

Project Deliverable E:
Project Plan and Cost Estimate

Group 16: The Sample Snatchers

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Abstract

This report provides the team's project task plan, prototyping plan, and cost estimation for the development of prototypes. The objectives met were establishing a clear and detailed schedule for completing three iterative prototypes while maintaining within the specified budget and managing resources effectively. The document includes a refined concept design, a comprehensive bill of materials (BOM), and a breakdown of the required equipment. Moreover, the detailed prototyping test plan outlines key objectives, analytical methodologies, and stopping criteria while responding to the general how, why, when, and what. The team task plan describes specific tasks to develop prototype one and test the sampling method of the device. Additional project timeline management is managed through Trello and Gannt charts, allowing for any adjustments and updates.

This report serves as a map to guide the team from the initially selected concept to multiple prototypes to receive feedback to refine and improve iteratively. Further instructions for developing additional prototypes will be created to ensure design efficiency and reliability.

1.0 Introduction

1.1 Purpose

The report outlines the structured procedure the team will follow to develop, document, and complete a minimum of three project prototypes by Design Day. As the team progresses into the prototyping and testing phase of the Design Thinking process, it is essential to establish a clear and detailed plan to ensure efficiency and feasibility.

1.2 Structural Overview

This document provides a comprehensive breakdown of the chosen concept, including critical features such as the sampling, containment, and movement systems.

The team will outline a plan and schedule for prototyping and testing. This plan will include an extensive list of tasks, an estimated time duration, and assigned responsibilities. Throughout these phases, all significant project risks are further evaluated. An additional prototyping test plan will describe the prototype's tests, including critical issues, objectives, test descriptions, analysis methods, results, a stopping criterion, etc.

As the team considers the \$100.00 budget provided for the project's completion, we have outlined the estimated costs and components of the materials in a Bill of Materials (BOM) based on the detailed concept design. Additionally, the team has considered all of the equipment that may be required to build each prototype.

Overall, the team will apply these plans from now until the end of the project to meet all analytical requirements and critical components during these two phases: prototype and test.

Lastly, the team will update and refine the project schedule using a Trello/Gantt Chart to ensure alignment with project objectives. The necessary adjustments will be made to task timelines, ownership, and subtasks.

2.0 Detailed Design Drawing

2.1 Chosen Concept

The inflatable tube device was the concept chosen to proceed with. The group found this device the most versatile for prototyping, allowing us to switch to different ideas or concepts without issue. For now, CAD modelling and prototypes will be used to pursue this concept.

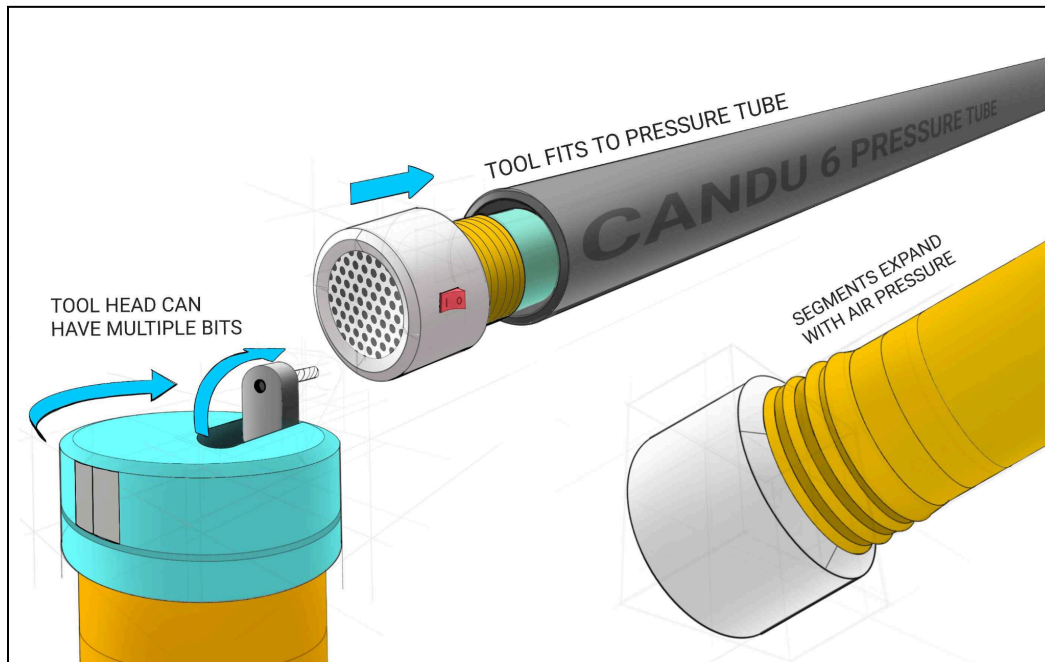


Figure 2.1-1: Inflatable Tube Concept Drawing

2.2 Refined Concept Design

Our original concept, described in section 2.2, underwent design modifications. The tool head assembly (Figure 2.2-1) was altered from a cylindrical design to a more rectangular box shape. This allows more room in the interior of the assembly for other components, such as a load cell, scraping tool, and sample container. The flatter design also makes it easier to mount components within the assembly.

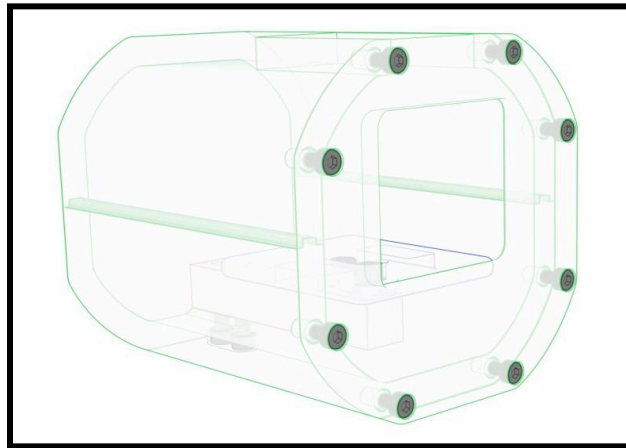


Figure 2.2-1: Tool Head Assembly

The air compressor base (figure 2.2-2) was altered to include screws and screw holes to show the assembly of this part. A power connector was added to the side of the part to indicate a connection to an external power supply.



Figure 2.2-2: Air Compressor Base

The orthogonal view of the inflation device (Figure 2.2-3) further depicts the air compressor base and how its components must extend into the pressure tube to support the components inside. This makes it easier for the user to collect the sample of the tool head without direct contact, as when the tool head is retracted, the structure will be limp. This collar will allow it to be supported so the user only has to handle the base.

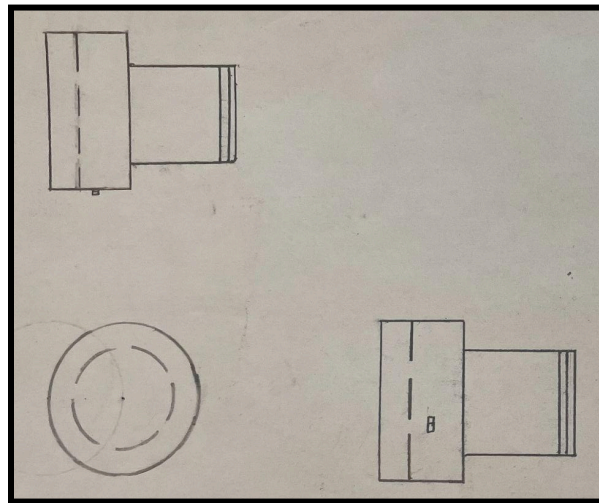


Figure 2.2-3: Orthogonal view of inflation device

2.3 Technical Drawing

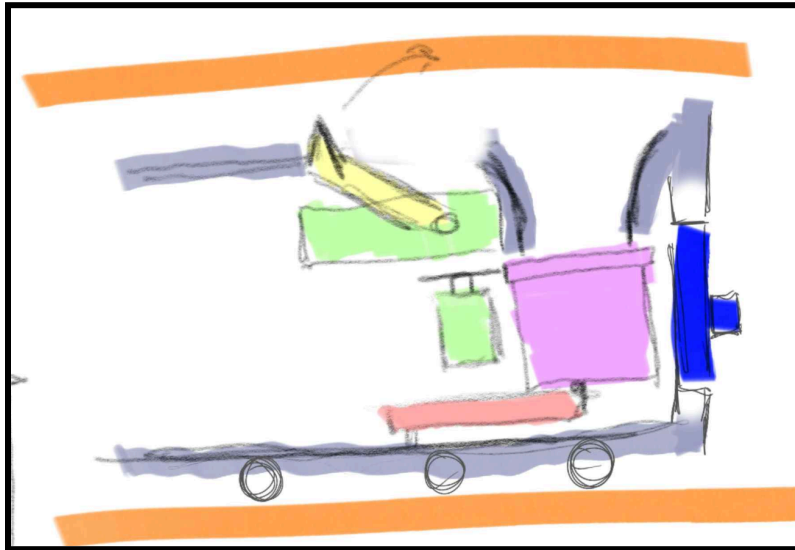


Figure 2.3-1: Tool Head Mounting Hardware Breakdown

Table 2.3-1: Devices Mounting Hardware - Tool Head

	Servo Motors	M3 Bolts, various length
	Load Cell	M4 Bolts: 4 x 16mm Magnet: 20 x 10 x 5
	Container	Magnet: 20 x 10 x 5
	Scraping Tool	M3 Bolts, Length TBD
	Front Plate	M3 Bolts: 8 x 6mm
	608 Bearing	Press fit

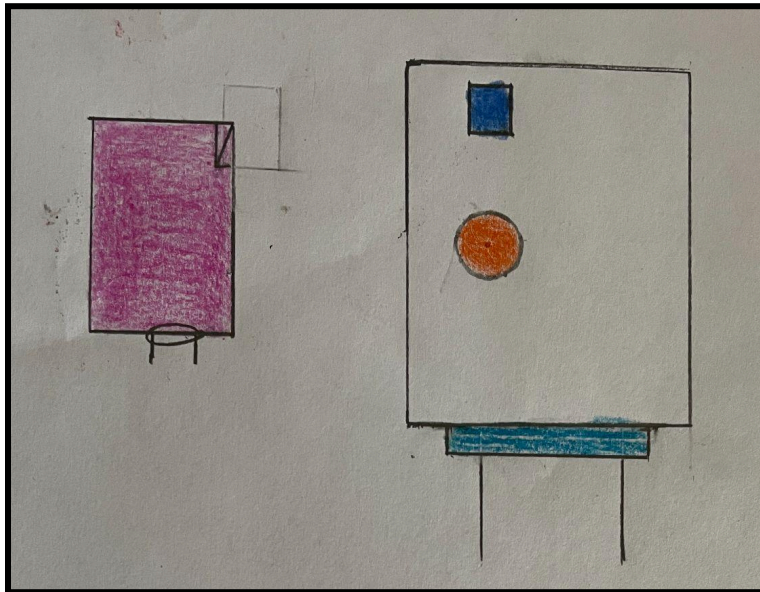


Figure 2.3-2: Compressor Mounting Hardware Breakdown

Table 2.3-2: Devices Mounting Hardware - Compressor

	Air Compressor	PVC air hose, 25 in
	Pump Connection Coller	M4 Bolts: Length TBD
	Inflation collar	M3 Bolts: Length TBD
	Inflation Switch	M3 Bolts, Length TBD

2.4 Design Justifications

The system is divided into two notable sections, as outlined in Section 2.3—Technical Drawing. Both sections use the same mounting hardware, which allows the team to design components using a standardized system.

The Tool Head is designed in segments that can be connected. This way, as the project progresses, if new design requirements are found, they can be easily implemented into the design. The battery chassis is one component being made independently in this way. For the prototype, we will use servo motors and test their effectiveness for sampling. We suspect that the strength of these motors might not be sufficient, so other 12V DC motors are also being considered. The load cell has similarly proven ineffective as planned, and more accurate load cells are being sourced to achieve a tolerance range of 10-20 mg. As a result, the specificity of the design for this deliverable only details the hardware for attaching the various components rather than every detail for the chassis, as it is subject to changes. A design change to one component may change how every other device is attached.

The original design for the air compressor base implemented the necessary components into the unit. After some consideration, connecting a standard 12V air mattress pump externally to the base will likely be more straightforward. This pump would be powered by the same system that powers the other electronics. This component has not been as detailed as the tool head, and we do not plan to test it with the initial prototype.

3.0 Materials & Equipment

3.1 Bill of Materials (BOM)

This Bill of Materials (BOM) lists all of the parts, materials, and descriptions required to develop the prototypes for the design. This documentation structures a shopping list of the necessary components for all aspects of the initial design to concentrate future purchases where required while adhering to the provided budget of \$100.00. It is developed in an organized manner to simplify any future reference.

Table 3.1-1: Bill of Materials

Sample Snatchers - Bill of Materials						
Item #	Part	Vendor	Description	Qty	Cost	Purchase
1	ESP32-WROOM -C3	Elegoo	Controller w/ Wifi + BT	1	9.99	Link
2	PLA - ~0.5 KG	Bambu	Filament for chassis	1	9.99	Link
3	Load Cell Sensor + HX711	Aliexpress	Strain gauge for mass analysis	1	3.34	Link
4	608 ZZ 608RS	Aliexpress	Ball bearings	1	2.40	Link
5	M3 Female Threaded Insert	Aliexpress	Heat set threaded inserts for chassis	1	0.80	Link
6	LM2596	Aliexpress	Step down buck converter, 36V/24V/12V/5V/3V	1	2.35	Link
7	M3/M4 Machine Screws	Aliexpress	Various length M3 Machine Screws	1	3.00	
8	XT60 Connectors	Aliexpress	Connectors for battery pack	1	3.26	Link
9	22 awg Wire	Aliexpress	Wires for connecting components to the circuit	1	3.00	Link
10	15ft pipe	?	Testing apparatus	1	?	
11	Resistor set	Aliexpress	Various resistors	1	4.30	Link
12	Power button	Aliexpress	Push button for power	1	1.85	Link
13	Pump? Valves? Motors?	Aliexpress	We are still figuring it out	1	30.00	
Total				13	74.28	

3.2 List of Equipment

The team has developed a list of equipment considering all software and hardware that may be useful for developing each prototype.

Table 3.2-1: List of Equipment

Equipment	Purpose
3D Printer	Additive manufacturing for creating models from CAD files
Soldering Iron	Connecting electrical components
Fume Extractor	Removing hazardous fumes while soldering
Screwdriver	Assembling model with M3 and M4 bolts
Breadboards	Prototyping electronic circuit
ESP32 Dev Board	Prototyping electronic circuit
Multimeter	Testing power delivery
USB-C Power Supply	Temporary power solution while waiting for batteries
USB-C Cable	Used for flashing device hardware and powering device
Computer	Used to write programs and design CAD models
Spot Welder	For assembling sheet metal components and connecting batteries
Heat Gun	For applying shrink wrap to electrical conduits and packaging battery cells

Table 3.2-2: List of Software

Software	Purpose
Keyshot	Product visualization and assembly information
Onshape	Designing 3D CAD models
Arduino IDE	For creating programs and flashing them to microcontrollers
Google Sheets	Documenting data
KiCAD	Designing PCB hardware

4.0 Prototype Test Plan

Using the developed “Prototyping Test Plan” template in the lecture, the team has built off the template to create our own. This prototyping test plan guides the procedure for analysis of these phases. The formulated plan considers critical issues, objectives, test descriptions, analysis methods, measurables, metrics, fidelity levels, prototype type with the associated results, feedback, and additional notes after completion of the tests, meeting the stopping criteria. The allocated column dictating the stopping criteria specifies the test's success or failure, which will be tested at least five times to validate the test to stop. In brief, the plan strives to obtain input, verify feasibility, and analyze the critical subsystems while reducing risk and uncertainty.

Additional table on the following page.

5.0 Project Schedule (Task Plan)

A project schedule has been created to guide the objectives throughout the prototyping and testing phase. This task plan includes a general list of tasks to be completed, an estimated time for completion, and assigned responsibility to a team member. Considerations regarding project risks and contingency plans have also been shown to mitigate risks and provide ease for any necessary adaptations to the task.

A foundational plan has been developed where the necessary adjustments and the respective requirements can be filled out as the team progresses. Throughout the development phase of prototyping, clear changes and additional tasks will be made to the plan.

Additional table on the following page.

6.0 Conclusion

This document provides structured plans to aid our progression in the prototyping and testing phase of the design thinking process to develop a successful design. The chosen concept has been further detailed, emphasizing the necessary components for manufacturing and functionality. The prototype test plan considers the procedure by which tests will be performed, with notable reflection points detailing the guiding questions of why, when, how, and what. The project task plan outlines the list of tasks to be completed and provides an estimated task time, delegating responsibilities to the team members. The necessary adjustments to the generated plans and design will be performed throughout these phases, where required. The team is on track to proceed with developing the prototype.

Trello: Task Plan Update

The team has updated the task board in Trello.

Please refer to the link below to access the updated Trello:

<https://trello.com/invite/b/67846e4e793783740d87aed9/ATTIbb8224a0c532547c0a69acd41093c7c7A4D60EC7/gng1103-project-sample-snatchers>

Additional formatting of our team schedule is represented on the following page (Gantt Chart).