2.00AJ / 16.00AJ Exploring Sea, Space, & Earth: Fundamentals of Engineering Design
Spring 2009

Writing a Technical Report

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7 February 2007

with slides developed by
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Topics

- Elements of the report
- Process of writing the design report
- Introduction / Proposal
- Process of writing the design report
- Revising and Editing

The goal of oral presentations and written reports is to explain a technical finding . . .

BUT . . . they're not the same. . .

Written Reports ⟷ **Oral Presentations**

- Random reading (re-reference text)
- Reader controls pace
- Message is archival
- Reader must actively read
- Feedback not possible

- Linear (cannot "go back")
- Speaker controls pace
- Message presented in the moment
- Audience can be passive
- Feedback possible (questions)

Image removed due to copyright restrictions.
Please see any issue of Nature.

Eakins, Thomas. *The Agnew Clinic*. 1889.

Writing the Design Report -- Prewriting

Image courtesy of vincos on Flickr.

- Start early
  - Technical papers are like spaghetti sauce or stew -- they get better when they sit for a while
- Read the assignment
  - List what you are supposed to do
- List design criteria
- List different solutions and evaluate them in terms of design criteria
- Use models
- Define audiences and purposes

Introduction

- Give background and context of problem
- State problem clearly & concisely
- State why it is important
- Give one or two sentence overview of paper
- Use terms your audience can understand

Background & Context of Problem

Capstan drives have many uses in products, such as printers, plotters, copiers/scanners and tape recorders. For example, in printers, the head that supports the ink cartridge is typically actuated by a cable driven by a capstan[1] [1]. Another use in printers is the feeding system; paper from the tray is fed onto the platen by a rotating capstan[2] [2]. Tape recorders use a capstan that supports and controls the speed of the tape[3] [3].

In precision machines, capstans can be used as rotary power transmission elements. For example, a device from SensAble Technologies[4] uses a combination of two input drums and one output drum to aid in a 3 degree-of-freedom touch based application, as shown in Fig. 1. Capstans in these applications are typically configured with a cable wrapped in a figure-eight pattern around input and output drums. Multiple wrappings give the drive high stiffness and reduce radial loads. Two input drums are

Problem Statement ⇒ Overview

rameters.

While there is significant experimental data supporting the use of porous media aerostatic bearings, few published theoretical models seem to exist that reliably predict their behavior. Accordingly, this paper presents a simple analytical modeling approach for circular porous air bearings that captures the physical phenomena governing the airflow.

The problem of modeling an air bearing is illustrated in

Lab Notebook is Bridge Between Introduction / Proposal and Rest of Paper

Courtesy NPS. Image from Wikimedia Commons.

Lab Notebook

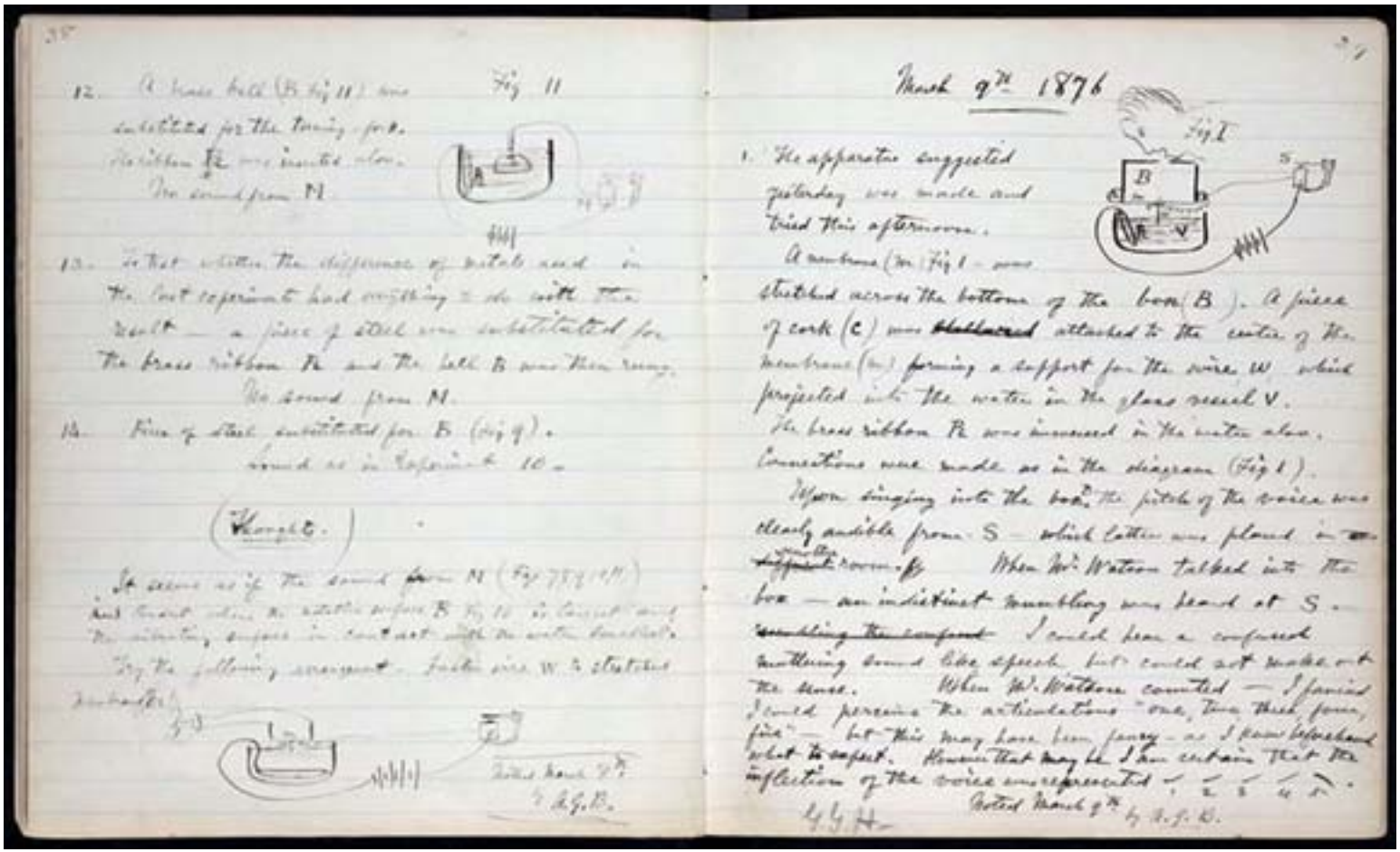


Image from Wikimedia Commons.

What to include in Lab Notebook

- All procedures
- All results
- Possible inferences from results
- Sign and date each page
- Cross-out only with a single line

Image courtesy of Julie70 on Flickr.

The form of scientific communication follows its function

- Forms of technical reports:
  conceptual, **empirical**, observational, methodological, review

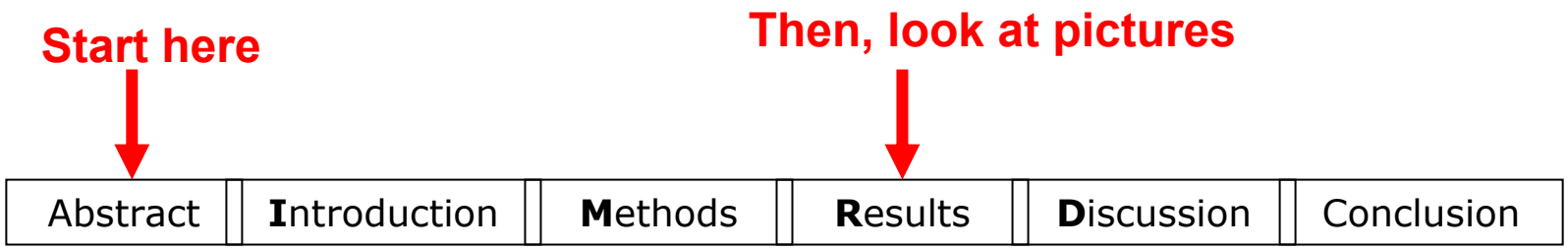
  convey the **values** of science
  - Contextualizes research in the field
  - Provides a repeatable methodology
  - Forces writer to speak from the data
  - Forces writer to separate results from opinions

The form also conveys function needed by readership

- Scientific readers maximize potential of the form when they read.
- Makes it is easy to locate data & compare experiments (methods, etc.)

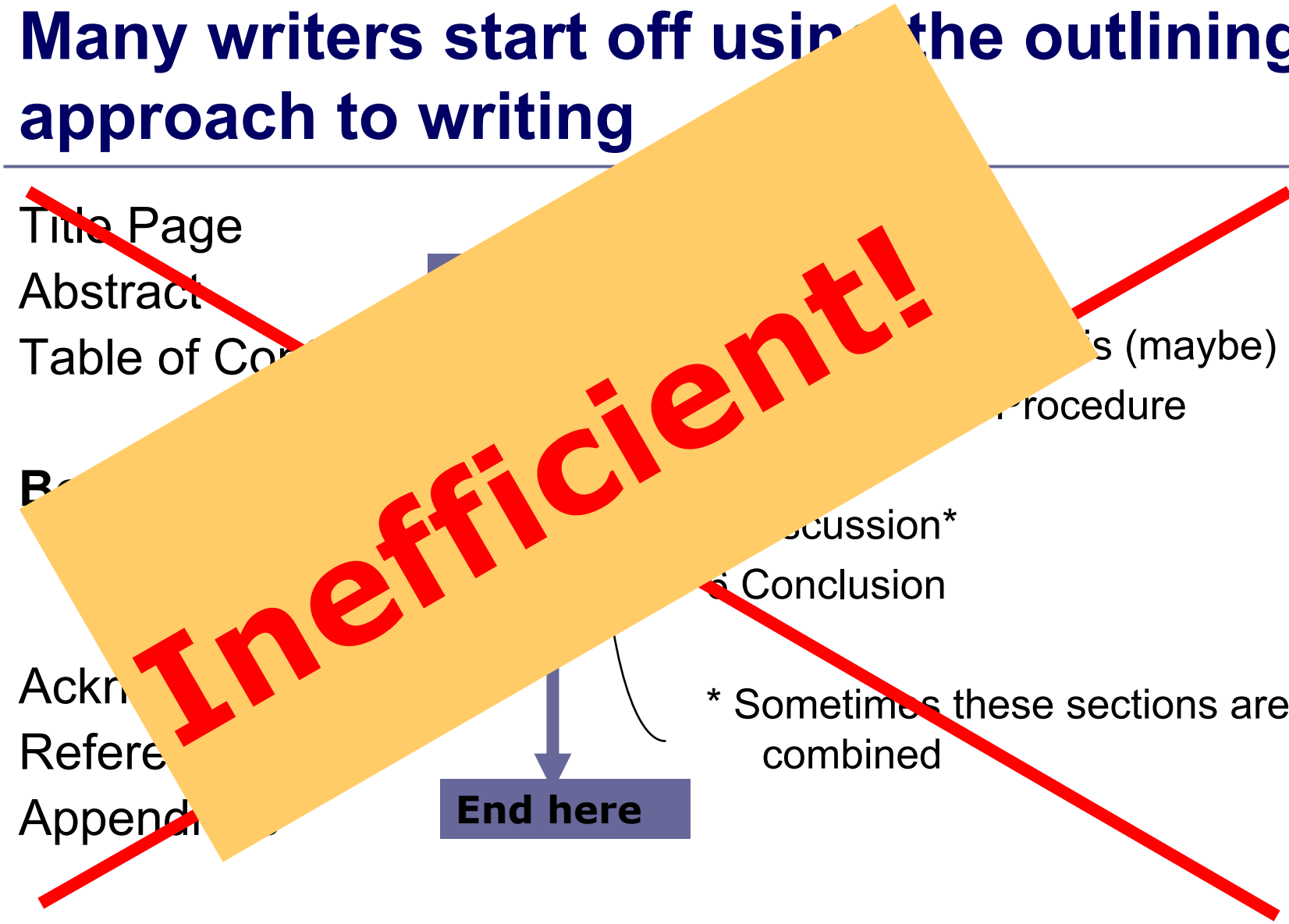
- Easy to write? No
- Easy to read? Yes. Optimized for reading

- Document design and use of figures conveys ethos of scientist.



Known as the IMRaD Format

Many writers start off using the outlining approach to writing



Try the storyboarding approach instead

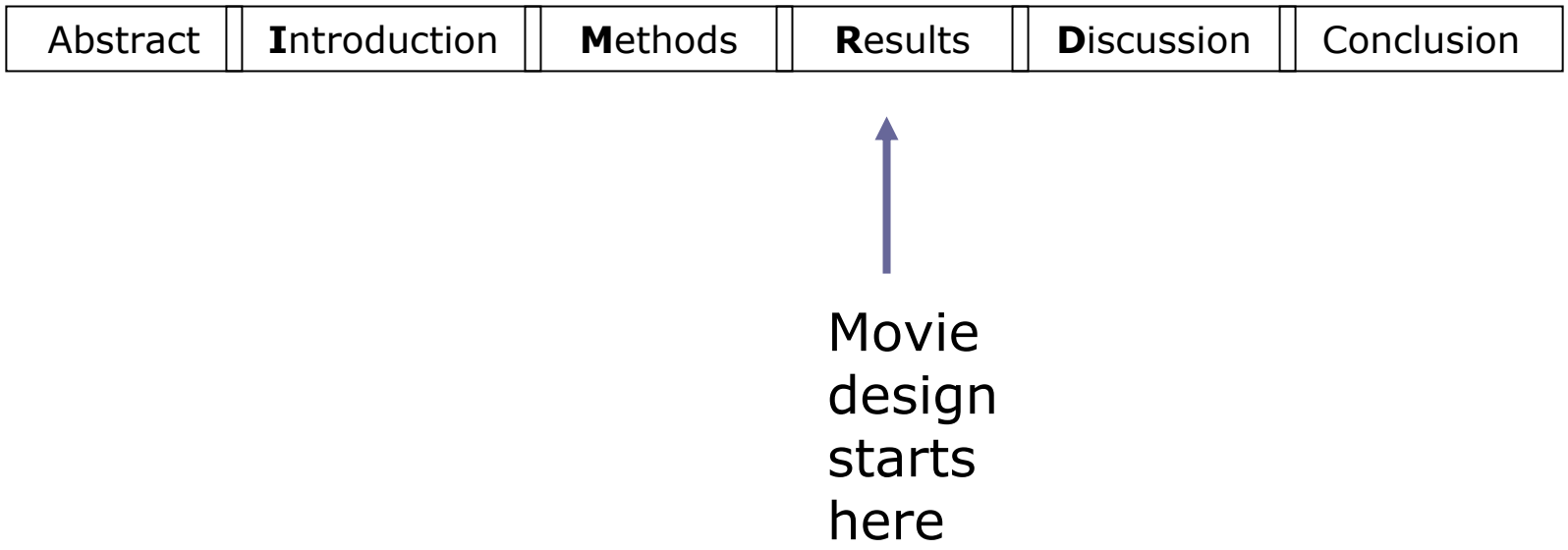
A “movie-making” approach to writing

Each section of report is a “scene”

Abstract	**I**ntroduction	**M**ethods	**R**esults	**D**iscussion	Conclusion

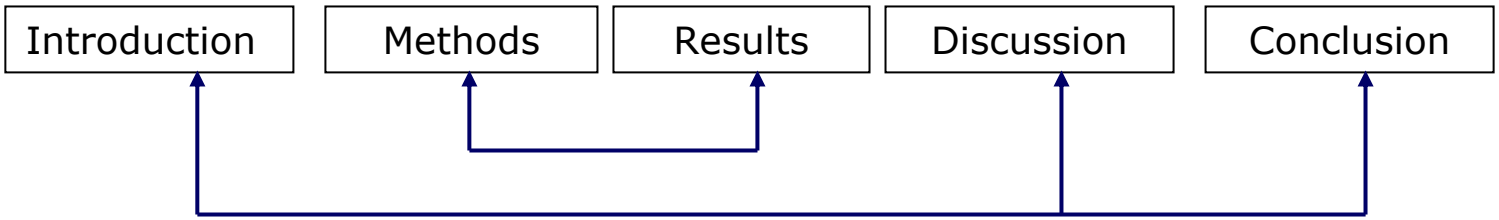
Try the storyboarding approach instead

A “movie-making” approach to writing



Try the storyboarding approach instead

A “movie-making” approach to writing



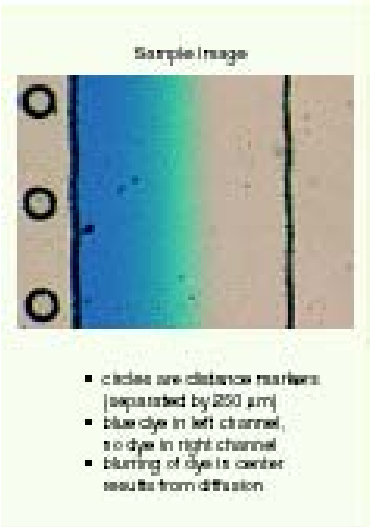
Lab report is built around **Results** data

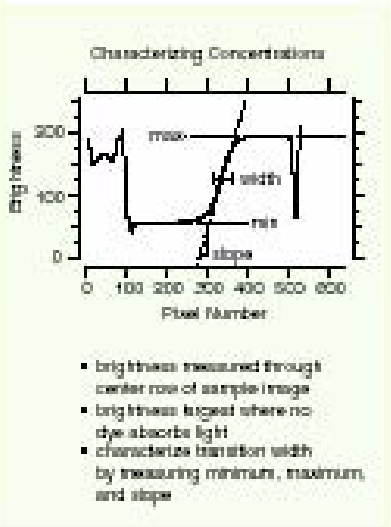
How do you make a movie of your data?

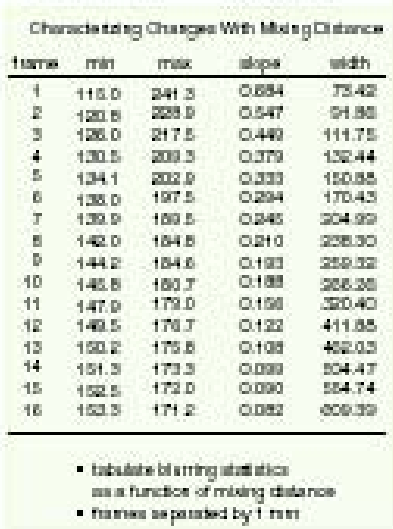
Step 1: Organize your data

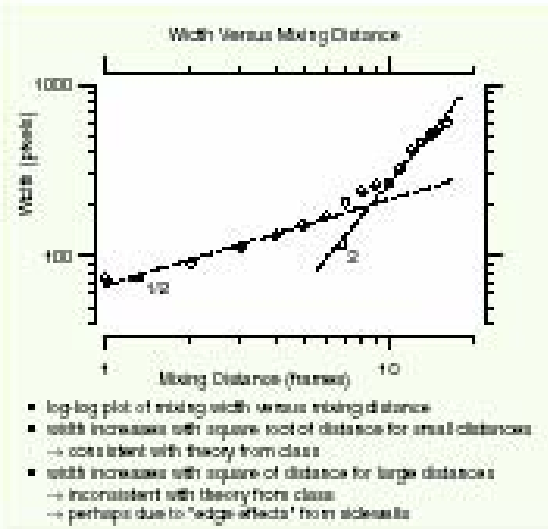
Start with figures:

- Assemble hard copies of your figures in a “storyboard”
- Figure out the major technical theme of the report
- Assess how each figure contributes to the major theme
- REVISE figures to focus on the major theme
  (develop figures that summarize that major theme)









Say it in Pictures

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Please see http://www.anl.gov/Careers/Education/rube/Images/rube_back.gif

Again, say it in pictures

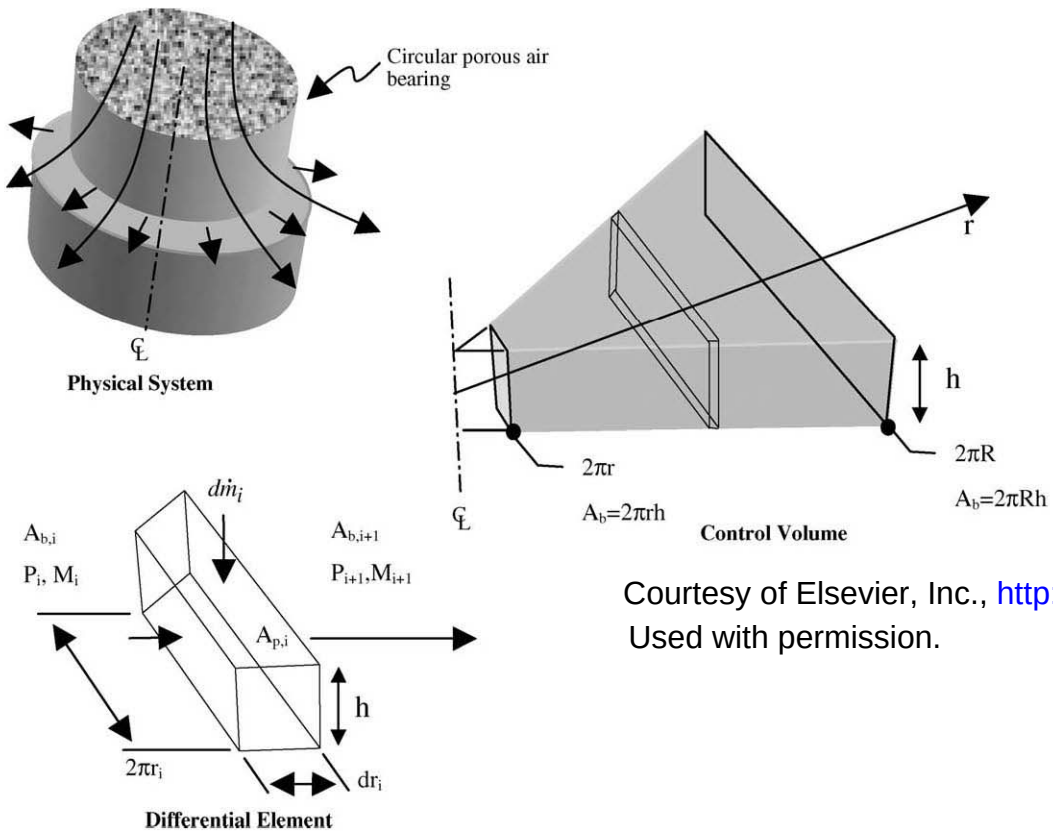


Fig. 4. From the physical system to the 1D model differential element.

Step 2: Plan the report

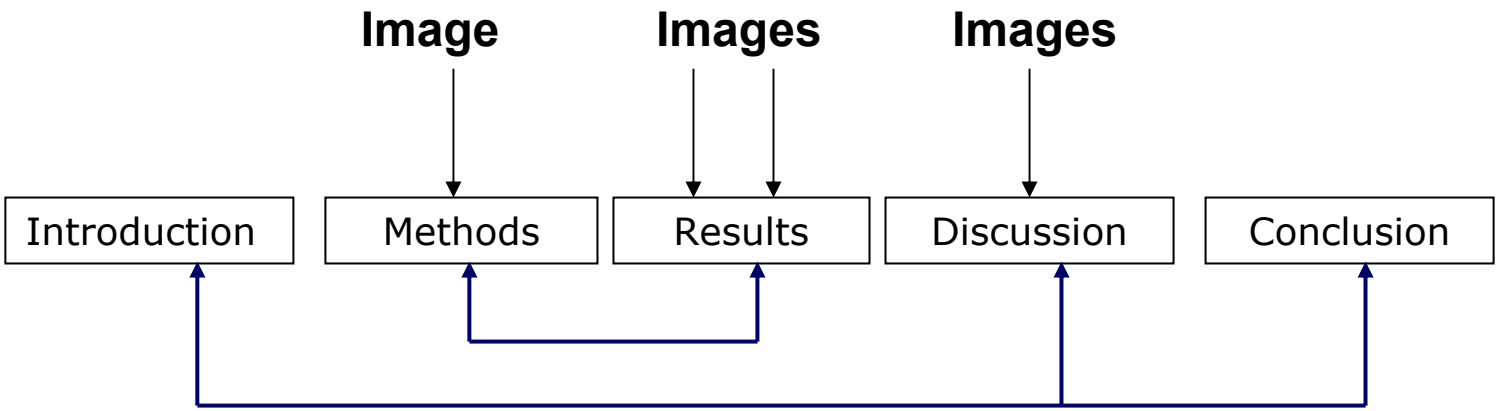
After you've got your data, consider if it's appropriate "screenplay" for your audience and venue:

- Who is the audience?
  - technical expertise
  - level of interest
  - personal familiarity

- How much space do you have?
  - 2-3 pages? 10 pages?
  - Can Results be combined with Discussion?
  - Do I need a Theory section?
  - How much background information to motivate study?

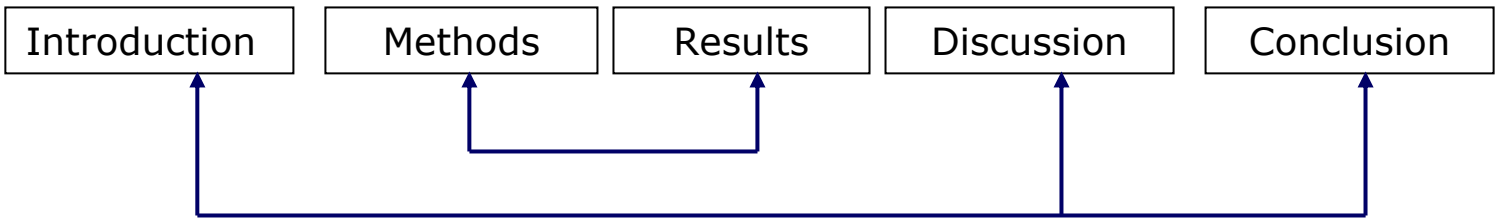
Step 3: Write in non-linear sequence

- What was the purpose of the project? What were the Results?
- Readers read Results first, so start there.
- “plug and play” other sections.
- Make sure you have accurate lab notebook



Use storyboard as the “backbone” of your report/presentation

Step 4: Continue building the report



Add Discussion, Introduction, & Conclusion around the Methods and Results

Check for coherence between and across sections

General Design Strategy

- Modularity
  - Autonomous sections
  - *Chunking*
    - use of white space
- Hierarchy
  - Section levels
  - Use only 3 levels
- Use of levels of abstraction
  - Move from overview to specifics

Step 5: Add End/Front Matter

Title

Abstract

Table of Contents

Acknowledgements

References

Appendices

Abstract

- **Informative abstract** summarizes
  - problem
  - constraints
  - essential elements of design solution

- Do not write a **descriptive abstract** that just lists the parts of the paper

Abstract template

- What is the problem?
- What are the general and important design constraints and specifications?
- What are the essential elements of the design solution?
- What important conclusions can be drawn from the design?

Step 6: All the Good Stuff: Edit, Peer Review, Bake, Revise, Edit, & Proofread

and . . . Submit!

Check the figures!

1. Revise for **completeness**
   - Is all relevant information included?
   - Where might readers have questions?

2. Revise for **organization and document design**
   - Is each section divided logically using subheadings?
   - Does the information link clearly across sections?
   - Do the figures support the text?

3. Edit for **prose style**
   - Are there irrelevant sentences, sections, plots?
   - Can you read the report aloud without verbally stumbling?

Editing the Paper

- Are the sentences clear and easy to read?
- Is the language grammatically correct?
- Read it aloud
- Cut out needless words
  - Text is like code
    - Less is more

The grammar of scientific communication also follows its function

Because science readers do not read chronologically and skim, the grammar of science is:

- Prose that is not laden with jargon or vague expressions
- Simple sentence structure S – V – O
- Provides links between text and visuals
  e.g., “As shown in Figure 2 . ..”
- Provides time reference (e.g., Methods – past tense)
- Distances subjectivity of the researcher (e.g., passive voice)
- Unambiguous prose It = ??, This = ??

See “The Science of Scientific Writing” By Gopen and Swan

Omit Needless Words

- The question as to whether . . .
  - Whether . . .
- There is no doubt
  - No doubt
- In an interactive manner
  - Interactively
- This is an element which
  - This element
- During which time
  - while

Get rid of *the fact that*

- Owing to the fact that
  - Because
- The fact that the system had not succeeded
  - The system failed
  - The system's failure . . .
- The fact that the packet arrived
  - The packet's arrival

Resources

- Mayfield Handbook
  - http://www.mhhe.com/mayfieldpub/tsw/toc.htm
- Writing and Communication Center
  - http://web.mit.edu/writing/