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

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Writing a Technical Report

> Les Perelman 7 February 2007

with slides developed by Dr. Mya Poe

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

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

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

Oral Presentations

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



Eakins, Thomas. The Agnew Clinic. 1889.

Writing the Design Report -Prewriting

Start early

Image courtesy of vincos on Flickr.

- 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 capstan¹ [1]. Another use in printers is the feeding system; paper from the tray is fed onto the platen by a rotating capstan² [2]. Tape recorders use a capstan that supports and controls the speed of the tape³ [3].

In precision machines, capstans can be used as rotary power transmission elements. For example, a device from SensAble Technologies⁴ 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

March 97 1876 713 11 12. A lines held (B. Hig 11) and insisting jos The toning of the delithen the me insuited alove AD! 1. He apparatus suggested no sound from M Jularday was made and tried this afternoone. 13. is hat white the difference of particle and in at another (m) fig 1 - mos The last reprime to had confilling = do with The stretched across the bottom of the bon B). a friese "wealt - a first of abel and substituted for of costs (C) mus bladlaced attached to the centre of the The prass nothern The and The hall B was Then rung. mentione () forming a support for the wine w while Ma Bound from M. projected into the water in the glass recel V. 14. Fine of start invitituted for B (sig 9) . the breas rithon Re some increased in the water alon . Connections were made as in the diagram (Fig 1) . around as in Referent 10 -Moon singing into the book the pitch of the voice was (Vergel 5 .) clearly andible from S - which latter and pland in the toget room by When Witcom talked into The It seems as if The sound from N (Fig. 754 1011) for - an indictinat pumbling sons beard at S. And Trank where the astation property B to be to Consect and The million of fails in contract with the water function? sundling the compared I could been a confirmed By the following ansignant - Factor size W & stratitud molling bound like speech but could not make out When Willow counted - I farried The Almet. a mader Scould perceive The articulations "one, Time Thick, form, bet this may have been faney - as I kam beforehand what to support. However that may be I am contrain That the There & Barris 9 7 influction of the voice enverymented - 2 444 Anter March 9 7 1 8.9. D. a.g.B.

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

Image removed due to copyright restrictions.

Please see http://www.nlm.nih.gov/MEDLINEPLUS/ency /images/ency/fullsize/9494.jpg

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 Intro	duction M ethods	Results	Discussion	Conclusion
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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:

300

- · 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)



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- bluring of dye is center secula from diffusion

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6	135.0	197.5	0.294	170.43
$\sim \tau$	139.9	109.5	0.245	304.93
18 - E	142.0	184.8	0.210	228.30
<u></u>	144.2	184.6	0.193	259.52
:40	145.8	160.7	0.188	206.20
.11	147.9	179.0	0.150	320.40
32	149.5	170.7	0.122	411.85
13	150.2	175.5	0.108	452.03
14	151.3	173.3	0.099	304.47
3.5	152.5	172.0	0.090	384.74
-16	153.3	171.2	0.082	009.39



- with increases off square tool of distance for small distances.
 -> cots intent with theory from data
- with increases with square of distance for large distances -> inconsistent with theory from class.
 - -+ perhaps due to "edge effects" from sideaulis

Say it in Pictures

Image removed due to copyright restrictions. Please see http://www.anl.gov/Careers/Education/rube/Images/rube_back.gif

Again, say it in pictures

J.-S. Plante et al. / Precision Engineering 29 (2005) 336-346



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

339

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 <u>audience</u>? technical expertise level of interest personal familiarity
- How much <u>space</u> 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



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

Check the

figures!

and ... Submit!

1. Revise for completeness

Is all relevant information included? Where might readers have questions?

- 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 = ??

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



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/