# How to write a technical report


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Three important disclaimers:

1. I am not a physicist; I'm a science writer and technical editor. No questions about the quantum Hall effect in topological insulators, please!
2. All my experience as a writer and editor has been in physics and nuclear engineering. I think the basic principles of scientific communication transcend disciplinary boundaries, but your experience may differ.
3. The opinions expressed are solely my own and are not necessarily shared by the University of Illinois or the Department of Physics. But they should be.

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## Close your eyes and picture in your mind your favorite childhood storybook


**What made it so attractive to you?**

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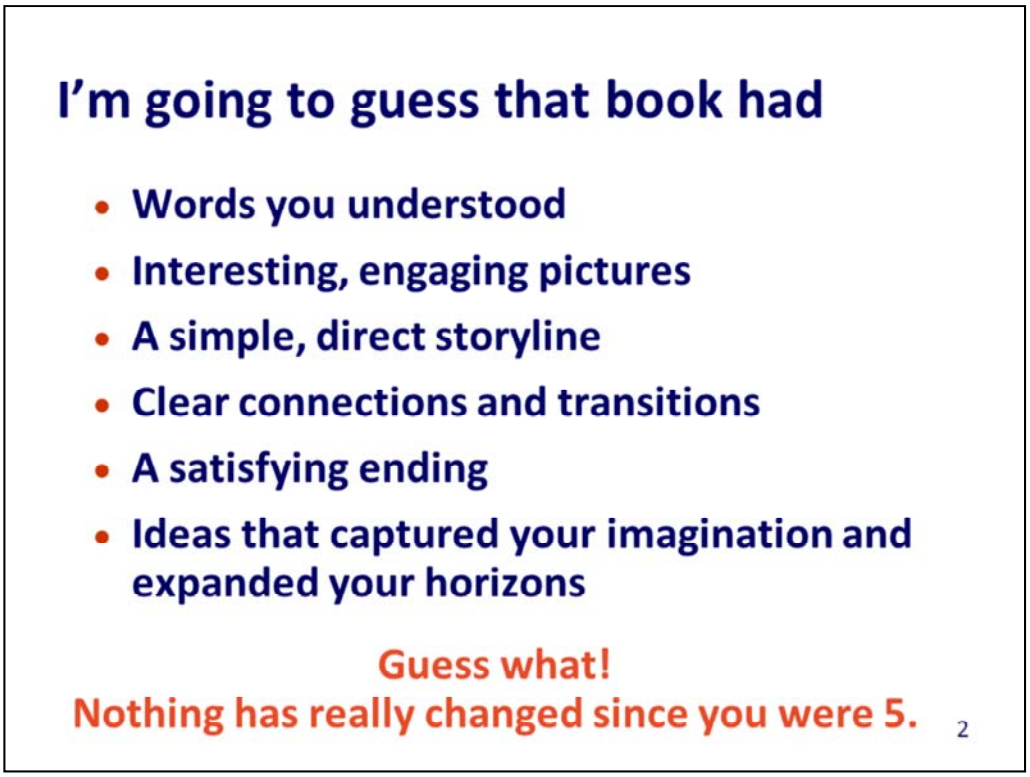


Think about what made a good story when you were 5 years old. The same elements that attracted you as a child still work—interesting pictures, words you understand, simple, direct storyline, a logical structure, analogy, an enthusiastic narrator, something that stimulates your imagination and makes you think.

## RULE #1: Never write *anything* without first analyzing your audience

Who is going to read this report?

What do they already know?
(words, concepts, methods)

What *don't* they know that
I will have to explain?

Where might they become confused?

Where can I send them for more information?

What is most important for them to understand?

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Think carefully about who you want to read your paper, and craft your message to engage that reader.

## RULE #2: Tell a good story

- Orient the reader with a solid introduction
- Emphasize what is new and important
- Use language that is understandable and meaningful for your reader
- Arrange the narrative so the logic is clear—use transitional statements to guide your reader
- Provide clear, visually interesting, memorable figures
- Provide a strong summary; don't just trail off at the end

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If the first rule of writing a successful *anything* is to know your audience, the second rule is ***tell a good story***, in language that your reader will understand.

## RULE #3: Never write *anything* without first writing an outline and a synopsis!


"If you don't know where you are going, you might wind up someplace else."

—Yogi Berra

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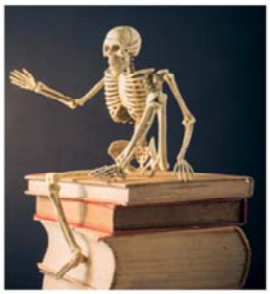
## Start out with a six-sentence synopsis



1. What was the goal?
2. How does your work fit into the context of prior work?
3. What method(s) did you use? Why did you choose it/them?
4. What were your results? How did you validate and analyze them?
5. What have you learned?
6. What's next?

**Answer each question in one coherent sentence**

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

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

## Next, make an outline to avoid an amateur's mistakes


- Using chronological instead of analytical order
- Devoting the most ink to the parts that took the longest to do
- Including superfluous or discursive information
- Omitting discussion of assumptions
- Failing to provide logical transitions
- Each sentence in your synopsis becomes a section of your outline

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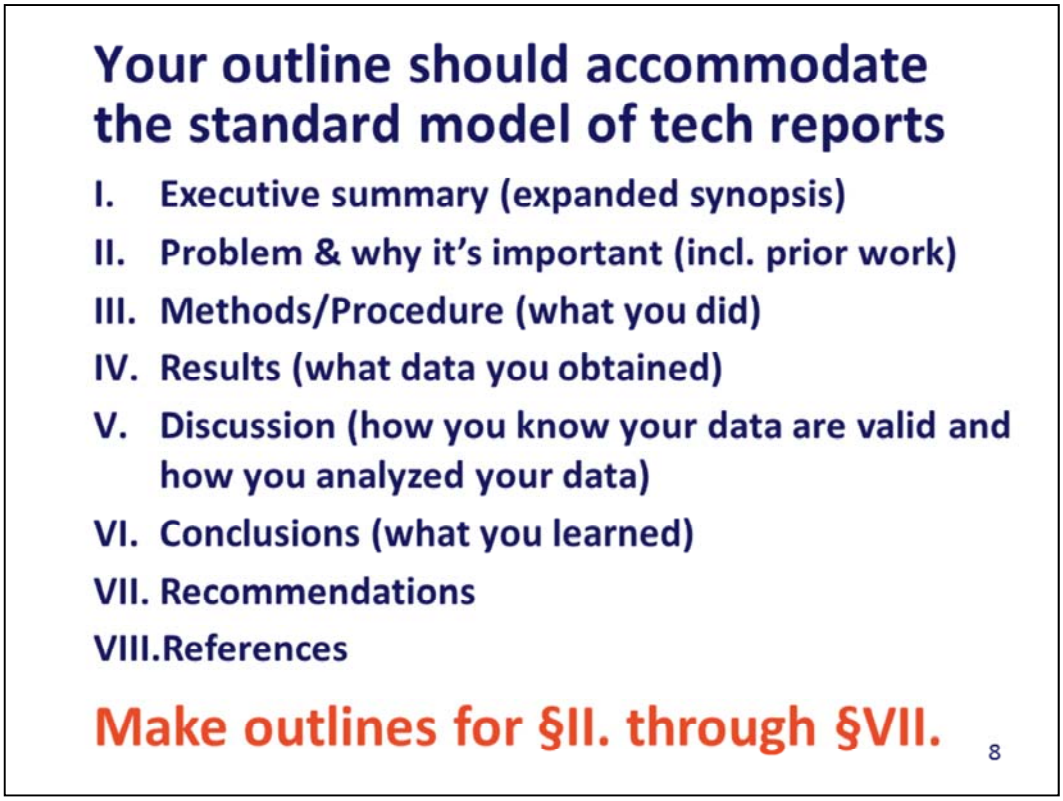
Some beginning authors think that if they spent 90 percent of their time on some aspect of the project, they should devote 90 percent of the report to that topic., or they should present a chronological history of the experiment.

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, what you think they mean, and what your recommendations are.




Formal scientific reports are ***always*** presented in this order, but they're not written in this order.

No experienced researcher that I know starts with the title and writes a report sequentially. Nobody.

Most scientists and engineers usually write reports in the following order:

1. Methods
2. Results
3. Discussion
4. Conclusions
5. Recommendations or Next Steps
6. Background and Introduction
7. References
8. Acknowledgments
9. Executive Summary & Final Title

You ***must*** have an outline to keep a coherent narrative flow as you write the separate sections of a report.

## NOW you're ready to start writing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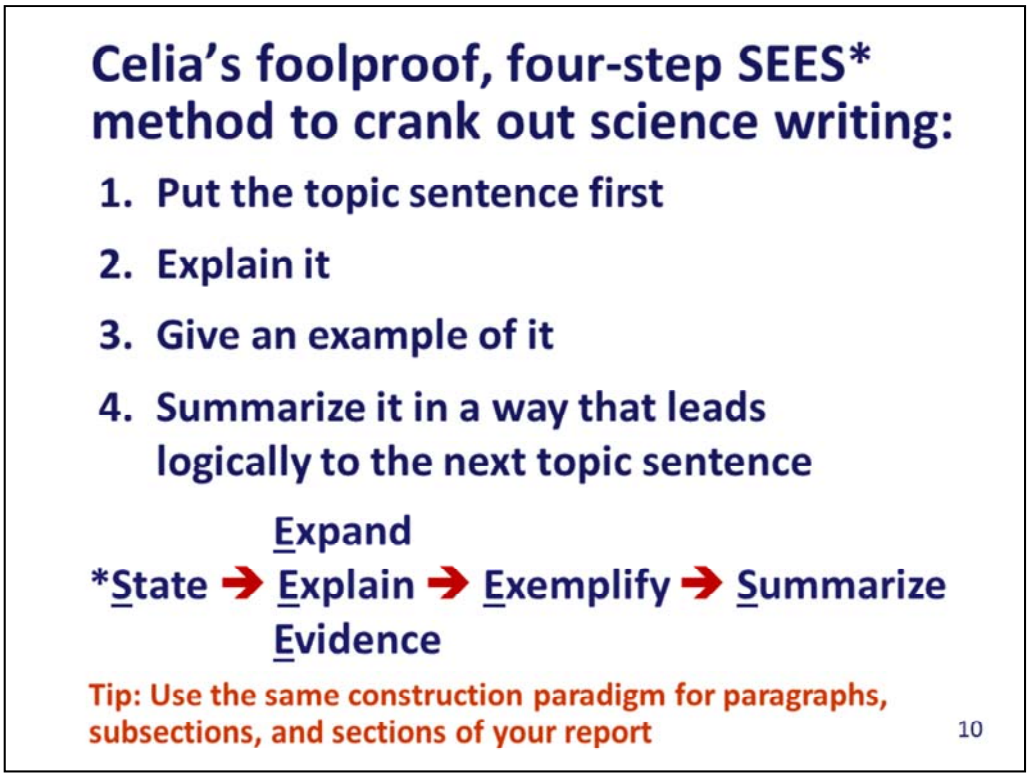


One of the key advantages of this method is its scalability—you can use it for short papers, theses, talks, posters—for any audience.

Use the formula to create logical, coherent paragraphs.

## Paragraph equation:

$$1\ S_t = 1\ ¶, \qquad [1]$$

where $S_t$ is a topic sentence, and ¶ is a paragraph

**Don't put more than one topic sentence in a paragraph**

**Don't put anything in a paragraph that doesn't support, explain, exemplify, or summarize the topic sentence**

**Write shorter paragraphs (<8 sentences)**

**Write from an outline!**

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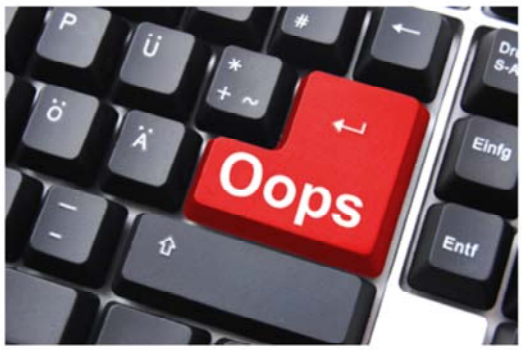
No superfluous "stuff" in a paragraph. If it is not directly related to the topic sentence, delete it or move it to its own paragraph.

In fact, no superfluous stuff anywhere!
(q.v. http://people.physics.illinois.edu/Celia/Lectures/Fluff.pdf)

## 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)**

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The results, conclusions, and recommendations sections should comprise the bulk of your report.

## Start with the "Results" section…

Include only *relevant* information

Emphasize results achieved, not a chronological history


Use tables and graphs to organize, summarize and show trends in quantitative data

…it *is* the point of writing the report

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Include only relevant information.

Emphasize the results achieved, not the chronological history of the experiment.

Use tables or graphs to organize, summarize, and reveal relationships in numerical data (q.v. Edward Tufte's *The Visual Display of Quantitative Information*).

## Then write the "Methods" section…

- Describe the apparatus, computer codes, or other "devices"
- Identify materials and give exact specifications

- Describe procedures in detail—give operating ranges
- Include sufficient mathematical detail to reproduce derivations
- Explicitly describe any hazards

**…how you did what you did, in *detail***

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The standard—Give sufficient detail so that other practitioners "trained in the art" would be able to reproduce your experiment and obtain the same results.

## "Discussion": present your observations and how you've interpreted them

- Explicitly state your assumptions and explain your reasoning
- Relate your results to prior work and what you set out to prove

- Disclose any selection or treatment of data
- Discuss limitations of the work and alternative explanations
- Report what should be tested further
- Emphasize what is "new" about this work

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Compare the results to prior work, both yours and others'.

Interpret the results; explain what you think they mean.

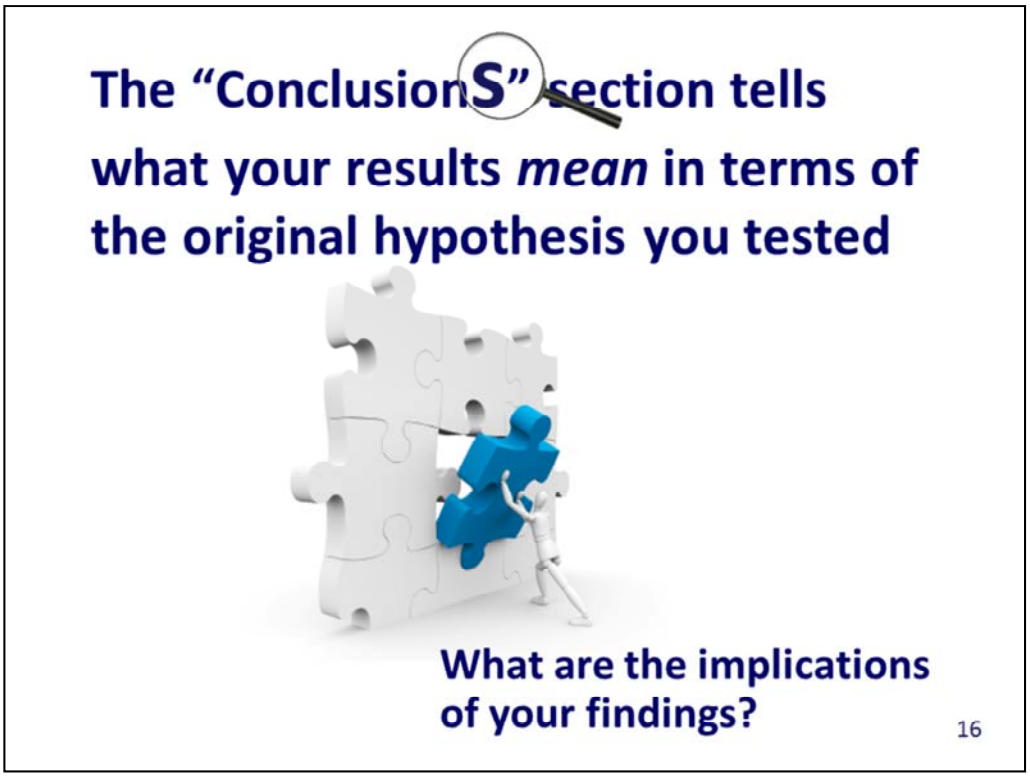
Explicitly state any assumptions that you've made and disclose exactly how data were selected or treated in detail.

Discuss honestly any limitations of the work or alternative interpretations.

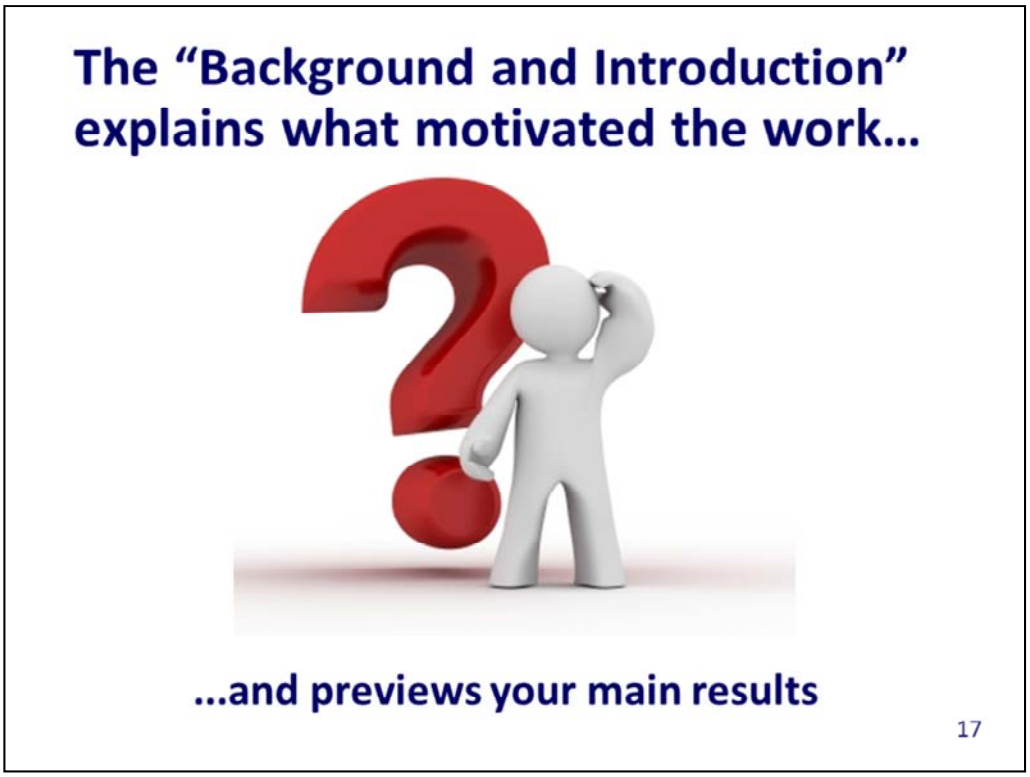
Suggest aspects of the work that should be tested further, and how to do it.

Emphasize what is new about this work; what have you contributed?

For intermediate reports, include a "Future Work" section.




Note that this section is titled "Conclusion**s**" ("what we have deduced from doing this experiment"), NOT "Conclusion" ("congratulations, you've slogged your way to the end of this report")!




Think of "questions" from two perspectives when you write this section:

1. What question the work is addressing.
2. What questions will the reader have in thinking about your work? What do you need to tell him that he might not already know to understand the work and its significance?

The introduction section should establish the significance of the work being reported and clearly state its objectives and scope.

## Write the "recommendations" next

- Make explicit recommendations for action
- Discuss next steps
- Provide a cost/benefit analysis if appropriate
- Outline various scenarios based on your recommendations

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## Write the "executive summary" last*

**Go back to your synopsis, but reverse the order—start with the recommendations**

**Adjust the synopsis to reflect any changes that have occurred during the writing process**

**Expand each sentence in the synopsis to its own paragraph using the SEES method**

*The summary must represent the final report, which may have evolved during the writing process

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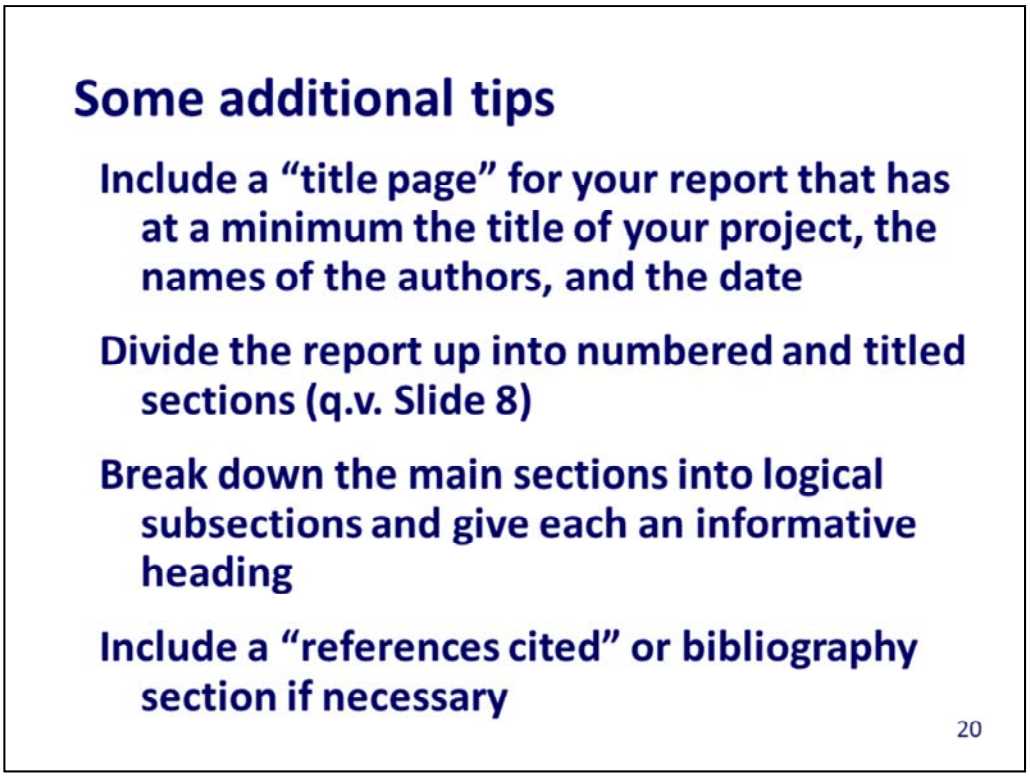
Go back to your original six-sentence synopsis.

Reverse the order and start with the recommendations first.

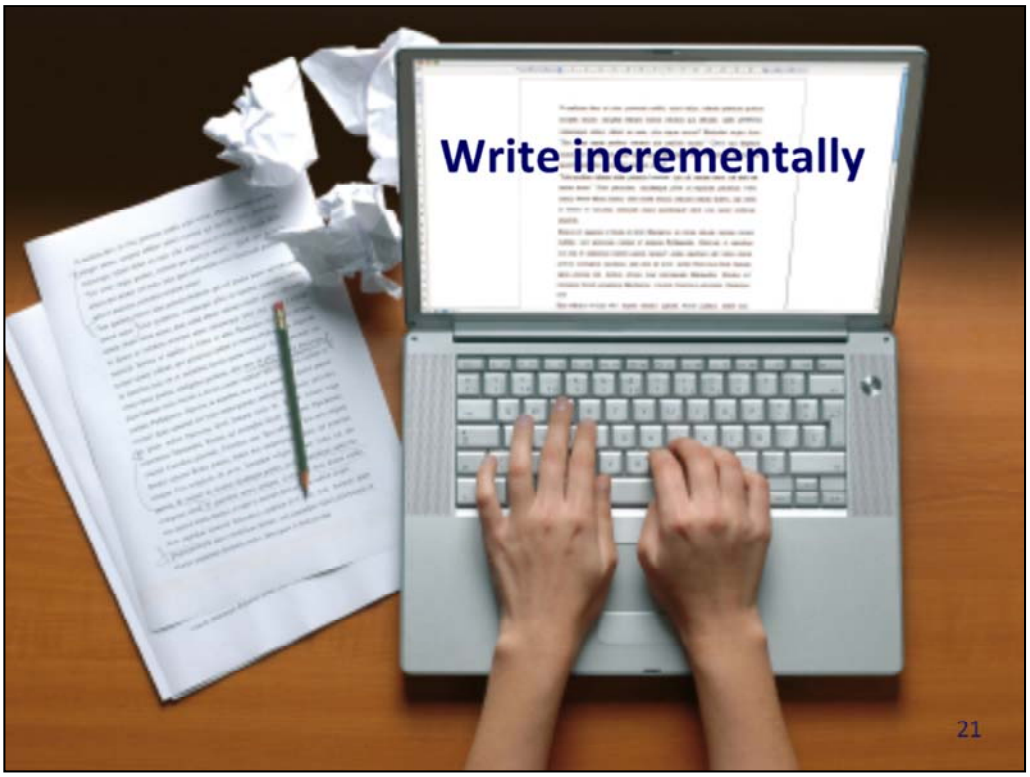
Check to see if anything has changed in the process of writing.

Adjust the synopsis to reflect the finished report.

Expand each sentence into its own paragraph.




Break up the text with informative, content-rich headings and subheadings. Could somebody who just flipped through your report and read the headings get an idea of what your project was about. (Busy readers will do just that before they decide to invest the time in reading the whole report.)




Write in increments:

1) Construct a preliminary outline, based on the your initial goals for the project.
2) Write portions of the “results” and “discussion” sections while you’re taking and analyzing your data.

Advantages of the incremental method:

You may discover additional data that are needed while the equipment is still set up and the project ongoing.

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).


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.

Revising should incorporate four distinct elements:
1) clarifying the selection and presentation of ideas.
2) organizing the narrative logically and incrementally.
3) using language precisely and concisely.
4) correcting "mechanical" errors that detract from a professional argument.

Ideally, editing should be done in three passes:
1) reading for content (the science).
2) editing for style (organization and language).
3) proofreading for mechanics (spelling, punctuation, grammar, usage).

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

## To recap...


Think


Plan


Write & Revise

**Think first**
- Analyze your audience and purpose

**Plan next—synopsis and outline**
- Make an outline and follow it

**Use the SEES method for paragraphs and sections**

**Get words on paper/screen**

**Revise, revise, revise, revise, revise, revise, revise...**

**FINISH!!!***

*Tip: Don't use too many exclamation points in scientific writing!!
People will think you're a crackpot!!!!

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*http://physics.illinois.edu/people/Celia/*

NOTES: