Project Schedule, Cost, and Prototyping Test Plan

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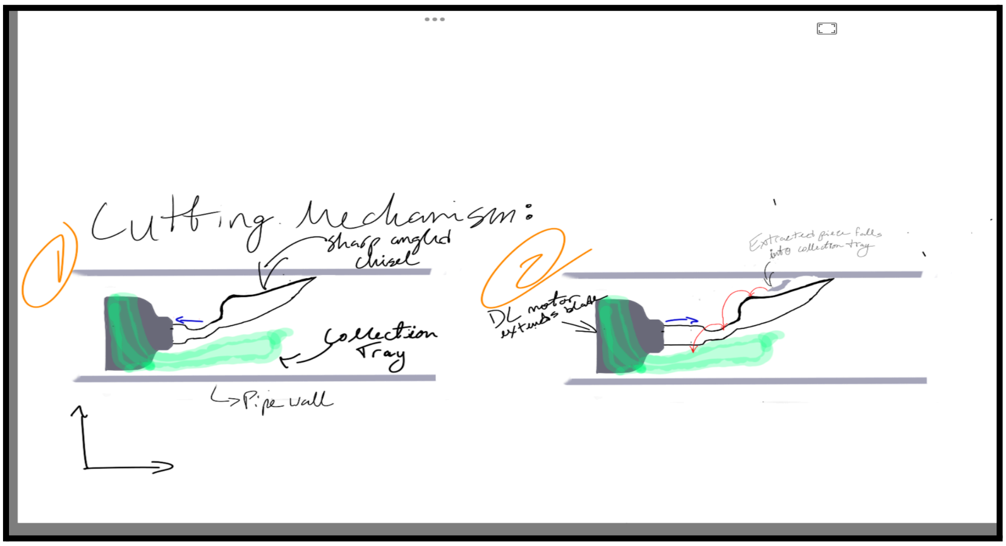
1. Introduction & Objectives

Introduction:

This deliverable takes the ideas and advice from the client meeting to create a prototype for our task. Additionally, we provided a new detailed design, project task, scheduling, a bill of materials, and our prototyping plan

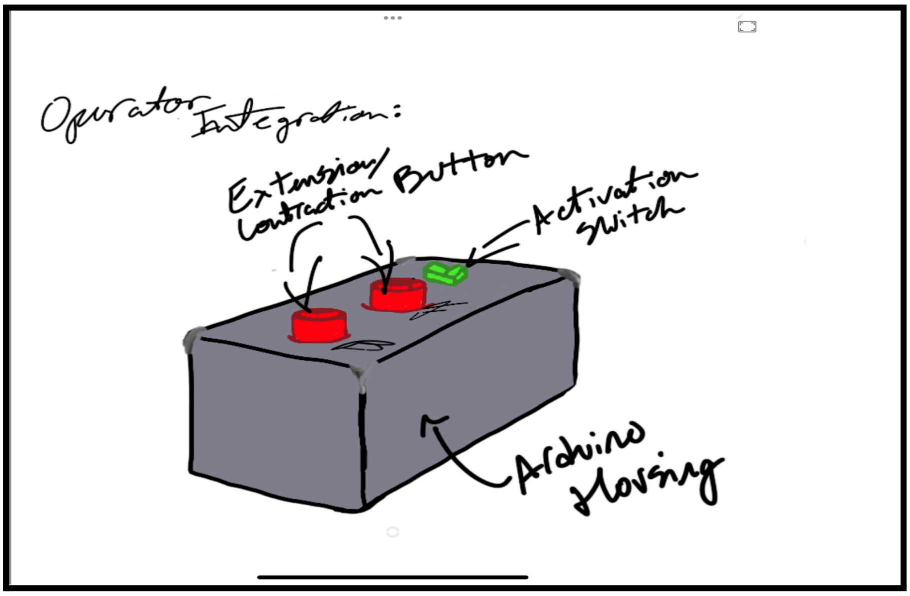
Design Drawing

- Sampling Mechanism: Extendable blade with vacuum collection (Nolan’s contribution) for precise metal scraping.



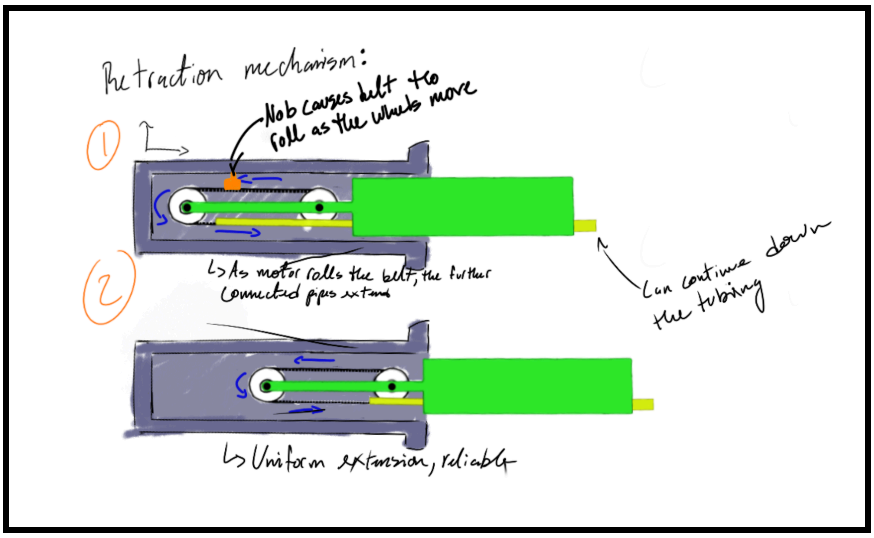
- Fairly straightforward; sharp chisel cuts into pipe wall by extension from a DC motor, with the bits collected in a plastic tray that wraps around the neck of the pipe. Given that its done by a code ran when a switch on the remote is pressed, it allows for a great degree of accuracy.

- Feedback & Monitoring: Arduino integration



- Allows for operator control of the length of the tube by arduino integration. Simple design; labelled buttons indicate direction which the pipe will extend with a sound indication when maximum length is achieved. Activation switch begins cutting process at the blade end.

- Extension & Retraction: Telescoping rod with belt mechanism



- Connected motor rotates the wheel, in turn spinning the belt which allows for the rod to extend in one uniform motion to ensure equal pipe extension. Little notch ontop rotates the belt by holding onto the belt so that while the wheels turn the belt essentially moves with it. The further pipes are connected similarly by being attached to the belt; moving along the belt when the wheels rotate. Simple yet reliable design.

3. Project Task Plan & Schedule

Task List & Responsibilities:

Task	Duration	Assigned To	Details
Finalize Detailed Design Drawing	3 days	Nolan & Franco	Refine schematics; confirm component placements and annotations.
Update Trello & Project Task Board	1 day	Entire Team	Reflect updated tasks, sub-tasks, durations, and responsibilities based on current progress.
Procure Components & Materials	5 days	Felipe	Identify suppliers, obtain cost approvals (BOM with links), and ensure adherence to budget.
Prototype – Sampling Subsystem	7 days	Nolan	Build and test extendable blade & vacuum system; conduct initial focused tests for scraping efficiency.
Prototype – Retrieval Mechanism	7 days	Felipe	Assemble spring-loaded retraction system; calibrate tension

			and perform safety tests.
Prototype – Feedback Integration	5 days	Franco	Install sensors, integrate protective casing, and validate video feed quality.
Prototype – Extension Subsystem	5 days	Omar	Construct and test collapsible telescopic rod; verify smooth operation and structural integrity.
System Integration & Comprehensive Testing	7 days	Entire Team	Integrate subsystems, conduct comprehensive prototype tests, and resolve any integration issues.
Risk Review & Contingency Planning	2 days	Project Manager (PM)	Identify risks (e.g., component delays, integration issues) and update contingency measures.

4. Economics: Project Costs and Component/Tool Selection

Bill of Materials (BOM):

Component/Tool	Estimated Cost	Supplier/Link	Justification
Extendable Blade & collection platform	$7	Extendable Blade Vacuum Pump	Critical for accurate and contained sample scraping.
Rod Motor	$13	Stepper Motor	Extends and retracts the rod when needed
Blade Motor	$9	Micro Servo Motor	Spins the blade to collect the sample
Collapsible Telescopic Rod	$20	Telescopic Rod	Enables required reach and maintains portability.
Miscellaneous (fasteners, wiring, adhesives)	$30	Heat Inserts Screws Wire	Necessary for secure assembly and component integration.

Arduino + feedback sensors	$17	Arduino Uno	Necessary for constant feedback and determining collected sample size

Total cost: $108.48 w tax

Equipment List:

- Permanent: Feedback sensors, power supplies for motors.
- Temporary: Breadboards, test fixtures for initial prototype evaluation.

Budget Management:

- Total estimated cost is approximately $110.
- Justifications are based on cost-effectiveness while ensuring reliability and quality.

This section follows the rubric by providing realistic cost estimates and well-supported component selections.

5. Prototyping Test Plan (Prototype 1)

Test Plan Overview

Purpose:

- Assess performance metrics (precision, retrieval speed, feedback quality) and identify any design flaws early.

Test Objectives:

- Sampling Efficiency: Measure if the extendable blade and vacuum system collect the target sample size (30–80mg).
- Retrieval Functionality: Confirm the spring-loaded mechanism retracts the tool within a defined timeframe (e.g., <5 seconds).
- Feedback Quality: Ensure the feedback sensors are returning good data.
- Extension Integrity: Verify the telescopic rod extends/retracts smoothly and maintains structural integrity.

Prototype Attributes and Fidelity

Fidelity:

- Start with low/medium fidelity focused prototypes to test individual subsystems before integration.
- Increase fidelity iteratively as each subsystem meets performance metrics.

Cost & Iteration Time:

- Minimize costs by using cost-effective materials for initial prototypes.
- Rapid iteration cycles will be employed to optimize design parameters.

Test Plan Structure (Following Lecture Template)

Test Number	Critical Issue/Assumption	Test Objective (Why)	Test Description (What)	Analysis Method (How & When)	Measurables/Metrics	Prototype Fidelity & Type	Results & Interpretation
1	Sampling Efficiency	Validate sample collection capability	Bench test using a metal pipe mock-up; operate extendable blade with vacuum system.	Time-based tests over 2 hours; record sample mass per cycle using a precision scale	Sample mass in mg; target: 30–80mg per cycle	Low Fidelity Focused Physical Prototype	Record pass/fail and collect qualitative feedback
2	Retrieval Mechanism Functionality	Confirm safe and rapid tool retraction	Activate spring-loaded retraction; measure time from activatio	Use sensor to measure retraction time; conduct 5 repeated trials	Retraction time (seconds); target: <5 seconds	Low/Medium Fidelity Focused Physical Prototype	Note any delays or failures, adjust tension calibration accordingly

			n to complete retrieval.				
3	Feedback Quality	Ensure real-time monitoring is effective	Operate under simulated operating conditions; assess clarity and responsiveness.	Compare recorded video resolution and clarity under different lighting conditions	Resolution (p) and clarity score from user feedback; target: 720p+	Low Fidelity Focused Visual/Physical Prototype	Collect quantitative data and qualitative feedback
4	Extension System Structural Integrity	Test smooth operation and rigidity	Extend and retract the telescopic rod repeatedly; apply minimal loads to test stability.	Measure extension/retraction speed; observe any mechanical issues during 10 cycles	Extension uniformity and mechanical integrity under repeated use	Low/Medium Fidelity Focused Physical Prototype	Record and interpret any deviations from expected performance

Stopping Criteria:

- Testing will conclude once the prototype meets all specified metrics consistently over three consecutive test cycles.
- If significant failures occur, testing pauses to reassess and refine the design.

6. Conclusion

This deliverable has presented a comprehensive plan for Concept 1 – “High Precision & Full Monitoring.” It includes a detailed design drawing with subsystem integration, a meticulously planned project schedule with task responsibilities, a cost and component justification, and a thorough prototyping test plan based on the latest prototyping methodologies. These combined efforts aim to meet client expectations and rigorously validate the design.