VCU College of Engineering

CS 25-301

Community Fridges Usage Data Acquisition

Project Proposal

Prepared for

Taylor Scott

RVA Community Fridges

By

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Under the supervision of

Dr. Daniel Cranston

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Executive Summary

In Richmond, Virginia 20.3% of city residents experience some level of food insecurity, which is much higher than the 14.3% of citizens across America who share that experience [3]. RVA Community Fridges is a 501(c)(3) backed mutual aid group that aims to address food insecurity by creating space for community members to support each other out of abundance. While addressing food insecurity is merely an indirect objective of this VCU Senior Capstone project, it is a core motivation for the students involved.

Providing and maintaining public refrigerators, pantries, and food to fill them is a costly mission that requires significant coordination between hundreds of community members. RVA Community Fridges (RVACF) currently follows a manual process of collecting usage data on fridges, where community members might post a picture of the inside of a fridge to the RVACF Discord server or denoting how full the fridge is on the RVACF website. This makes it difficult to articulate credible general usage data in grants, as well as creates challenges for community members to perform responsive maintenance on refrigerators.

In this VCU CS Senior Capstone Project, students aim to serve RVACF by engineering a solution to automate data usage monitoring in a manner that is useful to community members and organization leaders. An ideal solution strikes the perfect balance of being cost effective, robust to the elements, discreet, requiring low maintenance, and as informative as possible about the current condition of a community refrigerator.

Note: The Executive Summary should be updated between major reports as more knowledge is acquired and understanding of the project expands. For example, when submitting Preliminary Design Report in December 2024, make sure you update this page to reflect the progress on the project since the submission of Project Proposal in early October 2024.

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Section A. Problem Statement

RVACF's challenge of refrigerator telemetry is anything but trivial. There are numerous design considerations that must be accounted for from cost to robustness. Since other community fridge programs exist throughout the United States, the first question the team asked was, "What are other organizations doing to tackle this issue?" The team reached out to these other programs across the nation, and found that strategies for data collection were limited to online form completion by community volunteers, indicating that no well-fitted, pre-existing solution exists. The next question that must be answered is, "What *kind* of solution is most appropriate?", to which the natural answer is an internet-of-things (IoT) device. The IoT domain is the industry's first choice for any problem requiring cost-effective computing solutions for collecting sensor data. [4]

Design of a Telemetry Device

The first and primary problem that must be addressed by this Capstone project is to *design and implement a device that collects data relevant to the stakeholders.* This problem can be further broken down into subproblems, outlined below.

Who are the stakeholders?

The stakeholders in this project include any individual or organization which could stand to benefit from the data collected by the proposed telemetry device. This includes, first and foremost, the project sponsor Taylor Scott at RVACF, and all community volunteers involved in that particular organization. Secondarily, community fridge organizations across the nation may also benefit from our proposed solution. Indirectly, yet perhaps most importantly, anyone who is affected by food insecurity stands to benefit from this project.

What data is relevant to collect?

The primary purpose of this project is to collect data that may secure funding for RVACF. The data collected will be presented to larger organizations that may provide grants to address food insecurity, and typically the most critical data to be provided are either *volume of food* served by RVACF or *number of people* served by RVACF. A solution for data collection must provide one or both of these types of information. It may be trivial to add additional sensors to an IoT package to collect data that secondarily helps community volunteers identify issues with refrigerators (such as an out-of-temp refrigerator), resulting in a more focused maintenance effort of community fridges. Any data collected can be used for multiple purposes, beyond those listed in this document.

How can cost be minimized?

There are numerous cost-effective IoT solutions that can be combined into a single telemetry device, however the single biggest cost to consider is *recurring costs*. An ideal solution should have a minimal recurring cost. RVACF's fridges are positioned outdoors, on property owned and maintained by small-businesses who support the cause. In most (if not all) cases, these small-businesses allow RVACF to place these refrigerators on their property *for free*. An important cost consideration for our team is *the cost of data transmission,* as this is typically a recurring expense, so minimizing this cost is another problem for the Capstone team to solve.

Subsequent Problems

After a telemetry device has been implemented, the team will implement auxiliary solutions so the devices can be most useful to RVACF and community volunteers. A pipeline for the data must be constructed. How/where will the data be stored? How should the data be presented to stakeholders? How can the team integrate the data into software already in use by the organization, such as the organization's website or Discord server?

The Problem Domain: Internet-of-Things

Integrating physical objects (such as refrigerators) into the internet has been a concept since as early as 1982, when programmers at Carnegie Mellon University connected a Coke machine to the network in order to report inventory, and whether recently stocked drinks were cold yet [4]. It has since evolved into its own field, leading to the commercial industry that we know today – featuring products like smart light bulbs, thermostats, and of course, refrigerators.

There are numerous academic papers that have been written about designing IoT refrigerators using DIY electronics [7] [8] [9], which indicates that similar efforts have been undertaken with generally successful results. The key difference between the work done in these papers and this VCU Senior Capstone is the data transmission component, since one of the team's objectives is to design a solution that is independent of local WiFi networks in order to abstain from dependence on local businesses for the operation of these devices as much as possible.

Section B. Engineering Design Requirements

At present, RVACF has no automated system for tracking fridge usage across its network. All information on food pickups and fridge conditions is gathered manually by volunteers, who report updates via the community Discord. This reliance on manual reporting creates gaps in communication, especially regarding fridge maintenance, where issues may go unnoticed until the next food drop-off. An automated system to notify community members of fridge status would significantly improve volunteer coordination and fridge maintenance, ensuring that faulty fridges are addressed promptly. Additionally, tracking fridge usage would provide valuable insights into how the RVACF network is serving the community and support efforts to expand its impact.

B.1 Project Goals (i.e. Client Needs)

- To design a fast and convenient way to track usage data of fridges across the RVACF network
- To provide a more convenient way of detecting and notifying issues relating to fridge maintenance
- To create an accurate method for measuring the capacity of fridges for community volunteers
- To establish a system for monitoring fridge cleanliness and ensuring regular sanitary maintenance

B.2 Design Objectives

- Low power consumption of LoRa devices will ensure that fridges can still work at their optimal functionality
- The design will ensure that cost of operations can be replicated if needed
- The design will prioritize low recurring data transmission costs to ensure consistent operation and minimize the risk of service interruptions due to insufficient funding
- The design will create a local network of LoRa devices for transmission of relevant data
- The design will ensure accurate measurements of fridge utilization
- The design will minimize the need for human intervention and frequent maintenance of data transmission devices
- The design will be scalable, enabling the efficient collection of extensive usage data across all fridges in the RVACF network

B.3 Design Specifications and Constraints

Design Concern 1 — Consumption

Specification 1: The power drawn for devices in the fridge must not exceed 15% of the overall fridge manufactured power.

Design Objective: Ensures the fridge can still work at its optimal performance and effectively preserves the content without disruption.

Design Concern 2 — Expenditures

Specification 1: The maximum budget allocated for any single fridge must not exceed $100.

Design Objective: Ensures the cost of operations can be replicated if needed.

Specification 2: The monthly budget for the GSM phone plan must not exceed $25.

Design Objective: Keeping a low recurring fee minimizes the chances of fridge data transmission being stopped due to funds.

Design Concern 3 — Reliable

Specification 1: The LoRa device has to be able to communicate at a distance of up to five kilometers of another LoRa device.

Design Objective: Allows for creating a local network of LoRa devices that can transmit relevant data.

Specification 2: The local network of LoRa devices has to transmit data at least once every 6 hours.

Design Objective: Ensures accurate measurements of fridges utilization.

Specification 3: Data transmission from any LoRa device should be measured to have 100% accuracy, maintaining the integrity of the transmission data for all measurements.

Design Objective: Since data is sensitive to bit error, thorough checks after transmission will ensure correct metrics for fridge utilization.

Design Concern 4 — Robustness

Specification 1: Any modifications done to a fridge has to be durable enough to withstand the environmental conditions for at least 1 year.

Design Objective: Ensures maintenance of device setup will function without supervision and frequent fixing.

Design Concern 5 — Scalable

Specification 1: The design has to be able to be implemented in all 14 fridges, including any fridge that is added to the RVACF.

Design Objective: Ensures for further measurements of utilization.

B.4 Codes and Standards

Codes

- *FCC Part 15.247 : Frequency Hopping Spread Spectrum (FHSS)*
- *FCC Part 15.247 - Digital Modulation*
- *FCC Part 15.249 : All Other Transmission in the 900MHz Range*
- *UL 60335-2-24: Refrigerating Appliances*

Standards

- *TS009-1.2.1 Certification Protocol*
- *TS001-1.0.4 LoRaWAN® L2 1.0.4 Specification*
- *TS011-1.0.1 Relay*

Section C. Scope of Work

The scope of this capstone project includes designing and implementing a system that monitors community fridges across Richmond, transmitting usage data from 14 individual fridges to a central server on VCU's Monroe Park Campus. This project will involve integrating IoT devices like door sensors, food scales, and fridge thermometers on a LoRa communication network to track fridge usage. The solution aims to provide daily insights on food availability and fridge usage patterns, supporting better management of resources by the RVACF organization and providing them with data to use for additional funding. We will also build a simple, user-friendly visualization of the fridge usage data of the RVACF website so community members can see which fridge has available food. Some tasks that fall outside of our scope include fridge repair and food distribution to fridges. Our team will follow an agile development approach, with weekly advisor meetings, weekly team meetings, and sponsor meetings as needed. Available funds include the initial $1000 budget given to all Capstone teams, funding from the Sternheimer award if received, and grant money from Dr. John Jones.

C.1 Deliverables

Promised Deliverables:

- Functional IoT system for daily fridge monitoring including door sensors, fridge scales, and temperature sensors
- Centralized server with a database for storing usage statistics
- Dashboard on RVACF website for data visualization
- Detailed documentation on the LoRa devices, including installation instructions for future fridges.

Potential Obstacles:

- Installing sensors and other devices require physical presence at fridges. Team members need to efficiently communicate with each other to determine availability for installation, especially if installation requires another person with a technical background other than computer science.

- Working with LoRa devices requires a steep learning curve, so a significant amount of time must be spent early on learning how to work with the hardware, and how the hardware communicates with each other. This includes becoming familiar with the programming language and IDE associated with the LoRa devices.
- Securing the devices and sensors in the fridge is a top concern. The team must devise effective methods to conceal, secure, or position the sensors in a way that prevents tampering or interference by users, while still allowing the devices to function accurately

C.2 Milestones

Project Timeline

- **August 2024**: Initial solutions brainstorming, assigning team roles
- **September 2024**: Meeting project sponsor, LoRa research, setting up LoRa devices
- **October 2024**: LoRa research, Sternheimer Award process, testing LoRa device communication, RVACF Volunteer Meetings
- **November 2024**: Sternheimer Award process, setting up server on VCU campus. testing solution on initial fridge, modifying solution if needed based on initial testing
- **December 2024**: Conclude fall semester work and prepare for the spring semester
- **January 2025 to March 2025**: Expand our solution to the rest of the fridges, begin work with data visualization of RVACF website
- **March 2025**: Capstone Expo preparation, continue work on data visualization
- **April 2025**: Capstone Expo preparation, finalizing project, Expo presentation

Hard Deadlines (Fall Semester):

- **September 6**: Team Contract
- **October 4**: Sternheimer Proof of Concept
- **October 11**: Proposal Proposal
- **November 12**: Sternheimer Completed Application (if selected)
- **November 15**: Fall Design Poster
- **November 15**: Sternheimer Presentation (if selected)
- **December 9**: Preliminary Design Report

C.3 Resources

- MakerFocus Development Board
- Breadboard Kit
- Mobile phone for Petersburg fridge
- LoRa temperature sensor
- Fridge scale

Section D. Concept Generation

A number of methods can be used to help generate design concepts from simple reflection and brainstorming, to working the problem backwards, using reverse thinking techniques, and looking to nature for inspiration (i.e. biomimicry). Existing solutions, or components of existing solutions, can be substituted, combined, adapted, modified, put to other uses, eliminated, or rearranged to meet new design objectives and specifications. A minimum of 3 overall design concepts is required for this section although more are welcome. Provide a brief description of how each design concept addresses the design problem. Discuss the potential pros and cons, including and potential risks of failure, of each of these concepts.

It is likely that each design concept may consist of several components. In this case, one or more of these components may offer a sub-problem that can be further explored, modified, or otherwise improved upon. These sub-problems may lead to the addition of several additional design concepts and may require the inclusion of a design concept chart or matrix to organize all ideas and potential solutions.

Provide any initial design sketches, drawings, 3D renderings, or conceptual models such as dataflow diagrams, process flows, etc. developed during the concept ideation phase. All hand drawings should be drawn to scale using basic engineering drafting tools (i.e. ruler, protractor, and compass). Geometric stencils can also be used to help produce quality hand drawings. Drawings should be presented in a profession manner, preferably done on engineering graph paper and using a high-quality scan. All sketches should be labeled to identify major components and different drawing views or projections if applicable. Basic dimensions should be provided to give a general sense of scale. Label each sketch or drawing with the name of the team member responsible for the sketch, the date it was drawn, and the drawing scale.

Section E. Concept Evaluation and Selection

Using a systematic decision-making process, evaluate each of the design concepts and choose the one that is most likely to succeed in meeting the design objectives and constraints. A Decision Matrix, or Pugh Matrix, helps to analyze alternatives, eliminate biases, and make rational decisions through thought and structure. First, work to develop a set of selection criteria for which to evaluate the previously generated design concepts. Selection criteria often include concepts of performance, cost, safety, reliability, risk, etc. Note that the selection criteria developed here will likely be more general than the project design objectives. As with the design objectives, conversations with the client help define appropriate selection criteria.

In many cases, the client may value the selection criteria differently, preferring that more emphasis be placed on some than others. In this case, weighting factors may be used to place more or less importance on the various criteria in the decision making process. Again, conversations with the client can be used to define criteria weighting factors. Often times, these conversations must be analyzed and interpreted by the team to determine which criteria are more important to the client and by how much. Feel free to discuss the assigned weighting factors with the client to see if they seem accurate.

Next, define an associated metric to represent each criteria. Metrics should be specific and quantifiable, providing numerical values that quantify the often vague concepts of the selection criteria. Metrics can be obtained, generated, or estimated through a number of methods including simple background research, preliminary design calculations, or basic analyses. Note that these metrics do not need to specifically align with the design specifications although there may be some commonality between the two. Provide a brief discussion of the rationale for selecting each of the assigned metrics.

Using the defined metrics, evaluated each design concept against all selection criteria by filling out a Decision Matrix. Design concepts can be compared by using simple rank scoring, raw scoring, or weighted scoring techniques and design concept with which to move forward can be selected. This type of process provides a meaningful, unbiased means for choosing a preliminary design concept prior to moving forward with more comprehensive, detailed analyses as provided in the design methodology section below. The results of this process should be discussed with the project client prior to moving forward with the selected design. Table 1 provides an example of a simple decision matrix.

Table 1. Example of a Decision Matrix.

	Design Concept A	Design Concept B	Design Concept C	Design Concept D
Criteria 1				
Criteria 2				
Criteria 3				
Criteria 4				
Criteria 5				
Total Score				

Note: Weights can be assigned to each criterion if desired.

Section F. Design Methodology

Provide a detailed explanation of the methods that will be used to help evaluate, improve, and evolve the design through the iterative engineering design process. Consider that ultimately, the final design must be verified and validated to ensure that it meets all of the previously developed and listed design objectives and specifications. Verification ensures that the design meets all specification, while validation confirms that the design functions as intended such to meet the client's needs. While it is common for initial design concepts to first be evaluated using simplified design criteria and metrics, the chosen design should be advanced, and later verified, using engineering calculations, computational models, experimental data, and/or testing procedures.

Use this section to describe any underlying physical principles and mathematical equations that govern the design. Provide details of any computer-aided modeling techniques used to evaluate the design including the software used, prescribed boundary conditions, and assumptions. Include a detailed description of any experimental testing methods including required testing equipment, test set-up layout, data acquisition and instrumentation, and testing procedures. If one or more prototypes is to be produced and tested, provide a detailed description of how each will be evaluated.

Note: The contents of this section are expected to vary from project to project. Subsections may be appropriate for providing details of analytical, computational, experimental, and/or testing methods. Some potential subsections that may be included in this section are provided. While critical design equations may be provided here, lengthy mathematical derivations may be included in an appendix. Validation procedures are critical and all projects should address such topic.

F.1 Computational Methods (e.g. FEA or CFD Modeling, example sub-section)

F.2 Experimental Methods (example subsection)

F.3 Architecture/High-level Design (example subsection)

F.5 Validation Procedure

Describe how the design team will validate that the final design meets the client's needs. This section should include a plan to meet with the client towards the end of the project to discuss final design details and demonstrate a prototype, experimental test, and/or simulation results. Provide a relative time frame for this validation to occur (e.g. "mid-March" or “early-April”). Include a brief discussion on how client feedback will be captured, such as a formal survey, interview, or observation notes of the client using the prototype. It may also include plans to solicit feedback from other stakeholders and/or potential users.

Section G. Results and Design Details

Use this section to highlight the major results of the design methodology described above including important analytical, computational, experimental, modeling, assembly, and testing results. This section should be one of the most substantial sections of the report showcasing all of the hard work and effort that went into the completion of the final design and delivery of the project deliverables. Show how the identified problem was solved.

Highlight the prominent features of the final design through analysis results, modeling, drawings, renderings, circuit schematics, instrumentation diagrams, flow and piping diagrams, etc. to show that the design functions as intended and meets all design objectives and constraints. Overview designs such as dataflow diagrams, process flow, swim lane diagrams, as well as presentation-layer designs (e.g. storyboards for front-ends) should be included here. Detailed designs such as database designs, software designs, procedure flowcharts, or pseudocode should be included here. Support computational and experimental results with key plots and figures. All supporting figures should be clearly labeled and annotated to highlight the most important points of the figure (i.e. explicitly point out what the reader should focus on or understand about the image).

Note that while all results should be used to help inform design decisions, not all results may be necessary to include in the main body of the report. Extraneous supporting results (e.g. graphs, data, design renderings, drawings, etc.) that are not necessary for presenting the fundamental findings can be placed in one or more appendices. Detailed documentation of each program module can be provided as appendix.

G.1 Modeling Results (example subsection)

G.2 Experimental Results (example subsection)

G.3 Prototyping and Testing Results (example subsection)

G.4. Final Design Details/Specifications (example subsection)

Note that while the design constraints and specifications may have provided minimum or maximum values, or ranges or values, that the design needed to meet, the final design specifications should be listed here showing that the required design values were met. A list of final design details can also be included demonstrate fulfillment of the design objectives.

Note: Preliminary results should be included in the Preliminary Design Report to show the progress made of the selected design concept to-date. This section should be updated for the Final Design Report to include documentation of all of the work that was completed on the project throughout the entirety of the academic year.

Section H. Societal Impacts of Design

In addition to technical design considerations, contemporary engineers must consider the broader impacts that their design choices have on the world around them. These impacts include the consideration of public health, safety, and welfare as well as the potential societal, political/regulatory, economic, environmental, global, and ethical impacts of the design. As appropriate for the project design, discuss how each of these considerations influenced design choices in separate subsections. How will the design change the way people interact with each other? What are the political implications of the design? Does the technology have the potential to impact or shift markets? Does the design have any positive or negative effects on the environment? Don't forget to consider unintended consequences such as process or manufacturing byproducts. What impacts might the design have on global markets and trade? Are there any ethical questions related to the design?

While it is hard to forecast the various impacts of a technology, it is important to consider these potential impacts throughout the engineering design process. When considered during the early stages of the design phase, consideration of these impacts can help determine design objectives, constraints, and specifications and help drive design choices that may mitigate any potential negative impacts or unintended consequences.

Note: A minimum of 4 of these design considerations, including the consideration of public health, safety, and welfare, are required for the Preliminary Design Report while a section for all considerations must be included in the final design report.

H.1 Public Health, Safety, and Welfare

Provide a list of all design safety features and provide a brief description of each. Discuss the potential effects the design may have on public health, safety, and welfare. References to the codes and standards previous provided and the organizations that produced them may be summarized or referenced here.

H.2 Societal Impacts

H.3 Political/Regulatory Impacts

H.4. Economic Impacts

H.5 Environmental Impacts

H.6 Global Impacts

H.7. Ethical Considerations

Section I. Cost Analysis

Provide a simple cost analysis of the project that includes a list of all expenditures related to the project. If an experimental test set-up or prototype was developed, provide a Bill of Materials that includes part numbers, vendor names, unit costs, quantity, total costs, delivery times, dates received, etc. Do not forget to include all manufacturing costs incurred throughout the completion of the project. If the design is expected to become a commercial product, provide a production cost estimate including fixed capital, raw materials, manufacturing (including tooling and/or casting), and labor costs to produce and package the device. Note that this type of detailed cost analysis may be listed as a project deliverable.

Note: The Preliminary Design Report should include all costs incurred to date. It is expected that this section will be expanded and updated between the preliminary and final design reports.

Section J. Conclusions and Recommendations

Use this section to summarize the story of how the design team arrived at the final design. Focus on the evolution of the design through the use of the engineering design process including lessons learned, obstacles overcome, and triumphs of the final design. Revisit the primary project goals and objectives. Provide a brief summary of the final design details and features paramount to the function of the design in meeting these goals and objectives.

A discussion may be included to discuss how the design could be further advanced or improved in the future. If applicable, summarize any questions or curiosities that the final results/design of this effort bring to mind or leave unanswered. If this project might continue on as a future (continuation) senior design project, detail the major milestones that have been completed to date and include any suggested testing plans, relevant machine drawings, electrical schematics, developed computer code, etc. All relevant information should be included in this section such that future researchers could pick up the project and advance the work in as seamless a manner as possible. Documents such as drawings, schematics, and codes could be referenced here and included in one or more appendix. If digital files are critical for future work, they should be saved on a thumb drive, external hard drive, cloud, etc. and left in the hands of the project advisor and/or client.

Appendix 1: Project Timeline

Provide a Gantt chart of similarly composed visual timeline showing the start and end dates of all completed tasks and how they are grouped together, overlapped, and linked together. Include all senior design requirements including design reports and Expo materials (i.e. Abstract, Poster, and Presentation). All major milestones should be included in the timeline.

Appendix 2: Team Contract (i.e. Team Organization)

Step 1: Get to Know One Another. Gather Basic Information.

Task: This initial time together is important to form a strong team dynamic and get to know each other more as people outside of class time. Consider ways to develop positive working relationships with others, while remaining open and personal. Learn each other's strengths and discuss good/bad team experiences. This is also a good opportunity to start to better understand each other's communication and working styles.

Team Member Name	***Strengths each member bring to the group***	***Other Info***	***Contact Info***
Ethan Leyden	Communication, leadership experience, programming.	Experience working with large datasets and building NLP models, experience maintaining websites	leydene@vcu.edu 704-500-5351 etleyden@gmail.com
Jermane Jackson	Programming, problem solving	Experience with full stack web development and deployment, most used/favorite language is Python	jacksonja13@vcu.edu
Damian Ashjian	Communication, programming, problem-solving	Experience building interfaces for web apps, strong Java and Python experience	ashjianda@vcu.edu 804-514-2509 ashjianda@gmail.com
Khuong Nguyen	Communication, programming	Experience working with SQL and Python for webscraping, intermediate experience with Java and Python	nguyenk20@vcu.edu

Other Stakeholders	***Notes***	***Contact Info***
Dr. Daniel Cranston		*dcranston@vcu.edu*
Taylor Scott		rvafridgeoutreach@gmail.com or vacommunityfridges@gmail.com

Step 2: Team Culture. Clarify the Group's Purpose and Culture Goals.

Task: Discuss how each team member wants to be treated to encourage them to make valuable contributions to the group and how each team member would like to feel recognized for their efforts. Discuss how the team will foster an environment where each team member feels they are accountable for their actions and the way they contribute to the project. These are your Culture Goals (left column). How do the students demonstrate these culture goals? These are your Actions (middle column). Finally, how do students deviate from the team's culture goals? What are ways that other team members can notice when that culture goal is no longer being honored in team dynamics? These are your Warning Signs (right column).

Resources: More information and an example Team Culture can be found in the Biodesign Student Guide "Intentional Teamwork" page (webpage | PDF)

Culture Goals	***Actions***	***Warning Signs***
Keep expectations clear	- Maintain detailed to-do list each week - Track what you've worked on/completed throughout the week	- Vague outline of plans for the week, leaving room for poor performance - No documentation of achievements
Being open-minded	- Take into consideration teammates ideas and feelings - Ask questions when you do not understand concepts	- Teammates withdraw from conversations - Teammates use words like "bad" or "stupid"
Follow through on commitment	- Meet deadlines and fulfill goals/requirements - Communicate with the team when you will be unable to fulfill a commitment that you made	- Student shows up for weekly meeting with no considerable work done - Student has been stuck on the same goal or deliverable for a long time without any follow up or communication

Step 3: Time Commitments, Meeting Structure, and Communication

Task: Discuss the anticipated time commitments for the group project. Consider the following questions (don't answer these questions in the box below):

- What are reasonable time commitments for everyone to invest in this project?
- What other activities and commitments do group members have in their lives?
- How will we communicate with each other?
- When will we meet as a team? Where will we meet? How Often?
- Who will run the meetings? Will there be an assigned team leader or scribe? Does that position rotate or will same person take on that role for the duration of the project?

Required: How often you will meet with your faculty advisor advisor, where you will meet, and how the meetings will be conducted. Who arranges these meetings?
See examples below.

Meeting Participants	***Frequency Dates and Times / Locations***	***Meeting Goals Responsible Party***
Students Only	*As needed in Discord*	*Give updates on work progress, especially if there are roadblocks to completing deliverables.*
Students Only	*Every Thursday from 6pm-6:50pm, location TBD each week.*	*Actively work on the project, and discuss what the team should be working on individually.*
Students + Faculty advisor	*Every Tuesday from 11am-12pm in East Hall of Engineering Room E4310*	*Update faculty advisor and get answers to our questions. Ethan will recap each meeting in*
Project Sponsor	*As needed during Tuesday meetings, or periodically over email*	*Significant updates on project progress, or for feedback on potential ideas*

Step 4: Determine Individual Roles and Responsibilities

Task: As part of the Capstone Team experience, each member will take on a leadership role, ***in addition to*** contributing to the overall weekly action items for the project. Some common leadership roles for Capstone projects are listed below. Other roles may be assigned with approval of your faculty advisor as deemed fit for the project. For the entirety of the project, you should communicate progress to your advisor specifically with regard to your role.

- **Before meeting with your team**, take some time to ask yourself: what is my "natural" role in this group (strengths)? How can I use this experience to help me grow and develop more?
- **As a group,** discuss the various tasks needed for the project and role preferences. Then assign roles in the table on the next page. Try to create a team dynamic that is fair and equitable, while promoting the strengths of each member.

Common Leadership Roles for Capstone

1. **Project Manager:** Manages all tasks; develops overall schedule for project; writes agendas and runs meetings; reviews and monitors individual action items; creates an environment where team members are respected, take risks and feel safe expressing their ideas.
   Required: On Edusourced, under the Team tab, make sure that this student is assigned the Project Manager role. This is required so that Capstone program staff can easily identify a single contact person, especially for items like Purchasing and Receiving project supplies.
2. **Logistics Manager:** coordinates all internal and external interactions; lead in establishing contact within and outside of organization, following up on communication of commitments, obtaining information for the team; documents meeting minutes; manages facility and resource usage.
3. **Financial Manager:** researches/benchmarks technical purchases and acquisitions; conducts pricing analysis and budget justifications on proposed purchases; carries out team purchase requests; monitors team budget.
4. **Systems Engineer:** analyzes Client initial design specification and leads establishment of product specifications; monitors, coordinates and manages integration of sub-systems in the prototype; develops and recommends system architecture and manages product interfaces.
5. **Test Engineer:** oversees experimental design, test plan, procedures and data analysis; acquires data acquisition equipment and any necessary software; establishes test protocols and schedules; oversees statistical analysis of results; leads presentation of experimental finding and resulting recommendations.
6. **Manufacturing Engineer:** coordinates all fabrication required to meet final prototype requirements; oversees that all engineering drawings meet the requirements of machine shop or vendor; reviews designs to ensure design for manufacturing; determines realistic timing for fabrication and quality; develops schedule for all manufacturing.

Team Member	***Role(s)***	***Responsibilities***
Ethan Leyden	Project Manager	✔ Develops overall schedule for the project ✔ Writes agendas and runs meetings ✔ Reviews and monitors action items ✔ Create an environment where team members are respected and feel safe expressing ideas ✔
Jermane Jackson	Financial Manager	✔ Keeps track of finances ✔ Emails sponsors and advisor for purchases ✔ ✔ ✔
Damian Ashjian	Logistics Manager Front-end Engineer	✔ Sends emails to sponsor/advisor; communicates responses to team ✔ Planning and design for any front-end applications
Khuong Nguyen	Test Engineer	✔ Oversees test plan, procedures, and data analysis ✔ Acquires any necessary software, as well as test protocols and schedules. ✔ Leads presentation of experimental finding and resulting recommendations.

Step 5: Agree to the above team contract

Team Member: Ethan Leyden *Signature: Ethan Leyden*

Team Member: Jermane Jackson *Signature: Jermane A Jackson*

Team Member: Damian Ashjian *Signature: Damian Ashjian*

Team Member: Khuong Nguyen *Signature: Khuong Nguyen*

Appendix 3: [Insert Appendix Title]

Note that additional appendices may be added as needed. Appendices are used for supplementary material considered or used in the design process but not necessary for understanding the fundamental design or results. Lengthy mathematical derivations, ancillary results (e.g. data sets, plots), and detailed mechanical drawings are examples of items that might be placed in an appendix. Multiple appendices may be used to delineate topics and can be labeled using letters or numbers. Each appendix should start on a new page. Reference each appendix and the information it contains in the main text of the report where appropriate.

Note: Delete this page if no additional appendices are included.

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