Deliverable F: Prototype I and Customer Feedback

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1. Introduction

This document presents our low-fidelity prototype for the Remote Pipe Sampling Equipment. Instead of a fully motorized system, we have constructed a basic

demonstration model consisting of a simple cylinder with sandpaper attached, mounted on a telescopic pole. The objective of this prototype is solely to showcase the overall concept and assembly approach. Feedback from our client and peers guided us to simplify the design, so for this iteration we have focused on proving the idea with readily available, low-cost materials.

2. Feedback Received and Design Improvements

- **Client Feedback:**

- "Simpler designs tend to work better as they're more reliable."

- **Peer Feedback:**

- "Excessive friction might prevent effective sample scraping."

- **Improvements:**

- **Simplification:** In response, we opted for a non-motorized, manually rotated prototype to demonstrate the core concept.
- **Elimination of Chute Mechanism:** The initially proposed motorized chute door was discarded to avoid complexity and potential reliability issues at this early stage.
- **Stability:** The prototype is mounted on a telescopic pole with a simple clamping mechanism, ensuring that the cylinder can be positioned against a pipe section while being manually rotated.

Prototype I

3. Prototype Objectives ("The Why")

- The primary objectives of this low-fidelity prototype are to:
  - **Demonstrate Feasibility:** Show that a cylinder wrapped in sandpaper can serve as a basic means to scrape material from an interior pipe surface.
  - **Validate Assembly & Concept:** Confirm that the chosen method of mounting (using a telescopic pole and clamp) is practical for positioning the device against the pipe.
  - **Collect Initial Feedback:** Provide a tangible model for the client and peers to evaluate the basic concept before investing in more complex, automated features.
  - **Guide Future Iterations:** Use the insights gained from this prototype to inform subsequent design refinements (such as potential motorization and more advanced sample collection features).

4. Test Plan

- Given the low-fidelity nature of this prototype, our testing is primarily demonstrative:
  - **Manual Operation:** The cylinder will be manually rotated while in contact with a representative pipe (or a substitute material) to observe the sanding effect.
  - **Visual Assessment:** We will assess if the sandpaper adheres properly, if the surface shows signs of material removal, and if any sample retention (e.g., in small divots or textured areas) is visually evident.
  - **Stability Check:** We will verify that the clamping mechanism holds the prototype firmly against the pipe during manual operation.
  - **Documentation:** Photos and qualitative notes will be taken during testing, noting any issues such as slippage or excessive friction.

- *Pass/Fail Criteria:*
  - **Sanding Effectiveness:** The sandpaper must visibly remove material from the test surface under manual rotation.
  - **Assembly Stability:** The prototype must remain stable during operation without shifting or slipping.
  - **User Feedback:** The demonstration should clearly communicate the design concept to the client and peers.

5. Preliminary Project Task Plan

- To further develop the design in future iterations, we have identified the following tasks:

Task	Duration	Responsible	Notes
Prototype Assembly Review	1 day	Entire Team	Evaluate current low-fidelity build and note improvements.
Manual Test Execution & Feedback Capture	1 day	Quin Ramos / Berke Dai	Collect visual and qualitative data during manual tests.
Analysis & Iteration Planning	2 days	Ian Kahuro / Visisht Kaushik	Use feedback to refine design for a motorized version
Documentation Revision	1 day	Caleb Gilbert	Update deliverable with new findings and proposed changes.

6. Updated Bill of Materials

Below is a draft Bill-of-Materials (BOM) for Deliverable F. This BOM reflects the key changes from Deliverable E - most notably, our updated sample collection system where the abrasive sandpaper drum is modified to include a slit (instead of machined divots) and a small chute door that automatically opens when the motor spins (and remains closed otherwise). In addition, the device is mounted to a broom-handle-like telescopic pole and clamped onto the tube rim.

Component	Description	Estimated Cost (CAD)	Comments/ Notes	Amazon Link

Telescopic Extension Pole	15-ft aluminum telescopic pole (or segmented rod) that allows the device to be pushed/pulled into/out of the tube	$24.99	Sourced from hardware suppliers; ensure lightweight durability	15ft Telescopic Extension Pole
Clamping/Vise Assembly	Adjustable vice/clamp mechanism with rubber padding to securely fix the device onto the tube rim	$15.49	Attached and secured to tube and broom handle.	Adjustable Tube Clamp
Rotating Sandpaper Drum Assembly	Custom aluminum drum with abrasive sandpaper wrap; modified with an integrated slit for sample collection and a hollow interior to hold the sample	$29.99	Key component-design revision from Deliverable E; precision machining required	Aluminum Rotary Drum Sandpaper
Brushed DC Motor	12V DC motor (approx. 15W, high RPM/high-torque) for driving the drum at the desired speed	$34.89	High torque for friction of sanding.	12V Brushed DC Motor 15W

Wiring & Connectors	Assorted copper wires, crimp terminals, solder, and connector housings to interconnect all electrical components	$9.99	Use durable, flexible wires suitable for moving parts and environmental exposure	Electrical Wiring Kit with Connectors
Broom Handle Wiring Harness	Dedicated bundle of insulated wires (e.g., 18 AWG) for routing power through the broom handle to reduce voltage drop and protect wiring	$13.70	High flexibility for in-handle routing - includes switch	Flexible Wiring Harness
Mounting Brackets & Hardware	Brackets, screws, bolts, and nuts for assembling all components and securing the device to the telescopic pole and tube clamp	$15.99	Corrosion-resistant fasteners	Assorted Mounting Brackets Hardware Kit
Enclosure/Housing Components	Protective casing (e.g., laser-cut aluminum or durable plastic) for the motor, wiring, and electronics to	$9.99	Dustproof and impact resistant	Project Enclosure Dustproof

	shield them from dust and debris			
Flexible Latex Sealant	Required for final assembly and environmental sealing	$10.34	Ensures structural integrity and protection against dust/debris	Flexible Latex Sealant

Total Estimated Cost: Approximately $165.37 CAD, given no failures. However, that is impossible, so we are most likely looking close to **$180.00** for the system overall.

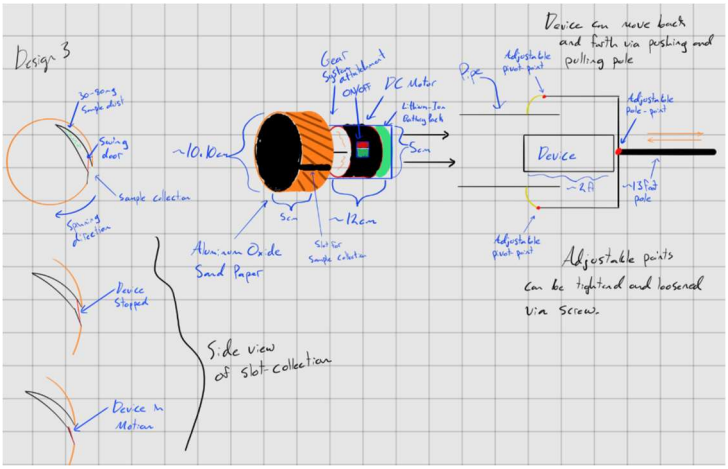
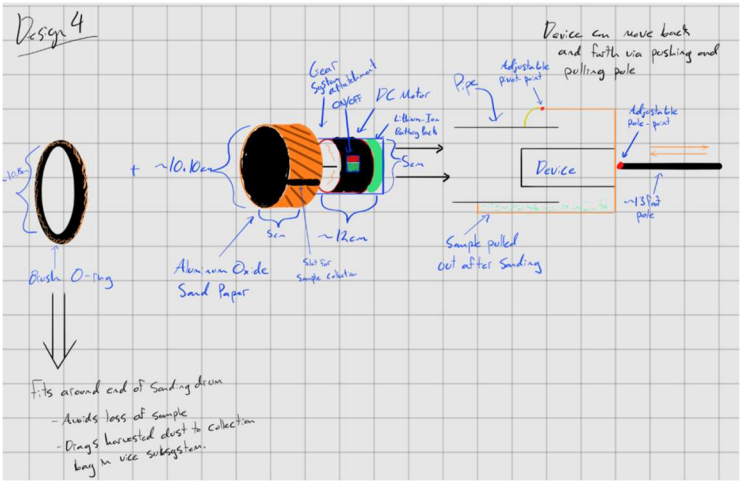
This BOM covers all major subsystems - from the mechanical drive (drum assembly) to the power and control electronics (motor, controller, sensors) and all necessary hardware and wiring. Each component's description outlines its role in ensuring the device can be inserted into the tube, clamped in place on the rim, and then operate the rotating drum with the unique sample collection slit.

7. Conclusion

This low-fidelity prototype - a manually operated cylinder with sandpaper attached to a telescopic pole - successfully demonstrates our basic design concept for pipe sampling. By simplifying the system and discarding motorization and automated mechanisms, we have reduced complexity and cost while providing a tangible model for feedback. The prototype allows us to visually and manually assess the feasibility of the sanding mechanism and supports clear communication of our design intent. Moving forward, the

insights gained from this demonstration will guide potential iterations toward increased functionality while ensuring reliability and simplicity.

Collection Method 1 -



Collection Method 2 -