



# How to Get Started if You Hate to Write



## Part I—Outlining

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**One thing I've learned in physics,  
you have to satisfy both the theorists  
and the experimentalists...**



**...so this talk has two parts:**

- I. a theory of technical writing**
- II. the nuts and bolts of first putting  
together a scientific paper**

In this lecture, I'll talk mostly about writing papers, but the advice and techniques apply to any form of communication—oral, written, or visual.

**First step, throw out most of what  
you've been taught about "writing"**

**Scientific writing ain't Shakespeare**


**Your purpose is to inform, educate,  
and persuade—not to entertain**

**Write with concrete, quantitative  
nouns and strong verbs, not  
adjectives and adverbs**

**Use the simplest word**

**Write short sentences and  
control your modifiers**

*No literary flourishes*



Scientific writing is fundamentally different from other kinds of writing—in tone, in style, in content, in organization.

Good scientific writing is concise, direct, concrete, and unambiguous.

The harder the concepts, the simpler and more transparent the writing should be.

## **Technical writing is a *craft*, not an art**

**Like any other craft,  
you have to learn  
the techniques**

**You have to get feed-  
back from experts**

**The same skills that  
make you a good scientist or engineer will  
make you a good technical writer**

- logic
- precision
- the ability to recognize patterns and sort out what's important



Learning to write in the style described here will not only make you a better writer, it will also make you a better scientist. It will force you to see holes in your thinking, areas where you've made assumptions, places where you should add references, or data, or further analysis.

**“Logic before language”**

Two-way relationship between thinking and writing—feedback loop

λογική πριν γλώσσα

Careful, *deliberate* writing assists in developing logical scientific thought

Scientific writing is a *process*; good writing evolves as your thinking matures

Learning to write well will make you a better physicist

logikí prin glóssa (loyeekee prin glōssuh)

Too often, scientists think of doing research and writing as discrete tasks that have little to do with one another. Today, I’d like you to think of them as a feedback loop, where progress in one informs and drives progress in the other.

From Peter Woodford: “Somehow the discipline of crystallizing a thought into a grammatical sentence with a beginning, a middle, and an end clarifies, sharpens, and delimits the thought.

## **Successful science writing is**

**Logically constructed—think “linear”**

**Clearly and succinctly expressed**

**Precisely and simply worded**

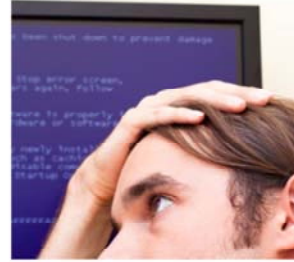
**Written to inform and persuade**

**Written with the *reader*  
in mind**



The first step in *any* writing project should be an analysis of the audience for whom the document is intended.

**Novice writers use the  
“core dump” method  
—inefficient and  
produces poor results**



**Always start from a plan—always!**

- 1. Promotes thinking**
- 2. Easiest way to get started if you don't like to write**
- 3. Gives you control over length and focus**
- 4. Increases the logical persuasiveness\* and coherence of your final paper (or talk)**

\*“Persuasion in Technical Communications,”  
<http://people.physics.illinois.edu/Celia/Persuasion.pdf>

Novice writers often just word-spew and then try to go back and “fix” what they’ve written. It’s inefficient, time-consuming, and usually produces bad results.

**As you are thinking about your writing task, first ask yourself four questions:**



- 1. What is my *purpose* in writing this document? What's my ultimate goal?**
- 2. Who is going to read it? What do they already know, and what am I going to have to explain? What do *they* want to get out of this paper?**
- 3. What *one thing* do I want the reader to remember? What's the "take-away" message?**
- 4. What are my space/time/page constraints?**

At this stage of your writing project, think about what you want to convey to your audience. What are the important points that you want them to understand and remember?





**Use the “reservoir” system\***

**Create separate reservoirs for**

- Background**
- Materials & Methods**
- Results**
- Discussion**
- Refs**

**Concentrate on facts, ideas, images, logical connections**

**Add to your reservoirs as you take and analyze data**

**Experiment with different reservoir methods to find what works best for you**

\*Scientific Writing for Graduate Students, ed. F. Peter Woodford (Rockefeller University Press, 1968).

The idea of creating separate holding pens for various parts of a technical document was first articulated, as far as I know, by F. Peter Woodford in *Scientific Writing for Graduate Students: A CBE Manual* (Rockefeller University Press, New York, 1968). Although targeted to graduate students in the life sciences and dated in language (not *all* scientists are men!), the fundamentals of Woodford’s approach remain sound.

Vernon Booth, a major god in my pantheon (*Communicating in Science: Writing a scientific paper and speaking at scientific meetings*, 2nd ed. [Cambridge University Press, Cambridge, 1993]) also recommends the use of writing reservoirs.

## **Fill your reservoirs thoughtfully**

**Is the item really necessary?**

**To what reservoir does it logically belong?**

**Content for reservoirs:**

**Facts, observations, data**

**Figures and captions**

**Tables**

**Analogies**

**Ideas and speculations**

**Unanswered questions**

**Key words**

**Felicitous phrases**



At this stage, don't worry too much about niceties of language—concentrate on including essentials, eliminating superfluities, and getting things sorted into the right categories.

## Now you're ready to start building a coherent narrative

In the next steps,  
we'll take the  
**content** of our  
reservoirs and  
make a **plan** to  
guide the building  
of our paper



**RULE #1: Never write *anything* without first writing a synopsis and an outline!**

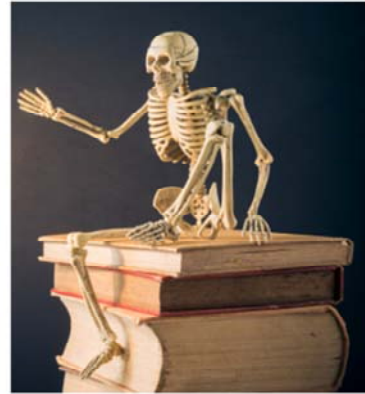
**“If you don’t know where you are going, you might wind up someplace else.”**

—Yogi Berra



## Start out with a five-sentence synopsis

1. What was the goal?
2. How does it fit into the context of prior work?
3. What method(s) did you use?
4. What were your results?
5. What do they mean?



Answer each question in one coherent sentence

**The synopsis is the skeleton that will hold up the rest of your story**

Writing a synopsis is a good way to get started because it defines the content and scope of your paper.

Think of the synopsis as the skeleton—it gives the whole paper its shape and supports your evidence and arguments.

## **Writers use two kinds of outlines— “topic” and “sentence”**

### **Topic outlines use short phrases**

- **CO<sub>2</sub> underground storage—motivation**
- **Advantages of deep saline formations**
- **Convection could provide “stirring”**
- **Boycott effect**

**A topic outline is a good way to get started,  
but it may not be detailed enough for  
science writing**

An outline is a tool that enables you to look systematically at how a paper or presentation is organized. Learning to write from an outline is one of the easiest ways to (1) get started and (2) improve the content and coherence of your scientific writing.

Today, we’ll look at how to use outlines to get started on any writing project.

A topic outline consists of short phrases. Here’s an example of a topic outline for a paper on carbon sequestration in deep saline geological formations.

A topic outline may be best for organizing a number of issues or ideas that could be presented in a several different ways, where the order of presentation is not important. Unfortunately, that is not typically the case for science papers.

## **Writers use two kinds of outlines— “topic” and “sentence”**

### **Topic outlines use short phrases**

- **CO<sub>2</sub> underground storage—motivation**
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### **Sentence outlines use full sentences (duh!)**

- **Deep saline aquifers (DSAs) are underground salt-water reservoirs capped by impermeable rocks.**
- **DSAs offer large storage capacity for carbon capture and sequestration.**
- **Sequestered CO<sub>2</sub> rises and forms a separate layer that restricts dissolution.**

Today we'll look at the sentence outline, which is better suited for papers (and talks) that require complex information to be presented in strict logical order.

Topic outlines are fast and easy to write. You might find it helpful to sketch out a topic outline first and then expand it into a full-sentence outline.

Many of the ideas about full-sentence outlining are taken from a course given by Ohio Eminent Scholar and Professor of Physics at The Ohio State University, John W. Wilkins (who is also a Physics Illinois alumnus). His trenchant thinking and incisive writing on communicating in physics are gratefully acknowledged.

## Practice full-sentence outlining

**Improved clarity**  
**Improved logical argument**  
**Improved cohesiveness; better transitions**  
**Improved conciseness**  
**Improved control of length**  
**Improved writing efficiency**  
**Improved reader experience**



**This slide is an example of a “topic” outline—the order that the points are presented in doesn’t really matter**

Writing a sentence outline will help you as a writer in a variety of ways:

- Your writing will be clearer and more direct. It’s unlikely that you’ll write a cogent paragraph until you can write a sentence that plainly articulates the point of that paragraph.
- Your arguments will be stronger. A sentence outline shows you the narrative flow of the paper. Are your ideas arranged in the most logical, persuasive way to lead the reader to the conclusions you want him or her to reach? It’s much easier to move sentences around as you are planning a paper than it is whole pages.
- Your paper will be more cohesive, because you’ll be more aware of where transitions are needed to move the reader from one idea to the next.
- Your writing will be more concise. A sentence outline will help you spot superfluous material that stands in the way of a straightforward narrative.
- You will get a better idea of the size and scope of your final paper. The length of proposals, journal articles, and conference papers is usually strictly limited. A sentence outline makes it easier to estimate what the final length of your document will be and allows you to make any needed adjustments earlier in the writing process. It’s agonizing to make major cuts after you’ve already gotten something written, and you’ll avoid the temptation of leaving digressions in your paper because of pride of authorship.
- You will ultimately save time. The investment in planning and getting organized now will pay off in an easier-to-write, coherent, clear final document.
- Your colleagues will eagerly look forward to hearing your next talk or reading your next paper. Your reviewers will expedite your publications. Funders will shower you with \$\$\$\$. (Okay, maybe not #3...).



## **Tips for writing a sentence outline**

**Make your sentences as specific and quantitative as possible.**

**If you have two closely related sentences, combine, differentiate, or eliminate one.**

**Make a logic map of your sentences; can you show a linear progression of your ideas?**

**Devise a method that makes it easier to move sentences around and “see” the overall structure of the paper.**

**This slide is an example of a “sentence” outline—use it for writing projects (papers, proposals, talks) where it’s important to show a logical progression of your ideas**

Make your sentences as specific as possible. The purpose of the sentence outline is to help you spot missing or superfluous material. If your sentences are vague and general, you’ll lose the main advantage of sentence outlining.

If you have two sentences that say about the same thing, eliminate one of them, combine them, or differentiate them.

Ideally in science writing, the narrative should flow logically and incrementally from Point A to Point B to Point C to the conclusions. If your outline does not reveal a logical progression of ideas, move things around until it does.

A word processing document that displays only part of your outline at a time may not be the best way to get an overall look at your paper. Experiment with other methods—index cards dealt out on a big table, Post-It notes stuck on a wall—use your imagination.

## Commit to writing incrementally

Think “feedback loop”



**Write in increments:**

1. **Construct a preliminary outline, based on your initial goals for the project**
2. **Write portions of the “results” and “discussion” sections while you’re taking and analyzing data**
3. **Add to your references as you go**
4. **Make your figures and tables early**

**Advantages:**

- **More complete, persuasive paper**
- **Finished result faster, giving you more time to edit and polish**



Commit to writing incrementally; writing should be an integral part of your research work—remember “feedback loop.”

Advantages of the incremental method:

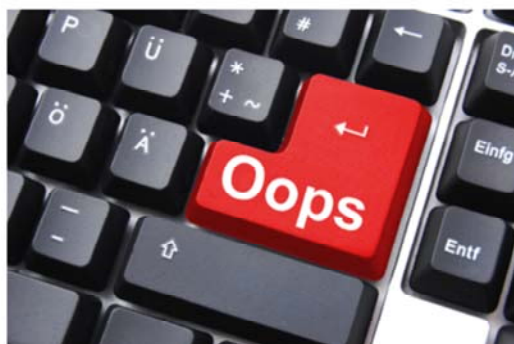
1. You may discover additional data that are needed while the equipment is still set up and the project ongoing.
2. You get a finished paper faster, with more time to revise and edit.

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

## Avoid common beginner's mistakes

Focusing on what took the most time to do

Presenting a chronological history of the work

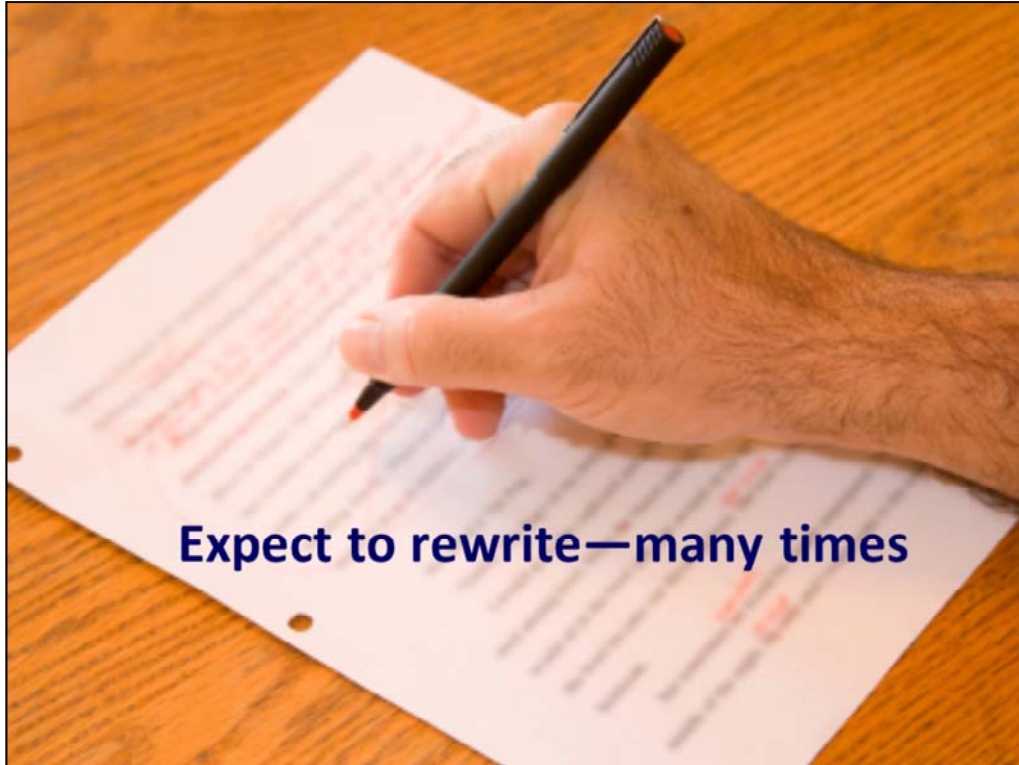


**INSTEAD, focus on the results and conclusions  
(that's what the reader wants to know)**

Some beginning authors think that if they spent 90 percent of their time on some aspect of the experiment, they should devote 90 percent of the paper to that topic.

Your job as an author is to distill your ideas and experience into a concise, coherent explanation and argument—not mechanically record everything you did.

Readers don't want to know all the things that went wrong, all the components that failed, all the adjustments that had to be made to get the data. They want to know what worked, how it worked, what the results are, and what you think they mean. Remember, a journal is an archive of results, not a cemetery where you bury all your mistakes.



The probability that a first draft will not require revision asymptotically approaches 0.

“Perfection is achieved, not when there is nothing left to add, but when there is nothing left to take away.”

—Antoine-Marie-Roger de Saint-Exupery

Brevity is a key goal. Use your revisions to clarify and simplify.

Give yourself adequate time to reflect and rewrite.

Writing well is a learned skill—train yourself to recognize good writing; emulate good examples, and practice, practice, practice.

**To recap...**



**Think**      **Plan**      **Write**

**Think first**

**Analyze your audience and purpose**

**Commit to writing incrementally—start filling  
your reservoirs while you're still taking data**

**Make an outline and *use it***



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NOTES: