Use font / spacing / italics and bolding / section organization to make the paper fun to read
 - Don't jam every possible space and use super-small font
 - Do multiple drafts until you get it to a level that will promote your success
- **Make the paper interesting**
 - Make the abstract compelling and stand-alone
 - Summarize your story in the Introduction and the Conclusion
 - Look at “Best Paper” recipients in your conference or highly ranked journal articles for good examples of writing and results
- **Don't “thumb your nose at the giant”**
 - Pay attention to page length. If there are page limits (e.g. in conferences), don't just make things smaller to fit in.
 - Be generous with related work – include relevant potential reviewers

Writing Ph.D. Theses

- **A Ph.D. thesis is a detailed manuscript in which you break new ground and indicate your ability to do professional-level research**
 - **Ph.D. thesis should be like a book and a document that stands on its own**, not just copy/paste of papers
 - Ph.D. thesis is very detailed, likely covers multiple results. Theses are often evolved into multiple journal papers
 - Format is very specific and depends on your university and what your advisor expects
- **Audience: Your advisor, your thesis committee and your institution (for format compliance)**
 - Your advisor's impression of your work is critical – they will be writing your recommendation for your next job based on this. It's also good to impress your committee
 - On your way to your dissertation, you will likely publish / vet your results at conferences in the field.

Writing Grants

- **A grant proposal is a formal request for funding to support a specific project.**
 - You haven't done the project yet so you don't have final results, however you need to compellingly convince the reviewers that your proposal is worth the risk
- **Audience: Review Committee and Program Officers**
 - Program officer can over-ride lukewarm reviews but they need to feel like the grant is really important
 - Strong reviews can help considerably but don't guarantee funding (money is scarce)

NSF Proposal Components

- Rules in NSF Grant Proposal Guide (GPG). Each grant is different so you need to **follow the instructions of your RFP**
- Grants have many sections, including
 - **Proposal Summary (1 page)**
 - Sections on **Intellectual Merit** and **Broader Impact**
 - **Proposal Description** (typically 10 - 12 pages) includes
 - Introduction
 - Related Work Section
 - Research Plan
 - Project Milestones and Metrics of Success
 - **Bibliography**
 - **Data Management Plan**
 - **Budget Justification, etc.**

How do you write about a problem you haven't solved?

- **Proposal Summary (Intellectual Merit and Broader Impact)** [Write this after main text as it needs to be a concise summary of what you'll do and why it's important]
- **Proposal Description**
 - Introduction [Demonstrate the problem is important and you that understand it well. Compellingly communicate that your approach is promising and treads new ground]
 - Related Work Section [Include relevant work as well as work from other areas / points of view that drive your new approach. Be generous and inclusive. Describe why your proposed work is more likely to solve the problem without dissing other researchers in the area]
 - Research Plan [What is your organized approach / methodology to solving the problem? What are the experiments? What will you compare your results to?]
 - Project Milestones and Metrics of Success [What will you do when and what will be accomplished? How will we know if you've solved the problem?]
- **Bibliography**
- **Data Management Plan**
- **Budget Justification, etc.**

Grant Submission Basics

- **Pre-work:**
 - Read the RFP (Request for Proposals) carefully
 - Make sure that you have all the right sections and are addressing the questions
 - **Talk to the Program Officer** about the program and what they expect if possible
 - Pay attention to the review criteria
 - Get the right team together: co-Pis, senior personnel, colleagues willing to write letters of support or collaboration (when permissible)
- **Work within the system:**
 - Get the grant to your university's contracts and grants office in plenty of time to get it into fastlane (or the grant system)
 - Develop the budget carefully so you have enough for relevant travel, equipment, staff, etc.
 - Start early – sometimes your best ideas come during the writing stage
- Use the “red team” approach to optimize your submission: Ask someone you trust who has been successful in getting grants in your area to look at your grant and critique before you finalize

Writing op-eds (and blogs)

- **Op-eds can have tremendous influence on community and stakeholders**
 - Can establish you as an expert
 - Can get your point of view into the national discourse
 - Can be useful to your company, project or community
- **Who is your audience:** General public
- **What is your purpose:** Persuasively get your point of view across

Op-Eds tell a story

Not all Op-Eds are like this, but many good Op-Eds have this structure:

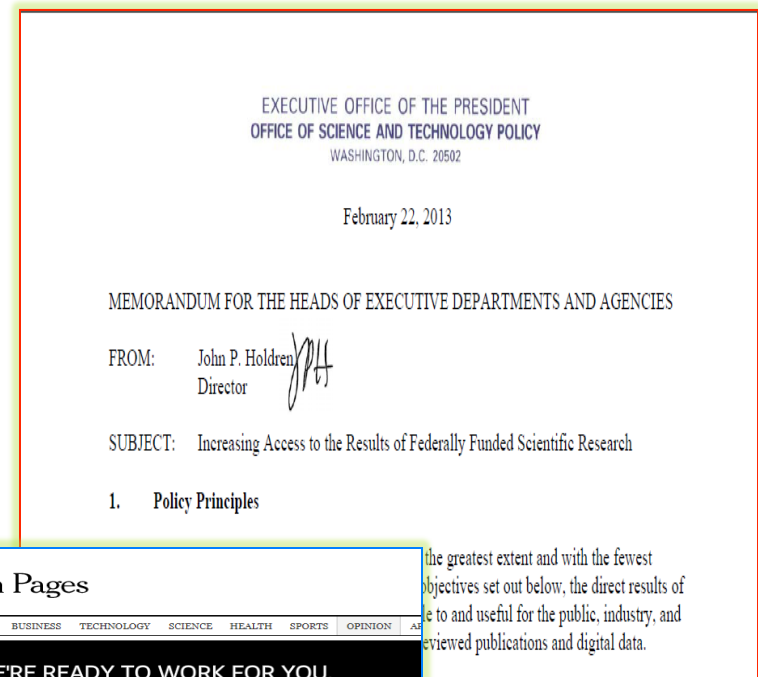
- **Lede** – *Lead-in around a news hook or personal experience*
- **Thesis** – *your position (explicit or implied)*
- **Argument** – *should be based on evidence (stats, news, reports, expert quotes, scholarship, history, experience). Arguments often presented as a series of points.*
- **Criticism pre-emption** – *take the lead in acknowledging the flaws in your argument and address potential counter-arguments*
- **Conclusion** – *circle back to lede?*

Lede Options

- Current news
- Dramatic or personal anecdote
- Reference to popular culture or twist on conventional wisdom
- Anniversary of an event
- Major new study

Fran's Op-Ed Story

- February 2013 OSTP Memo: Called on federal agencies (NSF, NIH, DOE, NASA, NOAA, etc.) for new policies for **public access to research data and publications** but *no new money* for infrastructure.



the greatest extent and with the fewest objectives set out below, the direct results of research to be made available to and useful for the public, industry, and reviewed publications and digital data.

Who Will Pay for Public Access to Research Data?

Francine Berman¹ and Vint Cerf²

On 22 February, the U.S. Office of Science and Technology Policy (OSTP) released a memo calling for public access for publications and data resulting from federally sponsored research grants (1). The memo directed federal agencies with more than \$100 million R&D expenditures to “develop a plan to support increased public access to the results of research funded by the Federal Government.” Perhaps even more succinctly, a subsequent *New York Times* opinion page sported the headline “We Paid for the Research, So Let’s See It” (2). So who pays for data infrastructure?

The OSTP memo requested agencies to provide plans by September 2013 that describe their strategies for providing public access to both research publications and research data. Plans are expected to be implemented using “resources within the existing agency budget,” i.e., no new money should be expected. Currently, federal R&D agencies are working hard to foster approaches to public access, to assess needs for supporting partnerships and enabling infrastructure, and to develop timetables and approaches for implementation. We focus here on the research data portion of the OSTP memo.

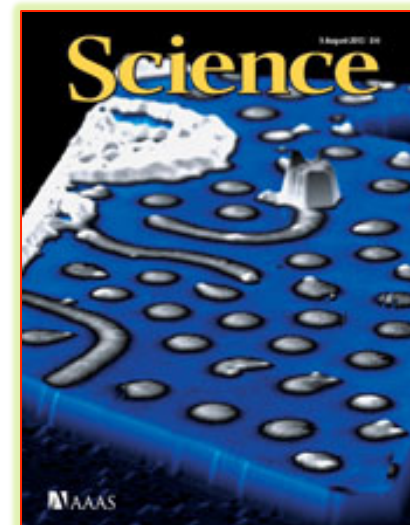


Research data of community value are supported today in a variety of ways. Some of them, like those in the Protein Data Bank (PDB) (3)—a database of protein structure information used heavily by the life sciences community—are supported by the public sector. (In particular, U.S. funding from the National Science Foundation (NSF), the National Institutes of Health (NIH), and the U.S. Department of Energy for the Research Collaboratory for Structural Bioinformatics (RCSB) PDB is \$6.3 million annually.) Other data, as from the Longitudinal Study

When economic models and infrastructure are not in place to ensure access and preservation, federally funded research data are “at risk.”

What happens to valuable data when project funding ends? Consider, for example, a 3-year research project in which valuable sensor data are collected from an environmentally sensitive area. Those data may be useful not just for the duration of the project but for the next decade or more to collaborators and a broader community of researchers. For the first 3 years, the costs of stewardship (including development of a database that supports analysis, access to the data for the community through a portal, adequate storage and management of the data collection, and so on) may be paid for by the grant. But who pays for subsequent support? In such cases, research data may become more valuable just as the economics of stewardship become less viable.

Up to this point, no one sector has stepped up to take on the problem alone, and it is unrealistic to expect as much. In the public sector, federal R&D agencies are unlikely to allocate enough resources to support all federally funded research data. The costs of



Op-Ed Tips

- Write it in a way that smart people can relate to, even if they are not in your discipline. Don't use buzzwords or talk “inside baseball” without explaining things.
- Pay attention to publication word count – op-eds are usually quite short, often less than 1500 words
- The final version may be reviewed and/or edited – what you send in may not be the final draft
- Do your homework – everyone will read this
- Be prepared for feedback – blogs, tweets, etc.

Reprise: Writing is a skill you can keep getting better at

- If you don't get accepted ... DON'T GIVE UP
- “Bounce”/improve the work!
 - Get over it, look at the reviews and improve the piece
 - Get more results if needed
 - Send it somewhere else (or for another round)
- Good writing takes **effort**. Better writing takes **practice**. You will keep improving your writing throughout your career.