Technical Memo Packet

**Assignments only required if enrolled in FWIS 188

Pre-Self Reflection: Setting the Stage for Personal Development

In-class Tasks

There are no in-class tasks for this memo.

Out-of-class Tasks

Spend some time reflecting on your current interests in academic majors and career options. Some of you may already know what major you will complete at Rice and which career field you hope to enter, while others of you may still be exploring all the options that are available. In thinking about majors, careers, and personal development, think about the reasons you have for taking this course.

1. What major have your chosen or which majors are you considering? Why this major? What factors did/will you consider in this decision?
2. What do you plan to do when you complete your undergraduate degree? What is your ideal job? What do you think that job entails on a daily basis?
3. What does it mean to be an engineer? Do you consider yourself to be an engineer right now? Why or why not?
4. Why do you want to take this class?
5. What skills do you want to gain from this class?
6. How do you see these skills being useful in your future career?

Pre-Self-refection Memo – Setting the Stage for Personal Development

Due V1: _____
Due V2: _____N/A_____
Authors: All, individually
Conferences: no writing mentor conferences will be held for this assignment
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this initial writing assignment is to capture who you are at the beginning of this course. First, spend some time reflecting on the questions posed above. Recall your thoughts, feelings, perceptions towards choices in academic major(s), potential careers, and course selection prior to the start of this semester. Write an expository essay reflecting on your interests in academic major(s), desires for your career, and what you hope to gain from this course. This is a personal reflection essay, but use a first-person academic writing style. Note: It is perfectly ok, if your intended major and/or career are outside of engineering.

Specifically for this pre-SM, begin with a self-introduction, describe your interests of academic major and career, and how choosing to take this course fit into these interests. Follow your introduction with a reflection what skills you believe you want to learn in this class, what skills you will apply in your future career, and expand upon your reasons to take this course.

Conclude your SM with some thoughts on what it means to be an engineer and in what ways do you or don't you see yourself fitting this image.

Each FWIS 188 student will author an individual SM. For SMs adopt a style that is more narrative in nature and less technical. In particular for this essay, do not just write short answers to the questions listed above, but construct a cohesive essay with effective transitions. **This SM should be no more than two single-spaced pages**.

NOTE: There are several essay contests at both the university level and national level; top essays will be considered for nomination to these competitions.

Step 1: Clarifying the Problem

In-class Tasks (Day 03)

- Meet your group, learn names, and share contact information.
- Meet your DM and talk about roles/responsibilities.
- Learn about your project by (re)reading the project proposal.
- Generate a list of ~20 questions for your client interview on Thursday (Day 04). A suggestion is that ONE person begins a list on paper or on a computer; everyone else should be focused on thinking of questions, not writing or editing. At a minimum, the following topics need to be covered:
  - Details on what is driving the design request. Why the design is needed?
  - What is currently used? What are the limitations? If nothing is available, why?
  - Who will use the new design?
  - How will the design be used?
  - What characteristics are important in a new design? What is mandatory (a constraint)? What are some desired features?
  - Logistical questions, including contacts
  - Confirm that questions are inclusive of what is needed for TM #1
- Identify topics needing research (before client interview) and assign responsibility
- Assign someone to type up the questions for the interview. Order the questions so that there is some logical flow to the conversation.
- Discuss any other preparation for Thursday.
- Check out with the instructor before you leave class.

Out-of-class Tasks

- Finish typing up the questions for the interview. Order the questions so that there is some logical flow to the conversation. Print copies of the questions for all team members before the interview (Day 04).
- Eat lunch or dinner together this week.
- Complete and compile information from your personal research.
- Synthesize the client interview, research, and project sketch into TM #1 (Problem Statement). Collect information required for Team Structure and Activities (see TM #1). Write and edit TM #1.

Technical Memo #1 – Problem Statement

Due V1: _____

Due V2: _____

Authors: All members of the team

Conferences: Sunday afternoon & evening; **ALL team members should attend the first writing conference**

Turn in: Upload to Canvas under the appropriate assignment

The primary purpose of this technical memo is to clarify your **team's problem statement**. In addition, you need to provide basic information about your team and its plans for the semester. TM #1 has two sections, Team Problem Statement and Team Structure and Activities:

Team Problem Statement

In the problem statement, your team will articulate its design project to clarify expectations, both between team members and between your team and your client. The process of writing the problem statement should help your team:

- Reach consensus on project aims
- Align objectives with those of clients and sponsors
- Initiate project planning
- Assure clients and sponsors that you understand your mandate

The problem statement should state the overall purpose of your design project, define your design problem, and identify general points around which quantifiable design criteria can be established. The problem statement should identify who will use the design solution (i.e., potential users). A clear problem statement should answer the following questions:

1. What design solution is desired?
2. Why is a solution needed? What is the problem with the status quo? Explain the limitations of existing solution(s) or the impact of having no solution at all.
3. What characteristics or features (e.g., power, size, safe) would your client like to see incorporated in potential design solutions? What characteristics or features would potential users like to see in potential design solutions?

Whenever possible, use numbers (e.g., number of carts, size of patient population), technical reasoning, and other quantitative data (e.g., costs) to support your claims.

Team Structure and Activities

Also, TM #1 should include a section on team structure and activities including:

- Team name
- Team members
- Team contact information
- Client, sponsors or other stakeholders
- List of deliverables (i.e., work products, such as prototypes or written reports) expected of the team
- Time frame in which the team is to complete its work
- Budget within which the team is to work ($500/team, more with written approval)
- Schedule of authors for each memo (table)
- Proposed weekly meeting time

The introduction to this memo should provide 1) relevant context for the engineering design process related to *your* design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your memo by succinctly capturing insightful key points from this step of the engineering design process.

Remember that ALL members of the team will author this TM. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than two single-spaced pages, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your memo.

Step 2: Understanding the Problem and Context

In-class Tasks (Day 05)

In the Understanding the Problem and Context portion of the EDP, your team gathers and studies information relevant to your project. You must become familiar with the terminology, previous and similar solutions, related technology, economics, and other important aspects associated with your project. The culmination of this research is in the creation of your design context review, a comprehensive report compiling your appropriate source material and background information. **Your self-education will be more extensive than the summary that you provide as TM #2.**

1. Create a "need-to-know" list. To fully understand your team's mission and begin to articulate a specific problem that will drive your project, your team will need to review literature in your project area. Your team should generate a "need-to-know" list that suggests topics and issues you need to research based on Figure 1. This list can be a hierarchical list or a spider web outline. There should be a **minimum of 30** unique topics that your team needs to "know" in order to solve your problem. A suggested strategy for tackling this work is to break up the team into subgroups of two or three. These subgroups can tackle one or two of the four main context areas:
   - Exploration of existing solutions
   - What governs the problem
   - Relevant background
   - Business perspective

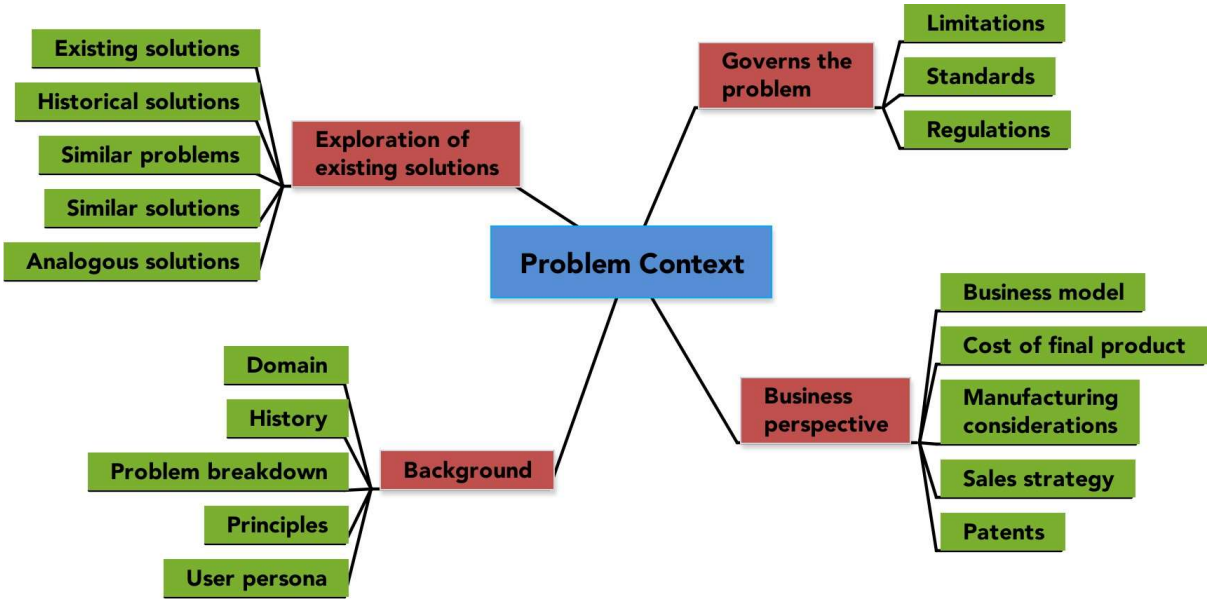


Figure 1. Topics for exploring the problem and context. Explanations of each can be found in the project workbook.

For each context area, consider the listed categories or topics of research (e.g., existing solutions). These topics should be key words that could form the basis for an initial search.

2. Once a complete need-to-know list for all four context areas has been generated, break up the research among your team members and assign work. Your team should research every topic in your need-to-know-list. As you are researching, take thorough notes about each source, including the location and any pertinent information that could help you to solve your problem. If you find a new item that warrants further exploration, add more items to your need-to-know-list.

Out-of-class Tasks

1. Either individually or in groups of two, finish your "need-to-know" list.
2. Identify areas of the "need-to-know" list that are most pertinent to the development of your project. Divide these pertinent topics equitably among your team and conduct your assigned research. All team members must participate in research! Use the search strategies discussed in the videos.
    a. Document your research insights using your own methods or the DCR research worksheets attached at the end of this document
        i. Print out important pictures and attach them to the DCR research worksheets
    b. When recording your insights write the COMPLETE reference for your sources. Focus on peer-reviewed (i.e. validated) sources. A website of a product is NEVER enough. Research worksheets need to be typed.

3. After completing the research, when your team meets, share the research insights and have every team member read them. The purpose of this is for everyone on the team to share and learn about their peer's research.

Tech Memo #2 – Need-to-Know List & Research for a Design Context Review

Due V1: _____
Due V2: _____
Authors: According to schedule from TM#1
Conferences: Sunday afternoon/evening; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

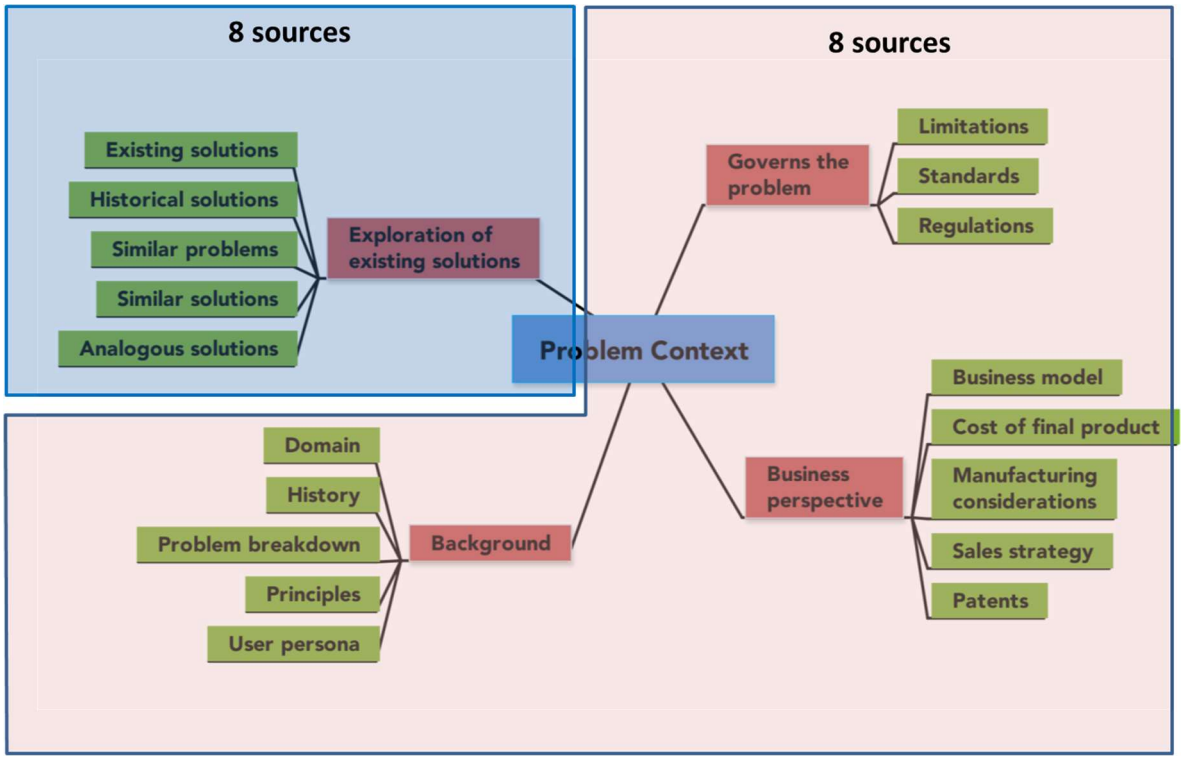
The purpose of this technical memo is to produce a "need-to-know" list that would be used to inform research for a design context review (DCR). You will conduct some research selected from this "need-to-know" using validated sources. You will not write a DCR or make an outline of a DCR. This work forms the foundation for a full **design context review (DCR)**.

The introduction to this memo should provide 1) relevant context for the engineering design process related to *your* design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your

memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically for this TM your introduction should set the context of your design problem in the development of your "need-to-know" list, describe the process that helped you generate your need-to-know list, and defensible reasons for your decisions of which topics to research. For this TM, you will produce two products:

1. Need-to-know list
2. Research worksheets. Below is the target for research:



Section 1: *Eight* research sources documented on the DCR research worksheets from the "Exploration of Existing Solutions" quadrant (i.e., *eight* unique references that include the topics in those five green boxes).

Section 2: *Eight research sources* documented on the DCR research worksheets among the "Background", "Business Perspective", and "Governs the Problem" quadrants (i.e., *eight* unique references that include the topics in those thirteen green boxes). You should complete research worksheets on the most important topics. Since the most critical research topics vary among projects, talk with an instructor or a DM to identify the focus of your research. For some projects, learning about the Background Principles is critical, whereas for others, applicable Regulations are key. For most projects, the topics under Business Perspective can be deemphasized. It is likely that you will have research topics across the different quadrants; avoid just doing the "easiest.

For this TM the conclusion should include a list of key points that insightfully discuss how your need-to-know list guided your research to find insightful knowledge that will influence your understanding of the problem and your development of a solution. For example:

1. What items on your need-to-know list were particularly useful for finding relevant information about your design problem?
2. How did your method (i.e. specific approach) of generating a need-to-know list help or hinder both the breadth and depth of the list?
3. What were the memorable moments or discussions that led to breakthroughs in this process or the creation of these products?

Remember that ALL members of the team must participate in the work to generate the product of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than THREE single-spaced pages OF WRITING, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour facilitated peer-review session for your team.

Research Reference Worksheet

Problem Context Area (circle one that best fits):

Exploration of existing solutions	Governs the problem	Background	Business perspective

Complete Source:

Is this source peer-reviewed (circle one): YES NO

Summary of Key Points:

Why is this source important to the project?

Step 3: Define Design Criteria

In-class Tasks (Day 06)
As a team, generate a list of design criteria and constraints. Use a whiteboard to complete this task and try to write legibly. 1) Start by listing out the criteria without the numbers (e.g., weight, cost, ease of use). 2) Identify if any of the criteria are really constraints, meaning that they must be present for a solution to be successful. Confirm a reasonable list of design criteria (typically 4-7) and constraints (typically 1-2).

After there is consensus on this list, make each design criteria and constraint quantitative. To determine appropriate numerical values, refer to the project statement, conversations with the client, and research from the DCR. Avoid making up numbers. (Note, you may need to consult with your client if you don't have all the information that you need.) Make sure that your design criteria can be measured or evaluated in a quantitative way.

Develop any needed user-defined scales that capture feelings or opinions. Chart out descriptions to correspond with the selected scale (e.g., 1-5). Remember that user-defined criteria should have a set target value, like other criteria.

Take legible photos of any lists or charts created as documentation.

Out-of-class Tasks
Finalize design criteria and constraints, along with target values, if not completed in class.

Step 3b: Define Design Criteria: Pairwise Comparison Charts

In-class Tasks (Day 07)
Complete a Pairwise Comparison Chart (PCC) for your team's design criteria. Write legibly on a whiteboard to complete this task. Take a picture of the PCC chart. If your team has significant difficulty with ranking the criteria, consider contacting your project client.

Out-of-class Tasks
Finalize the PCC, if not completed in class.

Tech Memo #3 – Define Design Criteria
Due V1: _____
Due V2: _____
Authors: Two authors, according to the schedule from TM #1
Conferences: Sunday afternoon/evening; one or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment.

The purpose of this tech memo is to produce and document your design criteria. Design criteria are quantitative, measurable objectives and constraints that define a successful solution. The selection of these targets should be justified with a rationale that supports the target numerical value.

The introduction to this memo should provide 1) relevant context for the engineering design process related to *your* design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically for this TM your introduction should set the context of your design problem in the development of your design criteria, describe the process that helped you set your design criteria, and defensible reasons for your decisions of which topics to research. For this TM, you will produce at least two products:

1. Design criteria
2. Pairwise Comparison Charts
3. User Defined Scales (if needed)

Format your table listing design criteria with two columns:

- Design criteria, including objectives and constraints. It should be clear which criteria characterize an objective and which characterize a constraint.
- Numerical target value for all design criteria, i.e., the quantitative value for design criteria to reach.

Examples of design criteria and target values are given in the Appendix below.

For criteria requiring user-defined scales, develop those scales and include them in the memo. User-defined criteria can then be listed in the table like other design criteria. Photos of user-defined scales are acceptable, assuming that they are legible (i.e., you do not need to type them up, assuming that the instructor can read them).

Based on the PCC, include the ranking of the objectives in the body of the memo. A clear photo of the PCC chart is acceptable.

For this TM the conclusion should include a list of key points that insightfully discuss how your initial list of features and characteristics drove the creation of your design criteria, including user defined scales, constraints, and the PCC. For example:

1. What was the driving force behind the creation of the design criteria: your client, quantitative defense based on research, something else?
2. Which design criteria do you think will be the most difficult to design for?
3. What were the memorable moments or discussions that led to breakthroughs in this process or the creation of these products?

Remember that ALL members of the team must participate in the work to generate the product of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than TWO single-spaced pages OF WRITING, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your team.

Appendix: Examples of design criteria and target values

Table 1. Example Design Criteria from various projects

	Design criteria	**Target value**
Constraints	Weatherproof	Able to last 35 + rainy days over 3 months with no leaks
	Safety	0 sharp edges, holes ≥ 8.85 cm diameter, complies with 100% of USDA laws and regulations
Objectives	Inconspicuous	Scoring an average of at least 3 on a user defined scale*
	Inexpensive	Materials cost is ≤ $5 per individual unit
	Ease of Opening	An average ≥ 4 on user defined scale **
	Easily Maintainable	≤ 5 minutes to clean, 100% of the surface area is accessible to the human arm (average diameter of 8.85 cm)
	Portability	Weight < 68 lbs per section able to be disassembled
	Reproducibility	Achieves an average of at least a 3 in the user defined scale ***
	Durability	Maintenance required no more frequently than every 3-6 months

*

5	Even if you tell me we have a new camera I am not able to find it
4	I can find the camera if you tell me that it exists
3	I can find the camera after a minute or two of looking
2	I can find the camera in a few seconds
1	I can find the camera immediately

**

5	Can open with one hand/easily without assistance
4	Can open with both hands without assistance
3	Needs assistance to open
2	Difficult to open even with assistance
1	It was easier to open Chapstick without this device

***

5	Does not require tools and can be produced with off-the-shelf components
4	Buildable with basic hand tools such as a hand saw, hammer and nails
3	Requires basic power tools such as an electric drill or powered saw
2	Can only be produced with OEDK level or better engineering facilities
1	Requires parts and tools that can only be sourced through a custom order

Step 4: Brainstorming

In-class Tasks (Day 08)
Procure the necessary materials for brainstorming (e.g., index cards, pens, post it notes, etc.). As a group, decide which brainstorming method you will use. Set a goal for the total number of ideas per person (e.g., 30).

Begin a brainstorming session that should last 30-45 min. (Note – when you start brainstorming, it should be quiet…). During sharing – either when discussing ideas or during formal hitchhiking – make sure to capture any new ideas by writing them down.

Reflect after your first brainstorming session. Prepare to address any deficiencies in your second brainstorming session.

- Did you meet your brainstorming goal for total number of ideas?
- Could your ideas be categorized as: basic, repetitive, innovative, wild?
- Did you use hitchhiking to generate more ideas? Wild ideas?
- Would decomposition be a helpful strategy to create design blocks? If so, decompose your problem and consider doing targeted brainstorming during the next session.

Schedule a follow-up meeting for additional brainstorming.

Out-of-class Tasks
Before completing a second round of brainstorming, meet out-of-class to do decomposition of your project. Decomposition will help you to understand the functions necessary for your solution. Organize your decomposition into a flowchart or appropriate diagram that articulates each design block. Meet for a second round of brainstorming that should last 30-45 min. Plan to address deficiencies you discussed after your first round of brainstorming, and any gaps in each design block. Follow the steps above for the brainstorming session and reflection.

Sort the brainstormed ideas into categories. (Categories could be ideas for a decomposed part, or it could be a 'type' of solution, or …)

- Sort idea into full/complete solutions and partial/incomplete ideas.
- Sort full ideas into categories around topics or other similar features
- Sort any component/partial ideas into design blocks that group like parts, features or components

Confirm that your handwriting and drawings are legible; a best practice for hand drawings is to trace every line in black ink, and then take well-lit photos of the physical media (e.g. whiteboard, paper, post-its). If you see gaps following the sorting step, have a short brainstorming session to fill in those gaps. Conclude this meeting with a list of 50+ ideas, sorted into categories. Capture photos of the post-it notes sorted into categories, these photos will be used in your TM, so ensure that they are legible and that the photo will fit on a single page without significant shrinking of the image.

Tech Memo #4 Brainstorming of Design Solutions
Due V1: _____
Due V2: _____
Authors: Two authors, according to the schedule from TM #1
Conferences: Sunday afternoon/evening; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this memo should be to provide your decomposition and sorted list of **brainstormed design solutions**.

The introduction to this memo should provide 1) relevant context for the engineering design process related to *your* design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically for the brainstorming memo your introduction should set the context of your project, describe the design blocks for your problem, cover your method of brainstorming, and your organization of the brainstormed ideas. For the products section, include 1) one figure which details your decomposition into design blocks, and 2) separate figures of each of your categories of brainstormed ideas. Do not include a typed list of your brainstormed ideas. Ensure that these images are readable when printed to letter-sized paper. Remember that figure captions go below the figure and include figure number, figure title, and a descriptive caption of the image. Conclude this memo with a list of key points that insightfully discuss how your process influenced your brainstormed ideas and their organization. For example:

1. What observations and insights were identified from your brainstorming sessions and how did you adapt the brainstorming method for your successive sessions?
2. Did your team adopt a technique that was not discussed in class?
3. What were the memorable moments or shared ideas that broke walls in creative thinking?

Remember that ALL members of the team must participate in the work to generate the product of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than TWO single-spaced pages OF WRITING, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your team.

Interlude 1: Team Pit Stop

In-class Tasks (Day 07)

In the Teaming Videos, you learned several characteristic of high performing teams (Figure 1). In class we talked about how to conduct an effective team pit-stop to evaluate current team performance and set goals for future performance. The team pit stop includes three steps.

1. As an individual you will respond to three prompts about your own roles in the team and your perspective of the overall team performance.
2. As a team, review responses and identify themes.
3. As a team select 2-3 issue to address and commit to an implementation plan.

Figure 1. Characteristics of High Performing Teams.

Out-of-class Tasks

1. Reflect on your individual behaviors that have both positively and negatively impacted the team performance and team dynamic or moral.

Self-refection Memo #10 – Team Pit Stop

Due V1: _____
Due V2: _____
Authors: All, individually
Conferences: Sunday afternoon/evening; Peer-review sessions; **ALL members attend** & participate
Turn in: Upload to Canvas under the appropriate assignment

Regularly held team pit stops are a foundation for a high-functioning team and address individual contributions to team dynamic. Written self-evaluations and team-reviews are a common professional practice in industry. These types of evaluations and reviews are not personal journal entries, but professional documents that may be reviewed by various members of an organization. The purpose of this self-reflection memo is to document and reflect on the first

team pit stop. You conducted a team pit-stop in class, now spend additional time reflecting on that meeting, and then write a reflection on this process.

Specifically for this SM begin your introduction by setting the context for your team (e.g. core values, major, college, and/or diversity in heritage) and the team pit-stop (e.g. the climate of the conversation and/or how the conversation went). Then describe your individual behaviors and actions in the team that have both positively and negatively impacted team performance and/or team dynamic. Remember this is not about your opinions or emotions, but about your behaviors and actions within this team. Follow your introduction with a summary of your team's pit stop.

1. What were some of the salient themes that emerged about your team's aspirations, strengths, and weaknesses?
2. What plans did your team commit to implement to address these issues? Rememberthese should be actionable or measurable.

Conclude your SM with an insightful discussion about what actions you believe will make a real difference in your team performance and dynamic, as well as how can you observe if positive change is occurring as a result of your actions?

Remember that ALL members of the team will author an individual SM. This is not about placing blame on yourself or others, but about identifying the current state of the team and committing to individual and team actions to improve your team performance and dynamic. For SMs adopt a style that is more narrative in nature and less technical. **This SM should be no more than two single-spaced pages**. It will be graded on a check scale, considering both the insightfulness of your reflection, and your written communication style. See attached rubric for more details. During your WM appointment, you will have a one hour facilitated peer-review session for your team.

Step 5: Evaluation of Design Solutions

In-class Tasks (Days 9, 10) and Out-of-class Tasks

The objective of this work is to narrow your design solution ideas down to one (or two) final solution ideas. This process takes time both in and out of class, and different teams will likely use different strategies. Below are steps A – D in text and a flow chart (Figure 1) that can help your team move from many ideas to a final solution.

A. Sort ideas into categories

- Sort your ideas into full/complete solutions and partial/incomplete ideas.
- Sort full ideas into categories around topics or other similar features
- Sort any component/partial ideas into design blocks that group like parts, features or components

B. Reduce many ideas down to 5-10 by using Pugh screening matrices

- Screen your ideas based on reality and common sense. Throw out ideas that are ridiculous or impractical.
- Complete a Pugh screening matrix for a first batch of ideas. Eliminate 50% or more of your ideas.
- Complete Pugh screening matrices for component/partial ideas. Eliminate 50% or more of these ideas.
- Repeat Pugh screening matrices until all ideas have been vetted and ~5-10 ideas remain.
- Take high-res photos of all Pugh screening matrices.

C. Combine component/partial solution ideas to full solution ideas using Morph charts

- Evaluate whether 'full' solutions can be constructed from the component/partial ideas in your decomposed design blocks using a Morph chart. If not, talk with a TA or instructor. The team may need to spend additional time brainstorming. Or, it may make sense for these partial solution ideas to be add-ons.
- If you have more than 4 or 5 ideas in a design block, use the steps outlined in "B" to reduce the ideas in that design block.
- Construct and complete a Morph chart to generate complete/full solution ideas.
- Take high-res photos of any Morph charts.
- Vet those newly developed full solutions ideas by following steps outlined in "B."

D. Move from 5-10 solution to a final solution

- Create detailed sketches with labels of all ideas that will be rated in the scoring matrices
- Complete one or two Pugh Scoring matrices to down-select the final/best 5-10 ideas (from Pugh screening matrix) to 1 or 2 ideas.
- There should be a relationship between the values entered into the Pugh Scoring Matrix (1-5) and the actual or estimated physical value. For example, consider weight as a design criterion. If one solution has an estimated weight of 0.5 lbs., this idea might receive a 5 on a Pugh Scoring Matrix. If a second solution has an estimated weight of 4.5 lbs., it might receive a 2 on a Pugh Scoring Matrix. See Table 1 as an example. Cite appropriate references as needed.
- Type up the final Pugh scoring matrices for TM #5

E. Create a flow chart that represents the selection process

- Starting with figure 1, recreate a flow chart that specifically represents the process your team used. In each block you could include the number of ideas evaluated at each stage.

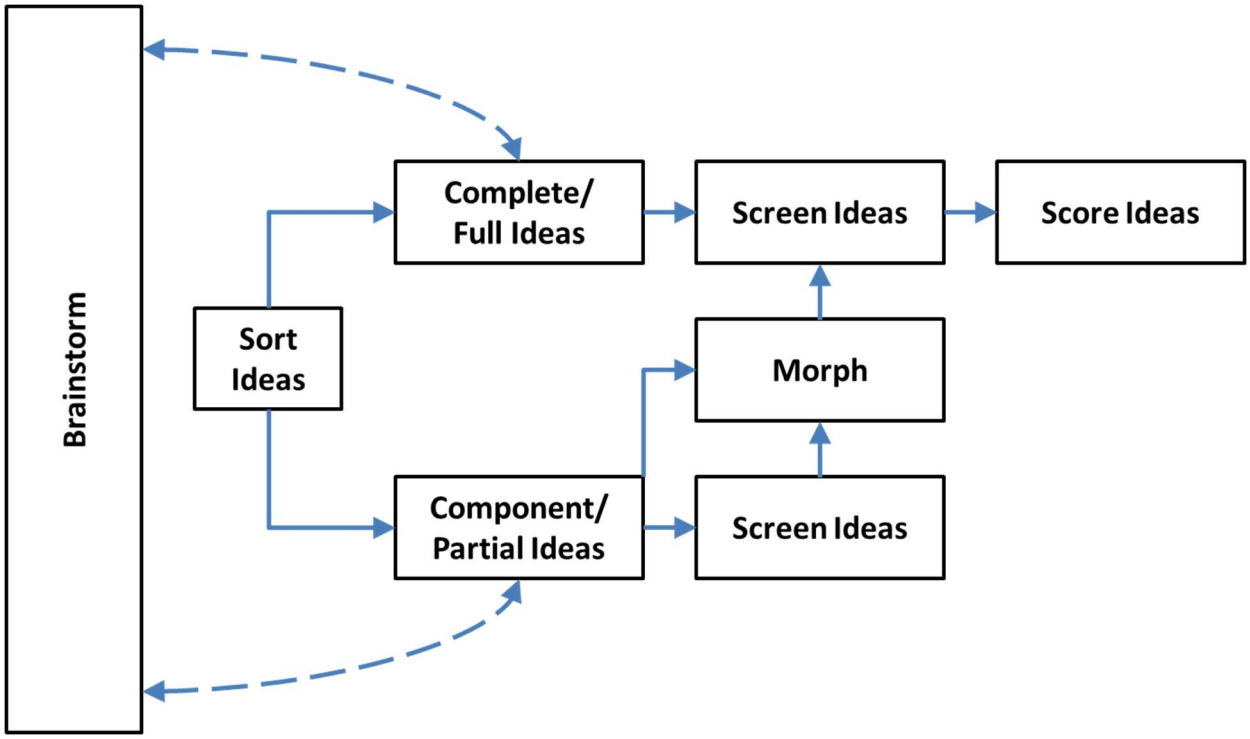


Figure 1. Sample Selection Process Flow Chart

Table 1. Example of Evaluation Rating System

Score	Weight
5	≤ 0.5 lbs.
4	0.5 < X < 2 lbs.
3	2-4 lbs.
2	4 < X < 5 lbs.
1	≥ 5 lbs.

Tech Memo #5 – Evaluation of Design Solutions

Due V1: _____
Due V2: _____
Authors: Two authors, according to schedule from TM #1
Conferences: Sunday afternoon/evening; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this memo is to describe the evaluation of your solution ideas and defend the selected solution.

The introduction to this memo should provide 1) relevant context for the engineering design process related to *your* design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically for the evaluate design solutions memo your introduction should set the context, and explain your process for down selecting from many solutions to the one or two solutions that you will choose to prototype. Be sure to succinctly justify the evaluative rating systems that drove your decisions. For the products section you should show your specific selection process flow chart (i.e, your version of Fig. 1), relevant screening, scoring tables, solution sketches (e.g. hand-drawn with labels are fine), table(s) of quantified 1-5 values, and morph charts. Those products do not need to be typed up (i.e., photos are fine), as long as they are clear. They should be presented in the order your team followed.

Conclude this memo with a list of key points that state your selected solution with insightful elaboration on WHY the solution was selected, and others were not, and defense of your process.

1. What were key features that helped to distinguish between solutions (i.e. Design components that influenced scoring either higher or lower)?
2. What features of your process heavily influenced solution selection (e.g. design criteria weighting, quantified 1-5 values)?
3. What salient process decisions were made during solution selection (e.g. choosing not to score a D.C., modifying D.C., not screening a particular category, etc.)?
4. What were the memorable moments or discussions that led to breakthroughs in process and/or products?

Remember that ALL members of the team must participate in the work to produce the products of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than three single-spaced pages, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your team.

Step 6: Prototype Solution

In-class Tasks

As a team, discuss what you envision your final design to be in detail. Start by sketching your overall final design by hand. Sketch smaller aspects or important design blocks in your design. Come to consensus on what the final design should look like and its physical features. Identify what you think will be the most complicated aspects of your design. Ensure that your solution is technically feasible and reasonably solves the design problem.

Continue your discussion and make decisions about the following topics for your ***final*** design solution or device:

- A specific but succinct description of what you plan to build or code
- A list of the design blocks of your final design
- Dimensions of the overall solution and individual design blocks
- How the different pieces of your solution should be held together (i.e., glue, tape, fasteners, tubes)
- Fabrication materials (i.e., 2" x 4" pine, plastic sheeting, 1/8" acrylic)
- Component parts needing to be purchased (e.g., electronics)
- An outline of computer code or existing programs to use

Before starting on a high fidelity prototype, it is important to test out your design ideas using low fidelity prototyping. Begin talking about the design blocks and components of the final design, and how they could be represented in a simpler or rudimentary fashion. Sketch out some ideas of how the most complicated components could be built from low fidelity materials. For physical projects, this might look like using cardboard and tape. For computer/electronic projects, this might look like a flowchart or a circuit diagram. In summary, identify how you plan to begin the "build" phase.

Encourage discussion in your team about what you don't understand. Be frank and identify the parts of your design you don't currently understand. Talk about what parts you think will be the most difficult to build or might fail first.

With both the "final" and "initial" prototype in mind, think through a 2-week plan to begin prototyping. The first prototype that you build should be of low fidelity materials; your team should be able to build this in 1 hour or less. For each prototype that you plan to build you should have a clear goal in mind and be able to address each of the bullets listed above. Within this 2-week period, subsequent prototypes may be created that evolve from low to even mid-range fidelity materials.

Tech Memo #6 Design Plan

Due V1: _____
Due V2: _____
Authors: Two authors, according to schedule from TM #1
Conferences: Sunday afternoon/evening; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this memo is to communicate specifics of the vision for your team's final design solution and first few prototypes.

The introduction to this memo should provide 1) relevant context for the engineering design process related to *your* design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically for the design plan memo your introduction should set the context, and explain your process of developing the selected solution that you plan to move forward with into the prototyping phase. For the products section you should include material that communicates exactly what you plan to build. Show drawings of your prototype, screenshots of relevant CAD files or flow chart/computer code, dimensions of the objects that you will make, use labels or captions to indicate materials and functions, and make a list of component parts that assemble to your final solution. Be as detailed as possible.

Conclude this memo with a list of key points that describe what you will prototype with insightful elaboration on how you developed the detail surrounding your selected solution.

1. What key features of your selected solution helped to select materials and develop prototyping steps (i.e. Design components closely look like previous solutions or existing objects)?
2. What features of your solution do you think are the "hardest" and will present the biggest challenge to successful prototyping (e.g. a way to lift a human, or a design block that changes rotary motion to linear motion)?
3. What salient process decisions were made during material selection for your prototyped solution (e.g. choosing a weaker but less expensive material or choosing a material that exactly fits the specifications at a higher cost, etc.)?
4. What were the memorable moments or discussions that led to breakthroughs in process and/or products?

Remember that ALL members of the team must participate in the work to produce the products of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than two single-spaced pages, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your memo.

Interlude 3: Project Planning

In-class Tasks (Day 16)

As a team, engage in a discussion about what needs to be accomplished to finish your project and complete the requirements for this course. Consider major components of your design project and the specific steps needed to complete these components. Talk with your team about the deliverables for the course and how those translate into tasks for the team.

Continue this discussion by making an exhaustive list of tasks for your project. Your team can use the hierarchy of a Work Breakdown Structure, or your team can brainstorm tasks in no particular order. You should check TM #6 (Design Plan) and the syllabus as starting points. Include processes like prototyping, testing, iteration, ordering, communication, and writing.

After this exhaustive list has been made, re-order the list chronologically. Then, review the list to identify what is missing and add those things. Also, break up any tasks that are very large into smaller tasks so that the team can identify how long each task will take.

Convert this list of tasks into a Gantt chart. The Gantt chart should include the major steps of prototype development and documentation and their respective deadlines, so that it is clear what tasks your team needs to complete by certain dates. Concurrent and dependent tasks should be noted. The Gantt chart should identify the leader and supporting personnel for each particular task.

Be as specific as possible with the scheduling of steps. As an example, pretend your team identified its design as being made of three different design blocks. Your Gantt chart should then reflect the sourcing, purchasing/acquiring, prototyping, assembly, testing, iteration, and documentation of each of those three blocks.

Tech Memo #7 Gantt Chart

Due V1: _____
Due V2: _____
Authors: Two authors, according to the schedule from TM #1
Conferences: Sunday afternoon/evening; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this memo is to communicate your team's **project schedule** for the remainder of the semester. In TM #6 you clarified your design specifications and the components of your solution. In this memo you will communicate the plan your team will apply to prototype successive solutions and meet the course requirements.

The introduction to this memo should provide 1) relevant context for the engineering design process related to your design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your

memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically for the Gantt chart memo your introduction should set the context including descriptions of both the problem statement and your chosen design solution. The solution description should highlight key components. Then describe important aspects of 1) how your overall task was divided and sub-divided into smaller tasks (i.e. what was the strategy for this organization – design blocks, similar type of process, etc.), 2) how the order and length of time for tasks were decided, and 3) how division of labor and task leadership was decided. Be specific, yet brief in description -- providing sufficient detail, but not all the details.

For the products section, display your Gantt chart. The Gantt chart should include the start and completion dates for the following:

- Prototyping each design block and/or successive prototype
- Ordering of materials
- Testing each design block and/or assembled device
- Documentation (written and oral) for each stage of prototyping and for the course
- Any other important step your team identifies (e.g., client meetings)

The leader for each task must be noted. Use symbols to make major milestones. The figure caption can be used to orienting the reader to its symbols, pieces, and parts. This table should be legible and easy to read (i.e., 10-point font or larger). PRO TIP: print out the memo ahead of turning it in to check legibility of your chart. Make sure that it is properly formatted and the parts can be clearly distinguished. If your team used a Work Breakdown Structure to develop some tasks, this should be included in the products section as well.

Conclude this memo with key points that insightfully discuss how the process of developing this Gantt chart influenced deeper understanding of the necessary tasks to ensure completion and success of this project. For example:

1. In what ways will the chosen order of tasks influence the success of your prototype?
2. How will the team ensure that the project stays on schedule or get back on schedule if it falls behind? Be specific. **Note that it is expected that you will keep to this schedule moving forward.**
3. What tasks will present the biggest "unknowns" (i.e. uncertain of the time it will take, lack prior skills needed to complete, unsure of how to do something, etc.)?
4. Discuss key steps that are dependent or concurrent, that will require close monitoring.
5. What were the memorable moments or discussions that led to breakthroughs in process and/or products?

Remember that ALL members of the team must participate in the work to produce the products of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than two single-spaced pages, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your memo.

Self Reflection: Development of Engineering Identity

In-class Tasks

There are no in-class tasks for this memo

Out-of-class Tasks
Spend some time reflecting on your interests in academic majors and career options. Some of you may know exactly what major you will complete at Rice and which career field you hope to enter, while others of you may still be exploring all the options that are available; both ends of this spectrum and anywhere in between are ok! In thinking about majors and careers, recall the reasons you had for taking this course.

1. What major have your chosen or which majors are you considering? Why this major? What factors did/will you consider in this decision?
2. What do you plan to do when you complete your undergraduate degree? What is your ideal job? What do you think that job entails on a daily basis?
3. In what ways has this course made you more or less certain of your decision of major?
4. How are your experiences in this course are preparing you for your academic and professional careers? Give examples.
5. What is the most significant thing you have learned from participation in this course? How did you acquire/learn this skill/knowledge?
6. How does this course fit or fail to fit your perception of what an engineer does?
7. What does it mean to be an engineer? Do you consider yourself to be an engineer right now? Why or why not?
8. Do you feel like you fit this perception of what is an engineer? In what ways do you or don't you fit this perception.
9. Think of the engineering students you know. In what ways are you similar to or different from them?

Self-refection Memo #11 – Personal Identity Development

Due V1: _____
Due V2: _____
Authors: All, individually
Conferences: Sunday afternoon/evening; Peer-review sessions; ALL members attend & participate
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this self-reflection memo is to document and reflect on the development of your personal identity through the lens of this course. First, spend some time reflecting on the questions posed above. Recall your thoughts, feelings, perceptions towards choices in academic major(s), potential careers, and course selection prior to the start of this semester. Now consider your thoughts, feelings, and perceptions at this moment. Then write an expository essay reflecting on your interests in academic major(s), desires for your career, and how this course has

influenced your personal identity development as a professional in preparation for your future career. This is a personal reflection essay, but use a first-person academic writing style. Note: It is perfectly ok, if your intended major and/or career are outside of engineering.

Specifically for this SM, begin with a self-introduction, describe your interests of academic major and career, and how choosing to take this course fit into these interests. Then, describe how this course so far has influenced your interests that you had prior to the semester (i.e. How has the course/project/teamwork reinforced or changed your academic and career interests and goals?).

Follow your introduction with a reflection on how your experiences in this course are preparing you for your future career, specifically highlighting significant skills you believe may benefit you in your future.

Now that we are more than halfway through the semester, we hope that you have a fuller idea of what is an engineer and what kinds of things engineers do. Conclude your SM with some thoughts on what it means to be an engineer and in what ways do you or don't you see yourself fitting this image.

Remember that ALL members of the team will author an individual SM. For SMs adopt a style that is more narrative in nature and less technical. In particular for this essay, do not just write short answers to the questions listed above, but construct a cohesive essay with effective transitions. **This SM should be no more than two single-spaced pages**. It will be graded on a check scale, considering both the insightfulness of your reflection, and your written communication style. See attached rubric for more details. During your WM appointment, you will have a one hour facilitated peer-review session for your team.

NOTE: There are several essay contests at both the university level and national level; top essays will be considered for nomination to these competitions.

Step 7: Test/Evaluate Solution

In-class Tasks (Day 19)
Begin by pulling out your TM #3: Design Criteria. As a team, review the memo, including your design criteria and constraints. Discuss how each of these design criteria is defined.

For each design criterion, consider how a test(s) could evaluate whether a design criterion is met. In other words, generate ideas for tests that could verify your stated design criteria. Verification can be accomplished through tests or calculations; when possible, testing is preferred. For criteria that involve physical properties you may need to conduct tests that probe these properties. For example, *capacity* is a physical property of a solution that can be tested by measuring the volume or weight. Design criteria that involve feelings or opinions may require a collection of responses from people. For example, "aesthetically appealing" can be verified by surveying people with a user-defined scale. Design criteria that are for abstract characteristics may need comments from experts or indirect verification. For example, safety can be verified by soliciting comments from experts.

For each developed test, you should answer the following four questions:

1. What criterion or variable is being measured? (e.g. For a Durability D.C., the variable might be functionality of device after a drop from X feet.)
2. How will the measurement be made? (i.e., What measurement device or method for estimating or calculating will be used?)
3. How many times will a test be repeated? Justify this number.
4. Who will conduct the test and how will the clients or users be involved, if deemed necessary?

In the creation of your testing plan, be specific and numerical with each verification method. For example, durability can be tested as 'the device will survive a drop test from 5 feet for 50 times and still sustain the following critical functions of X, Y and Z.' The test description would also need to include specifics on type of surface onto which the device is dropped, what range of orientations it is dropped from, how the functions of X, Y, and Z are measured, who will do the test, etc.

Tech Memo #8 Testing Plan

Due V1:_____
Due V2:_____
Authors: Two authors, according to the schedule from TM #1
Conferences: Sunday afternoon/evening; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this memo is to clarify the tests that your team will use to evaluate whether your prototype meets the specified design criteria described in TM #3. In this memo, you will specify and elaborate on these key proposed tests.

The introduction to this memo should provide 1) relevant context for the engineering design process related to your design problem, 2) a thoughtful and comprehensive overview of your process, and 3) well defended reasons for your decisions. Following the introduction, insert the products of the engineering design process (e.g., tables, figures, drawings). These figures and tables should be labeled, captioned, and referenced in the text of the memo. Conclude your memo by succinctly capturing insightful key points from this step of the engineering design process.

Specifically, for the testing memo your introduction should set the context including descriptions of both the chosen solution and what characteristics govern its function or usage. Each design criteria should be mentioned with a short explanation. Teams should explain the important aspects of how the critical design criteria were converted into verification tests. It should be clear how your team decided where estimates would limit the precision and accuracy of your tests or calculations.

For the products section, display your proposed methods to verify the design criteria have been met. This is best communicated in a table. For each test, state:

1. What criteria or variable is being measured?
2. How will the measurement be made? i.e., What measurement device or method for estimating or calculating will be used?
3. How many times will a test be repeated? Justify this number.
4. Who will conduct the test and how will the clients or users be involved, if deemed necessary?

Conclude this memo with key points that insightfully discuss how the process of developing your testing methods influenced deeper understanding of the necessary tasks to ensure that you will deliver a successful prototype at the end of the semester.
For example:

1. In what ways will the verification tests help to further develop the most critical aspects of the prototype?
2. How will the team ensure that these tests expose real deficiencies or opportunities for prototype improvement? i.e. selecting tests that the prototype will fail multiple times through development and iteration.
3. Which tests will need to be completed at varying fidelities to verify functionality? e.g. which tests will have limited precision or accuracy for the early prototypes?
4. What were the memorable moments or discussions that led to breakthroughs in process and/or products?

Remember that ALL members of the team must participate in the work to produce the products of this step in the EDP, regardless of your authorship on the memo. For TMs, adopt a writing style that is clear, concise, and quantitative. **This TM should be no more than two single-spaced pages, not including the tables and figures**. It will be graded on a check scale, considering both the products of the engineering design process, and the written communication of the design process. See attached rubric for more details. During your WM appointment, you will have a half hour review session for your memo.

Closing: Project Completion

Assignment: Technical Memo #9 Design Solution
Due V1: "Final" time assigned by Registrar
Authors: All members of the team
Conferences: 1-2 days before TM is due; 1 or more authors must attend
Turn in: Upload to Canvas under the appropriate assignment

The Design Solution memo should report the final design solution (i.e., details and drawings on the final prototype) and relevant testing results. The memo should be 3-4 single-spaced pages long.

Begin the memo with a one paragraph overview of the motivation for your project. Briefly describe the problem and the objective of your project.

In subsequent paragraphs, clearly state the status of your team's project. The team's final prototypes should be discussed and described fully. A picture of the most recent prototype should be included; multiple pictures, with labels for key components, are appreciated. Important technical details, such as sizes, materials, fasteners, etc., should be discussed in the text. How the components fit and/or work together should be noted.

Key testing results should be included in the memo; detailed testing plans and/or results should be included in an Appendix. Test results may include any test to measure a function or an attribute against your specified design criteria. Whether your prototype meets the design criteria should be clearly stated.

Conclude the TM with one paragraph that states the strengths and limitations of your design and your final prototype.

In addition to the written component of TM #9, make a brief video showcasing your prototype. This video should show off the prototype, important features and components, and demonstrate how it works. Animations and slides may be inserted if desired. This video should be no longer than 2 minutes. Post it to Youtube and link to it in TM #9.

Remember that ALL members of the team will author this TM. For TMs, adopt a writing style that is clear, concise, and quantitative. **There is no page limit for this TM**. It will be graded to 25 points, based on the attached rubric. Clear explanations of the status of the final design solution, built prototype, and testing results are expected. During your WM appointment, you will have a half hour review session for your memo.

Self-Reflection: Team Post-mortem

In-Class Tasks
There are no in-class activities for this memo—all must be completed outside of class.

Out-of-class Tasks
In the Teaming Videos, you learned several characteristic of high performing teams (Figure 1). In class we talked about how to conduct an effective team pit-stop to evaluate current team performance and set goals for future performance. A team post-mortem is a similar activity to the pit-stop with the purpose of "learning from past experience." In the post-mortem teams carefully analyze the project once it has ended and identify what went well and what went poorly so teams can do better on subsequent projects. Another purpose of a postmortem is to give closure to a project.

Figure 1. Characteristics of High Preforming Teams.

In preparation for this memo and your final team post-mortem, which will occur during your final time, you should consider some of the following questions:

1. Consider ways in which planning had positive influences on your project outcomes.
2. In what ways did division of labor or scheduling of tasks help project completion.
3. What communication methods did your team implement and how did they promote cohesion?
4. What processes were used to make team decisions regularly and what was the result?
5. Objectively evaluate the quality of your project outcome.

Self-refection Memo #12 – Team Post-mortem

Due V1: _____("Final" time assigned by registrar)
Authors: FWIS 188 ONLY, individually
Conferences: 1-2 days before SM is due; Peer-review session; ALL members attend & participate
Turn in: Upload to Canvas under the appropriate assignment

The purpose of this self-reflection memo is to document and reflect on the team function in preparation for the team post-mortem. Post-mortems form the conclusion of an effective project and understanding your individual contributions to the team. These types of evaluations and reviews are not personal journal entries, but professional documents that may be reviewed by various members of an organization.

Specifically for this SM begin your introduction by setting the context for your team project and the team post-mortem. Follow your introduction with reflection on your team's project process, using questions 1-5 to guide you. Then describe you team and individual behaviors and actions in the team that have both positively and negatively impacted team performance and/or team dynamic. Remember this is not about your opinions or emotions, but about behaviors and actions within this team. Consider highlighting growth areas since the team pit-stop.

Conclude your SM with an insightful discussion about what decisions you will make in future teams to positively impact team and project success. Think about what you would do the same and think about what you would do differently. This is not about placing blame on yourself or others, but about objectively reviewing the group actions and the repercussion/impact of these decisions.

Remember that ALL members of the team in a FWIS section will author an individual SM. For SMs adopt a style that is more narrative in nature and less technical. In particular for this essay, do not just write short answers to the questions listed above, but construct a cohesive essay with effective transitions. **This SM should be no more than two single-spaced pages**. It will be graded on a 20-point scale, considering both the insightfulness of your reflection, and your written communication style. See attached rubric for more details. During your WM appointment, you will have a one hour facilitated peer-review session for your team.