HOW DO WE WRITE GOOD?

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PURPOSE

- This lecture serves as an outline to set expectations for writing assignments
- It is important to set the expectations early in a written assignment so that students can understand the level of writing and detail that is expected and how they will be assessed
- This document is part of series that is used guide student expectation
  - Problem statement
  - Grading rubric
  - All aligned together
  - These are detailed expectations for technical writing
    - Style may change with topic and context
    - Please removed content that is overly rigid for the intended project
- This is all part of a grand scheme
  - This is too much information and must be reiterated throughout their writing process
  - In my classes we do writing groups. They complete each section of their papers and bring them for peer review in-class
  - Students also bring their sections to me for individual feedback where I reiterate these ideas

QUESTIONS?

- Is writing important in STEM?
- Why do we need to write?

QUICK POLL

- Are you a good writer?
  a) Yes
  b) No
  c) I don't know

WHAT MAKES A GOOD WRITER?

- Are some people just better at writing?
  - No
- Writing and Revising are what make a good writer
- 1st drafts are always bad, but they must be done
- "Shitty First Drafts. All good writers write them. That is how they end up with good second drafts and terrific third drafts." –Ann Lamott

PARTS OF A RESEARCH PAPER

- Abstract
- Introduction
- Methods
- Results
- Discussion
- Conclusion
- References
- Tables and Figures
- Appendices

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INTRODUCTION

- This is often the most time intensive/least fun part
- Provides background to the field
  - What is the problem you addressing?
  - Who is affected?
    - Number, type, location of individuals affected
    - Costs associated with the problem
    - Example: "Each year 250,000 hikers in the United States are injured in badger related incidents, resulting in $1 million in emergency room costs (BanBadgers.com, 2021)."
- What is the current state of science?
  - What has already been done
- What still needs to be explored?

INTRODUCTION

- Background motivates the reader to
- It should tell a story where the ideas (synthesis of information)
  - Example: Current prostheses are prim active[12-15] that simply providing variab
- By the end of the Introduction your s
  - Hypothesis/Objective should be expli
    - "We hypothesize that…"
  - Hypotheses should be concrete metri
    - Good: We hypothesize that use of a micr reductions in timed up and go (TUG) tes
    - Bad: We will improve amputee mobility

SECTION TEST

What are three main components of the Introduction?

a) Hook, Citations, Hypothesis

b) Audience, Research, Synthesis

c) Population, Background, Hypothesis

d) Hewey, Dewey, Lewey

OPTIONAL IN-CLASS ACTIVITY

- Review Introductions and determine if they tell a good story
- Review Introductions and come up with your own hypothesis from the provided information
- Practice defining your problem and population

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METHODS

- Now that you have your hypothesis established, everything you do will be related to that test
- What did you do and how did you do it (specifically)
  - Example: "Analysis of amputee mobility utilized an experimental study…"
  - References are often needed in this section to justify your actions
    - If you use a specific test or analysis that is well known you don't have to explain it, just give references to those who have already validated the Method
- What analyses did you do
  - Modeling (FEA, Math Equations, Musculoskeletal Modeling)
  - Experimental
- An educated reader should be able to reproduce your results based on the Methods
  - The Methods are not an instruction manual with step-by-step outlines
- Your Methods should not be specific to a single tool, but general enough that they could be used with any, similar engineering tool
  - ANSYS vs SolidWorks
  - MATLAB vs Python
  - Don't tell the reader what buttons you clicked

METHODS

- What specific metrics are you analyzing/calculating?
  - How will these metrics test your hypothesis?
  - What assumptions will you make?
- How will you compare your metrics – Statistical analysis
  - Words like ‘Significant’ have mathematical meaning and can’t be used without statistical testing
- Be careful not to put Results here

EXAMPLES

Results in the Methods:

For the energy savings of the building skin, a value of 32.7% total energy savings was calculated from information provided by Radwan & Osama (2016) and nationalgridus.com. The full calculations can be seen in Equations A1-A3 and the results in Figure 2.

SECTION TEST

Who reads and actually understands the Methods?

a) Everyone
b) Target Audience
c) Expert Audience
d) Professors

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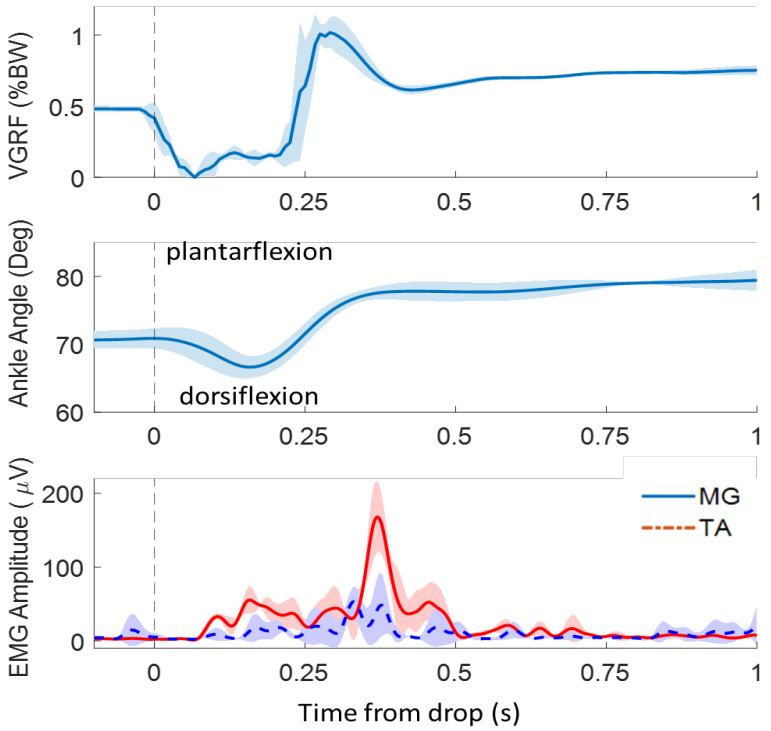
RESULTS

- Just the facts
  - That doesn't mean just the plots
  - All figures must be mentioned in body text
- Use the text here to point out important findings, but do not comment on their meaning
- Be careful not to slip Methods or Discussion in this section
  - If you explain how you found a Result you need to back up to the Methods
  - Example: "Vertical Ground Reaction Force, taken as the mean z-component of the in-ground force plate data, had a peak value just above 1 bodyweight.



EXAMPLE

Results

The bending stress required to break a single capsule was calculated using ultimate tensile strength and repeated for a polyester strand to calculate the maximum load for the polyester fabric as a tensile load that would result in a tear of the fabric.

SECTION TEST

What goes in the results?

a) Thoughts

b) Facts

c) Opinions

d) Analysis

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DISCUSSION

- This is where you bring it all together
  - **Discussion should start with a brief summary of the work**
- What do your Results mean in relation to your hypotheses?
  - Organize your Discussion to address the Hypotheses
  - Be sure to address all your results
- How do your results compare to those of others (validation)
- What are the practical implications of your Results?
- Acknowledge the limitations of your work
  - How would you change this in the future?
- Discuss the next steps, future work, that will stem from this work
- Tell the facts as they are, don't try to make them fit your narrative
- "Where you run into problems is when the authors know the story they want to tell before they collect the data and then try to jam those data into the framework." –Ann Lamott

SECTION TEST

What should the first sentence/paragraph in the Discussion contain?

a) Outline of topics
b) Restatement of Hypotheses
c) Brief summary of the work and its purpose
d) Shotgun listing of the Results

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CONCLUSION

- Summarize everything for the reader and tell them what they should take away from this work
- If you wanted the reader to remember 1-2 things, what would they be?
- This can be a separate section, or a final paragraph to the Discussion
- "If you don't provide understanding (or at least knowledge) readers will be left searching for it." –J. Schimel
- Try to make it simple

SECTION TEST

What feeling should the Conclusion give you?

a) Closure
b) Understanding
c) Confusion
d) Happiness

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ABSTRACT

- This is a brief summary of your entire paper
- The Abstract should contain features from each of the other sections
- The reader can absorb the main points of your work just from the Abstract
- No citations, pictures, or outside references. The Abstract stands alone
- Even though you state it in the Abstract it must be restated in the body text (e.g., acronyms)

EXERCISES AND EXAMPLES

- The following slides provide optional exercises in writing
- The objective is concrete, concise, direct writing

TABLES AND FIGURES

- All tables/figures should have captions that explain them
  - A reader should be able to understand the table/figure just from reading the caption
- All data should be legible without zooming
  - About the same text size as the rest of the paper
- Make sure to include all units and proper labels
- Do not include screenshots of code or scans of hand-written calculations

TABLES VS CHARTS

Table 1: Static loading results by part and material

Part	Material	Minimum Safety Factor	Maximum von Mises Stress (Mpa)	Maximum Displacement (mm)
Deck	Wood - Maple	8.01	8.18	0.13
Deck	ABS Plastic	2.49	8.03	0.69
Baseplate	Steel	15.0	9.60	1.43E-04
Baseplate	ABS Plastic	2.03	9.87	0.01
Baseplate Bolt	Steel	15.0	3.77	3.50E-05
Baseplate Bolt	ABS Plastic	5.13	3.90	3.39E-03
Baseplate Nut	Steel	15.0	6.96	2.66E-05
Baseplate Nut	ABS Plastic	3.04	6.58	2.59E-03
Wheels	Polyurethane	15.0	0.75	0.04
Wheels	ABS Plastic	15.0	0.66	3.00E-03
Truck	Aluminum	12.9	21.3	0.02
Truck	ABS Plastic	1.02	19.7	0.66

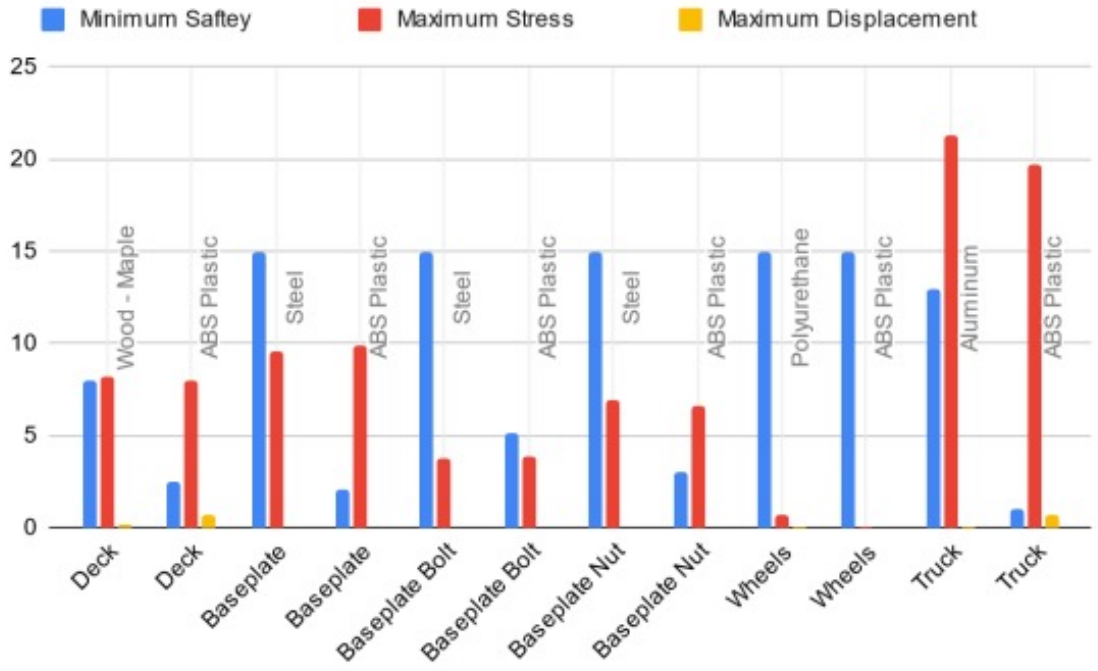
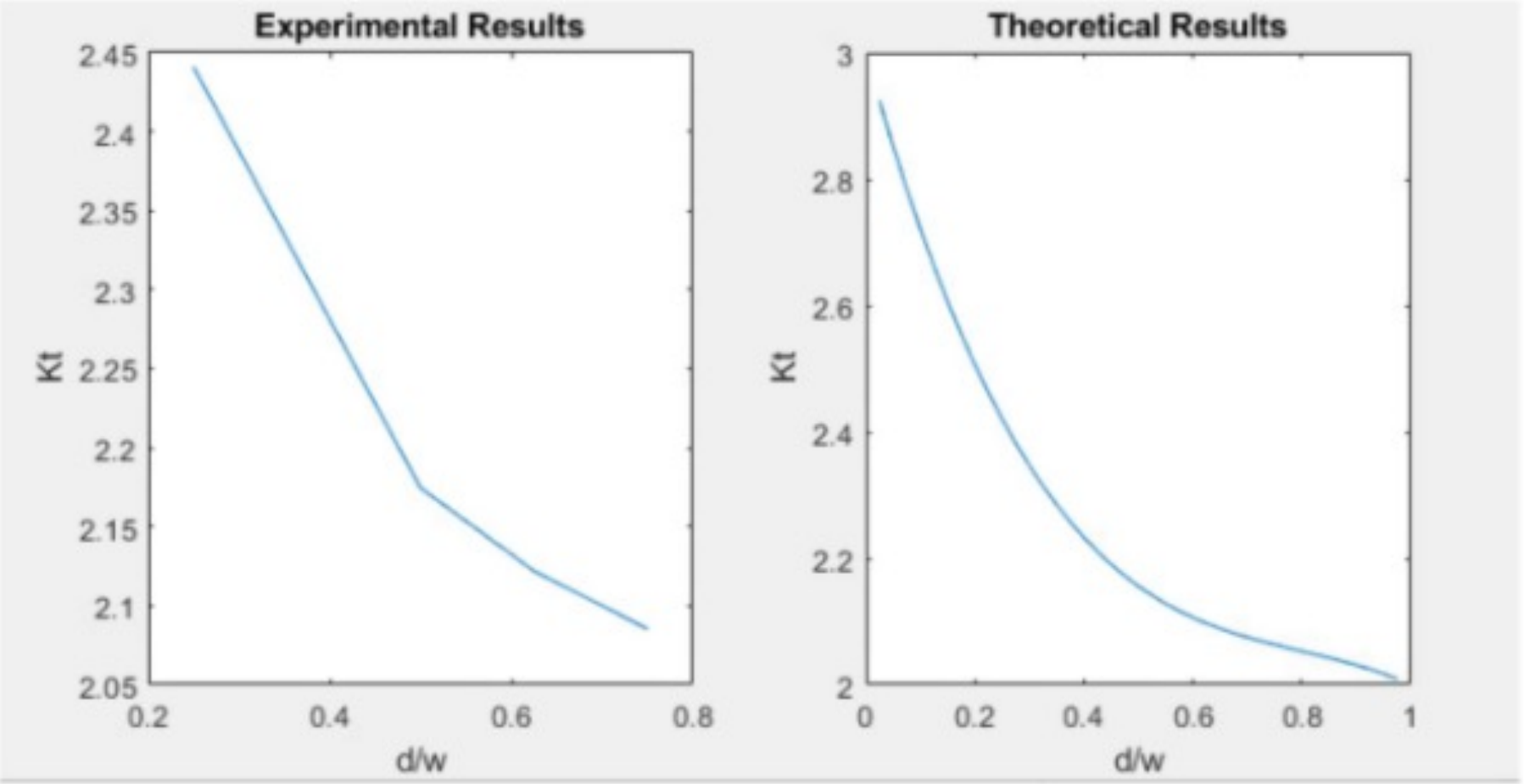


Figure 2: Chart comparing parts and materials safety factor, Max stress, and Max displacement

MAKING COMPARISONS



ORGANIZATION

Results

	Energy Use		Energy Generation		Pollution Mitigation	
	Skin	Spandrel (Glass)	Solar Panels	Electricity	Carbon Sequestering	No mitigation
Initial Price	$16,145,850	$168,000	$1,816,395	$0	N/A	$0
Yearly Cost	$0 /yr	$0 /yr	$0 /yr	$774,950 /yr	N/A	$0 /yr
Yearly Saved	$107,005 /yr	$0 /yr	$774,950 /yr	$0 /yr	$0 /yr	$0 /yr
Cost at 42 years:	$11,651,640	$168,000	-$30,731,505	$32,547,917	$0	$0
Yearly Electricity/pollution	N/A	N/A	N/A	$4,843,440 kWh/yr	$411 tons/yr	473 tons/yr
Total electricity/pollution	N/A	N/A	N/A	$203,424,480 kWh	$17,253 tons	19,845 tons

SIGNIFICANT FIGURES

- How many decimals do you need?
- NASA uses15 decimals of PI
- For our farthest craft (Voyager 1) which is 12.5 billion miles away, that results in an error of 1.5 inches

- https://www.jpl.nasa.gov/edu/news/2016/3/16/how-many-decimals-of-pi-do-we-really-need

Results

Table 2: Angles of incoming sunlight and it's refraction angle.

Angle of Incoming Sunlight	Angle of Refraction of Sunlight through glass (Eq.1) (in degrees)	Angle of Refraction of Sunlight through glass (Eq.2) (in degrees)
30°	19.47122063	19.47122063
45°	28.1255057	28.1255057
60°	35.26438968	35.26438968
90°	41.8103149	41.8103149

Table 3: Angles for different materials.

Material	Angle of Incoming Sunlight And reflected sunlight (degrees)	Angle of Refraction in solar cell (Eq.1) (in degrees)	Angle of Refraction in solar cell (Eq.2) (in degrees)
Silicon	19.47122063 28.1255057 35.26438968 41.8103149	10.87571649 15.47588345 19.07478679 22.17015716	8.916796253 12.66223167 15.57311682 18.05923049
Gold	19.47122063 28.1255057 35.26438968 41.8103149	19.0665801 27.51471666 34.45808999 40.79339495	19.17212901 27.6738533 34.66784231 41.05737476
Nanograss Coating			
Aluminum Oxide	19.47122063 28.1255057 35.26438968 41.810314	13.16627545 18.79157076 23.23620841 27.10068535	12.83958841 18.31673071 22.63754342 26.38779996
PGMA	19.47122063 28.1255057 35.26438968 41.8103149	19.32381677 27.90278173 34.96998176	19.47122063 28.1255057 35.26438968

APPENDIX

- This is where you put information that is interesting, but not necessary for the main paper
- This is not a spillover for your figures so that you can save pages
- If a Table/Figure/Equation is necessary for the understanding of the work, it doesn't go in the Appendix

CITATIONS

- All statements of fact not proven by the work you are doing need citations
- Citations must come from a primary source
  - Do not cite Review articles that cite the original source
  - Do not cite other works that cite an original source

OVERALL ORGANIZATION

- Everything should be in the same order in each section
- The order of information should follow logically
  - The reader should not have to jump back and forth to piece everything together
- Remember this is a story, if I am required to reread sections it was not told well
- "It's the Author's job to make the Reader's job easy." –J. Schimel

PUTTING IT ALL TOGETHER

- You have all the parts, but how do you put it all together?
- Excellent paragraphs have excellent structure
  - Introduction, body, conclusion
  - Tell them what you're going to tell them, tell them, then tell them what you told them.
- "If those who have studied the art of writing are in accord on any one point, it is this: the surest way to arouse and hold the reader's attention is by being specific, definite, and concrete." -Strunk and White, *Elements of Style*

PRACTICE: CONCISE WRITING

Write clear and concise sentences

- Get to the subject quickly

  'Since most undergraduate students change their major fields of study at least once during their college careers, many more than once, first-year students who are not certain about the program of study they want to pursue should not load up their schedules to meet requirements for a particular program.'

CLEAR AND CONCISE

Most undergraduate students change their major fields of study at least once during their college careers, so first-year students should not load up their schedules with requirements for a particular program if they are not certain about the program of study they want to pursue

First-year students should not load up their schedules with requirements for a particular program if they are not certain about the program of study they want to pursue, because most change their major fields of study at least once during their college careers.

PRACTICE: AVOID MEANINGLESS WORDS

Avoid meaningless or repeated words and ideas

- Meaningless words
  - Kind of, actually, basically, really, very, given
  - Don't write like you might speak

'Productivity actually depends on certain factors that basically involve psychology more than any particular technology'

MEANINGLESS WORDS

Productivity actually depends on certain factors that basically involve psychology more than any particular technology

Productivity depends on psychology more than on technology.

REPEATED WORDS

- Don’t pair words together to make your sentences sound smarter. Remove redundancy.
  - Full and complete
  - True and accurate
  - Any and all
  - Each and every

PRACTICE: REMOVE REDUNDANCY

- Remove what the reader can infer
- Common redundancies
  - Terrible tragedy, basic fundamentals, each individual, free gift, true facts

‘Do not try to predict future events that will completely revolutionize society, because past history shows that it is the final outcome of minor events that unexpectedly surprises us more.’

REMOVE REDUNDANCY

‘Do not try to predict future events that will completely revolutionize society, because past history shows that it is the final outcome of minor events that unexpectedly surprises us more.’

‘Do not try to predict revolutionary events, because history shows that the outcome of minor events surprises us more.

PRACTICE: REPLACE A PHRASE WITH A WORD

- Often, entire phrases can be represented by a single word.
  - ‘the thing to do before anything else’ → ‘first’
  - ‘use X instead of Y’ → ‘replace’

‘We must explain the reason for the delay in the meeting’

‘Despite the fact that the data were checked, errors occurred’

‘In the event that a class closes, you may petition to get in’

TURN PHRASES INTO WORDS

‘We must explain the reason for the delay in the meeting’

We must explain why the meeting is delayed

‘Despite the fact that the data were checked, errors occurred’

Even though the data were checked, errors occurred

‘In the event that a class closes, you may petition to get in’

When a class closes, you may petition to get it