**DESIGN PROJECT REPORT**

**ENGR 131- Transforming Ideas to Innovation I**

Section ###

[insert PROJECT TITLE]

[include an image related to the problem or your solution]

Team ##

Names of all contributing team members

E.g.,

Mary Smith

Date

[Please replace text as appropriate and delete all red text before submission. (PC01, PC05)]

# Executive Summary

*Important Note*: Section I, the executive summary, will be submitted later in the semester as part of your Final Report

An Executive Summary is a **succinct** description (max 1 page) and includes the following (PC05):

* A problem statement
* Design requirements (criteria and constraints)
* A description of the proposed solution and how it will be implemented
* An explanation of the proposed solution, its novel aspects, and how it successfully meets the need or solves the problem
* An explanation of the limitations of the solution proposed

Contents

[I. Executive Summary 2](#_Toc118892342)

[II. TEAM MEMBER ROLES 5](#_Toc118892343)

[III. PROBLEM SCOPING 6](#_Toc118892344)

[a. Problem Statement 6](#_Toc118892345)

[b. Design Criteria and Constraints 6](#_Toc118892346)

[c. Direct Users and Stakeholders 6](#_Toc118892347)

[d. Problem Finding 7](#_Toc118892348)

[e. Background Information 7](#_Toc118892349)

[f. Assumptions about the Problem 7](#_Toc118892350)

[IV. IDEA GENERATION & THOUGHT EXPERIMENTS 7](#_Toc118892351)

[a. Functional Decomposition 8](#_Toc118892352)

[b. Exploring Prior Art 9](#_Toc118892353)

[c. Sketching 9](#_Toc118892354)

[d. Low Fidelity Prototyping 10](#_Toc118892355)

[e. Biomimicry 10](#_Toc118892356)

[f. Thought Experiments with Pros and Cons Evaluation 10](#_Toc118892357)

[V. ITERATION #1 11](#_Toc118892358)

[VI. PROTOTYPING, TESTING AND WDM 11](#_Toc118892359)

[a. Prototypes 11](#_Toc118892360)

[b. Prototype Testing Protocol 11](#_Toc118892361)

[c. Test Results for Top 3 Alternatives 11](#_Toc118892362)

[d. Weighted Decision Matrix (WDM) 12](#_Toc118892363)

[VII. ITERATION #2 13](#_Toc118892364)

[VIII. OVERVIEW OF FINAL DESIGN 14](#_Toc118892365)

[a. Detailed Design 14](#_Toc118892366)

[b. Data on Final Solution 14](#_Toc118892367)

[d. Novel Aspects of the Solution 14](#_Toc118892368)

[e. Trade-off Decisions and Limitations of the Solution 14](#_Toc118892369)

[f. Lessons Learned 15](#_Toc118892370)

[IX. REFERENCES 15](#_Toc118892371)

[X. APPENDICES 15](#_Toc118892372)

[You can automatically update the Table of Contents (TOC) by clicking on the table and selecting the Update Table or Update Field option. If you add/revise headings, make sure you applied “heading styles” from the “home” menu.]

# TEAM MEMBER ROLES

[Describe contributions of team members (TW02). If a team member did not contribute in substantial ways, state with N/A (not applicable). Add each team member’s specific contributions to the corresponding section upon completion of that section. Each milestone shall contain all team member names and contributions.]

Our project team included 4 members (See Figure 1). We allocated roles and responsibilities to each team member by/based on ….

Table 1. Team roles

|  |  |  |
| --- | --- | --- |
| **Project milestones** | **Name** | **Specific responsibilities related to each milestone** |
| Problem scoping | Student 1  Student 2  Student 3  Student 4 | * . * . * . * . |
| Idea generation |  |  |
| Prototyping |  |  |
| Testing |  |  |
| WDM |  |  |
| Preliminary presentation |  |  |
| Iteration |  |  |
| Final report |  |  |
| Final presentation |  |  |

[Here, insert a team picture. Make sure the order in the picture matches the order of names above]

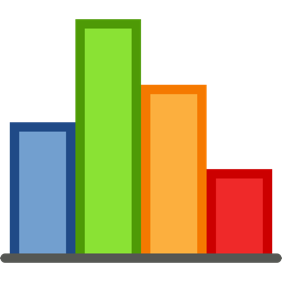


Figure 1. Project team

# PROBLEM SCOPING

[Problem scoping is an activity that occurs early in a design process but then is iterated (re-visited) throughout the design process. In problem scoping, engineers explore the problem context, gather information, and clarify the design requirements (criteria & constraints). To accomplish these, engineers engage with stakeholders (meet with client, observe or interview users, etc.).]

## Problem Statement

Describe the problem/need.

A good problem statement:

* clearly refers to a client or target users (PS01)
* clearly states the need, problem, or the focus of the project (PS01)
* explains why this need/problem/focus is important to solve (PS02)

## Design Criteria and Constraints

[Include a list of design requirements (PS03): design criteria (needs/wants your solution will address) and design constraints (what limits how you solve the problem). Some metrics may not have units]

Table 2. Design requirements

|  |  |  |
| --- | --- | --- |
| **Criteria and Constraints** | **Metrics (ways to quantify and measure the performance of your solutions and measure success)** | **Metric units** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Trade-off Considerations**

[Here add additional text recognizing potentially competing criteria and trade-offs associated with the design requirements. Consider: How might addressing one design criterion adversely affect performance on a different criterion (PS04)? For example, increasing the products’ durability may increase the product’s cost or increasing its safety may make it harder to use.]

## Direct Users and Stakeholders

[Recognize and list different user types or user segments (PS01). For example, if designing a solution for a toddler (as your direct user), you also need to consider parents as users. Your list can include direct, in-direct, primary, or secondary users. Note that an image is required for each user segment. Be sure to document the source of your images.]

Table 3. Empathizing with users

|  |  |  |
| --- | --- | --- |
| **User segment (include an image and a label)** | **Methods used to empathize with the user (interview user, survey user, observe user, read about user, simulate user behavior, put yourself in his/her shoes)** | **Lessons learned from this interaction** |
|  |  |  |
|  |  |  |
|  |  |  |

## Problem Finding

[Record your observations of the assigned location and the evidence collected from users and stakeholders at the location (SQ01). Describe how this evidence informs the identification of the major issues related to safety, accessibility, and mobility at this location (PS05). Support all claims made with the evidence that was collected (IL03). If external sources are used, don’t forget to add in-text citations and update Section X references.]

## Background Information

[Ask questions to stakeholders to determine what new information is needed to scope and understand the problem (IL01). Don’t forget to add in-text citations and update Section X references.]

Table 4. Information gathering for problem scoping

|  |  |
| --- | --- |
| **Questions asked** | **Answers to questions** |
|  |  |
|  |  |
|  |  |
|  |  |

[Add other data (charts or tables) and information that you gathered to scope the problem]

## Assumptions about the Problem

[When you need to delimit the scope of a problem or when you do not have access to specific information, you may need to make assumptions about the problem/need (EB02). Here, list any assumptions you made about the need, users, context, etc.]

# IDEA GENERATION & THOUGHT EXPERIMENTS

[Generate 8-12 unique solutions that are not readily obvious. This will mean 2-3 ideas per team member (IF01). Your list can include combinations and hybrid solutions when appropriate. Use different idea generation strategies: Functional decomposition (Figure 2), exploring prior art (Table 5), brainstorming with sketches (Table 6), low fidelity rapid prototyping (Table 7), and biomimicry (Table 8) (IF02). Make sure ideas are easy to understand and visuals convey form and function with text and labels (PC04)]

## Functional Decomposition

[Functional decomposition allows you to translate design requirements (criteria and constraints) into functions and sub-functions (as opposed to brainstorming a big picture solution). Re-visit design requirements first. Break up requirements into smaller sub-functions. By exploring sub-functions in isolation, you will be able to generate novel alternative solutions (IF02). See Figure 2 as an example and add additional figures when necessary. See <https://jzabaladesignhandbook.weebly.com/functional-decomposition.html>.

A similar approach is called Morphological charts, that allows identifying sub-functions to generate new design ideas: <https://www.youtube.com/watch?v=xzT6mpOQTTo> ]

|  |  |  |
| --- | --- | --- |
| *Main function* | *Sub-functions* | *Design ideas that meet this function* |

Figure 2. Functional decomposition for X

## Exploring Prior Art

[Explore what has already been done to solve this problem or a similar one. In Table 5, provide images and descriptions of current solutions. Describe their strengths and limitations, and then suggest improved alternatives (IF02). Don’t forget to add in-text citations and update Section X references.]

Table 5. Generating ideas by exploring prior art

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Image/Picture & Name of Prior Art** | **Strengths** | **Weaknesses** | **Improved alternative** |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |

[Again, include appropriate in–text citations (IL04) for the images of prior art and update your list of references at the end of your document (IL05). If using Google images, make sure to cite the actual website not the Google image link (IL05). Sample citation for Section X references:

* Pearson, J.L. (2001). *Smart buildings* [Photograph]. Retrieved from http://www.engineering.com
* Artist or Author (Year of image creation).  *Description or title of image*[Image format]. Retrieved from [http://www.someaddress.com](http://www.someaddress.com/full/url/)

## Sketching

[Brainstorming with sketches is one of the most common methods of idea generation (IF02). You can do this individually or collaboratively. For example, each person in your team can first sketch 2-3 ideas. Then, each passes their sketch to the person to their right to build on. This can be repeated multiple times to ensure all team members contribute to each sketch.]

Table 6. Generating ideas with sketching

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Sketch** | **Solution name** | **Unique aspects, brief description** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |

## Low Fidelity Prototyping

[Low fidelity prototypes are a quick and easy way of generating tangible models with inexpensive materials for the purpose of communicating an idea and checking its functionality (IF02). These prototypes do not focus on the visual appearance of a solution but rather focus on a function or sub-function.]

Table 7. Generating ideas with low fidelity prototyping

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Prototype picture** | **Solution name** | **Unique aspects, brief description** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |

## Biomimicry

[Also called bio-inspired design, biomimicry is a way of generating new ideas through inspiration from the natural world (IF02). With this approach, the designer focuses on a design problem or function and asks, ‘how does nature deal with this problem?’ ‘which plants or animal have this function?’ etc.]

Table 8. Generating ideas with biomimicry

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Sketch/picture/image** | **Solution name** | **Unique aspects, brief description** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

## Thought Experiments with Pros and Cons Evaluation

[Now that you have generated a long list of ideas, it is time to select some to further evaluate. To evaluate, you will conduct thought experiments. Select 6 of the solutions you generated earlier (or perhaps any new ones) to evaluate. This is a qualitative evaluation through discussion of each solution in relationship to the design criteria and constraints (EB06). Make sure to engage all team members in the discussion.]

Table 9. Thought experiments with pros and cons evaluation

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Design Alternative (include a name and an image)** | **Pros (advantages)** | **Cons (disadvantages)** |
| 1 |  |  |  |
| 2 |  |  |  |
|  |  |  |  |

# ITERATION #1

[Here describe any changes you have made based on feedback, prototyping, and/or test results (PA02/PA03)]. Summarize feedback received from other teams, instructors, and potential users

* *Illustrate*: How did your team incorporate feedback (from others, experimenting with prototypes, test results)?
* *Reflect*: Has your understanding of the problem changed? Have you made any changes to your project management or teaming process? Have you made any changes to your design process?]

Table 10. Responding to feedback

|  |  |  |
| --- | --- | --- |
| **#** | **Based on feedback/data from … about …..** | **We made changes in…by…** |
| 1 |  |  |
| 2 |  |  |

# PROTOTYPING, TESTING AND WDM

## Prototypes

[Build and describe 3 prototypes (IF03). These prototypes can represent your full solution or focus on a specific function. You need to go beyond sketches and build three **testable prototypes**. Present your prototypes in detail with clear images and figure captions (PC03). Use appropriate labels and text (PC04).]

Figure 3. Prototype 1 name

Figure 4. Prototype 2 name

Figure 5. Prototype 3 name

## Prototype Testing Protocol

[Describe your testing protocol in detail. Explain how you will measure success based on the metrics you have identified in alignment with each of the design requirements (See your Section IV.b.). Plan to conduct your tests and experiments by examining each metric separately (EB01).]

## Test Results for Top 3 Alternatives

[Present test results using tables or charts (DV04/05). Discuss the performance of each alternative on specific metrics with clear reference to data (EB03). Add new charts and tables when necessary.]

Figure 6. Testing for X

Figure 7. Testing for Y

## Weighted Decision Matrix (WDM)

[Using your testing and experimentation results above, compare each alternative systematically. Design involves a number of criteria and constraints that often compete with one another. Hence, engineers use tools to help facilitate such complex decision making. A weighted decision matrix (WDM) is one such tool. Here, you will compare 3 solutions and their performance on all design requirements.]

* You will submit an Excel spreadsheet with your WDM (DV04, PC05). Pay attention to accuracy of calculations and units (SQ01). Use automated solutions, such as cell referencing and built in functions (DV01).
* Below, justify the weights you have assigned to each design requirement and explain why some are more important than others (EB04). Alternatively, if you assigned equal weights, explain why equal weights were warranted.
* Below, also describe the design solution that performed best in comparison to the other solutions and in relation to design criteria and constraints, making explicit reference to data from your analysis (SQ02)

# ITERATION #2

[Here describe any changes you have made based on feedback, prototyping, and/or test results (PA02/PA03)]. Summarize feedback received from other teams, instructors, and potential users

* *Illustrate*: How did your team incorporate feedback (from others, experimenting with prototypes, test results)?
* *Reflect*: Has your understanding of the problem changed? Have you made any changes to your project management or teaming process? Have you made any changes to your design process?]

Table 10. Responding to feedback

|  |  |  |
| --- | --- | --- |
| **#** | **Based on feedback/data from … about …** | **We made changes in…** |
| 1 |  |  |
| 2 |  |  |

# OVERVIEW OF FINAL DESIGN

## Detailed Design

[Provide an image of a physical prototype and a CAD prototype along with a detailed description of your final solution. Make sure your images clearly illustrate form and function, with labels (PC04). Note that your final solution might be different than one of your earlier alternatives]

<insert image>

Figure 8. Physical prototype of …..

<insert image>

Figure 9. Computer-aided prototype of …..

## Data on Final Solution

[Now that you presented a detailed final solution, convince your audience that this solution effectively meets the design requirements. Present supporting data using tables or charts (EB01) (DV04/05). Use data analysis and visualization tools and techniques previously learned in class. Discuss the performance of your final solution on specific metrics with clear reference to data (EB03). Add new charts and tables when necessary. Note that your final solution might be different than one of your earlier alternatives. Your goal is to provide convincing evidence that your solution effectively meets the design requirements and solves the problem.]

Figure 10. Testing for X

Figure 11. Testing for Y

1. **Design Optimization**

[Describe your efforts in optimizing your solution (EB05)]

## Novel Aspects of the Solution

[Describe novel aspects of your solution (SQ04)]

## Trade-off Decisions and Limitations of the Solution

[All design involves trade-offs. Here, explicitly state your team’s trade-off decisions (SQ03). Given that you had only 4 weeks to develop a solution, your solution will have certain limitations. Here, recognize and describe these limitations (SQ03). In particular, pay attention to any unexpected new problems that can potentially occur with the implementation of your proposed solution (EE02). Provide recommendations for improving your solution given more time and resources.]

## Lessons Learned

[This is your opportunity to reflect on your learning as a team. Discuss strengths in your problem solving and design process and describe strategies you used effectively (PA01). Also recognize areas that can be improved (PA03). You can refer to your iterations, major changes in your approaches to your design or thinking about the problem (PA02).

Describe any changes you could make to your problem solving, teaming, or approach to the design process based on reflection, feedback, prototyping, and/or test results (PA02). Note, this is not asking about changes you would make to your design, itself, but rather asking you to reflect on the process and skills you will carry on to future projects.]

# REFERENCES

[Insert references following the APA formatting guidelines (IL05)]

# APPENDICES

[optional- here you can provide any additional documents that you want to share]