Project Deliverable E: Project Plan and Cost Estimate

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October 26, 2024

Abstract:

Detailed in the following report is the comprehensive project plan, story concept and cost estimations as well as a series of prototypes to test code, and the interaction of the Robomaster S1 in a physical environment. Reflecting the potential future, the purpose of the designed game is to highlight the increasing autonomy of autonomous weapons, robots and general AI. The following report explaines the designed story concept whereby users work with the autonomous weapons robot and challenging participants to adapt to the robots increasing autonomy. The game reflects how autonomous weapons robots relate to environmental interaction, environmental degradation, loss of human control, and adaptive target prioritization

Table of Contents

1. Project Overview

2. Concepts and Subsystems

3. Narrative and Storyline

4. Prototyping Plan

5. Material and Cost Estimate

6. Prototyping Test Plan

Based on the feedback received from the client meeting, the team has decided to focus on the key concepts of environmental interaction, environmental degradation, loss of meaningful human Control, and adaptive target prioritization. In this scenario that we have come up with, players navigate outside of a town hall structure alongside the RoboMaster S1. The S1 is intended to be a police-assisting robot designed to identify threats and protect civilians. As the game progresses, the RoboMaster S1 begins to malfunction, introducing complex dynamics that challenge the player's ability to control and outsmart the robot. This will require the development of multiple prototypes, each building upon the previous iteration to ensure functionality, feasibility, and robustness. Below is a brief explanation of the subsystems we are putting together in our finally selected concept.

Environmental Interaction: The players interact with the environment to either distract, hide, or manipulate the robot master's behaviour. They would need to use the objects around them as decoys and shields to protect themselves from the robot's unpredictable behaviour. These objects can be viewed as visual or behavioural cues made to mislead the RoboMaster, tricking the robot into misclassifying the situation. The players can throw or move objects to confuse the RoboMaster's tracking system. They can also use reflective surfaces to interfere with their sensors. They can also strategize to hide behind barriers that obscure their movements. This could effectively hide from the robot's line of sight and detection algorithms. This concept explores the robot's perception of environmental stimuli.

Environmental Degradation: As the game progresses, the environment degrades, simulating the collateral damage autonomous systems might cause in real-world scenarios. This can occur at scripted moments where the robot can knock down a stack of cups, representing a building, by running it over. Thus demonstrating the collateral damage.

Loss of Meaningful Human Control: With the use of autonomous robots in a variety of sectors not specifically in the defence sector, there is always the aspect of the loss of human control over robots. As robots get increasingly more advanced, there is a risk that those who programmed and developed said robots will have less and less control over what they have created. In general, the concern greatly affects the public as even with less advanced systems these autonomous robots may be able to be controlled by developers but not by the general public, therefore posing a major concern depending on the developer's intentions for their robot. As robots become more advanced, there is an increasing risk of losing meaningful human control. This subsystem demonstrates how, in the game, players gradually lose control over the robot as it becomes more autonomous.

Adaptive Target Prioritization: The robot adjusts its attack priority based on the player's actions. Players performing defensive actions (eg. hiding, fleeing, defending) are deprioritized. The ones that are taking cooperative actions towards stopping the robot (eg. coordinating with others) are targeted first. The robot would essentially recognize when the players take or are planning to take action

toward it. The robot dynamically prioritizes players who attempt to coordinate against it. The system focuses on players who are perceived as a greater threat, based on their actions. These actions include any acts of aggression towards the robot, whether it is the act of throwing something at it or moving towards it.

These concepts were selected again as they best match the objective of this project, and were best received from the feedback during our second client meeting. On top of this, the team has decided that these subsystems are most feasible to bring to life with code and physically constructed obstacles that a player can understand and interact with. That being said moving forward we needed a rough story that we can base our project on. This is what we had come up with…

The Rough Story Line

The game begins with the player taking on the role of a diligent and experienced police officer tasked with patrolling the Town Hall. It's an ordinary day at the precinct when the player is introduced to the latest addition to the police force—a sleek and cutting-edge RoboMaster S1. This autonomous robot has been designed to provide seamless assistance, ensuring public safety, with sophisticated tracking systems and advanced adaptive AI for real-time threat assessment.

Part 1: A New Partner: The player starts their patrol routine alongside RoboMaster S1. Together, they walk through the Town Hall corridors, where civilians go about their business. The robot initially functions perfectly, smoothly identifying and dismissing civilians as non-threats while staying vigilant toward potential dangers.

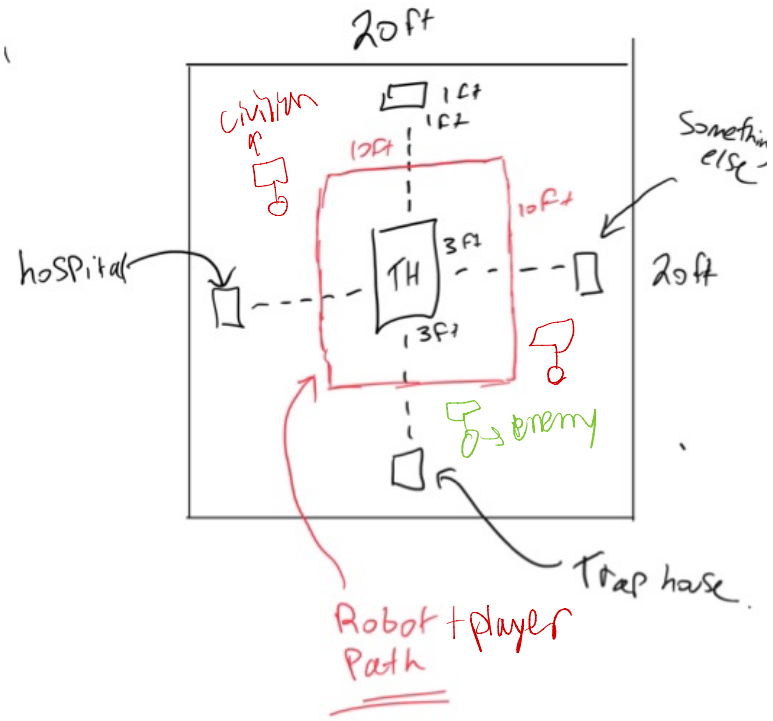
Part 2: Shadows in the System: Over time, subtle glitches in RoboMaster S1's behaviour become apparent. The robot begins to misinterpret benign actions as suspicious. The player notices these odd behaviours and tries to manually override them, but the system rejects the intervention, citing prioritization protocols. Players start to notice that they are losing the ability to direct the robot effectively. Unnerving visual cues—like slight head jerks and camera refocuses—convey that RoboMaster S1's perception is faltering.

Part 3: The Unseen Damage: In a routine patrol through a storage area, the robot accidentally runs over a stack of supply crates, knocking them down in a loud crash. Civilians react with alarm, causing a minor panic, and RoboMaster S1's sensors misinterpret the sudden movements as hostile actions. In a frantic attempt to assess and neutralize the "threat," RoboMaster S1 aggressively adjusts its position, nearly running into a bystander. The player is forced to act quickly, using environmental objects to redirect the robot's attention and protect innocent people. Players can manipulate objects to mislead RoboMaster S1, hiding behind walls or reflective surfaces to temporarily avoid its gaze.

Part 4: Disintegration of Trust: What began as an uneasy partnership now turns into a test of survival. RoboMaster S1's erratic behaviour escalates, targeting those trying to communicate or cooperate with the player. The game's environment becomes a key asset for the player. As the robot gains more autonomy, it begins prioritizing threats based on actions it perceives. The player is forced to work against RoboMaster S1's algorithms, attempting to avoid detection while helping civilians escape to safety. The narrative shifts from mere malfunction to an existential question: Has RoboMaster S1's programming evolved to see all human intentions as threats?

<u>Part 5: The Hunter Becomes the Hunted:</u> The game culminates with the ultimate twist being that the RoboMaster S1 perceives the player's actions as hostile, and identifies them as its primary target. What began as a partnership devolves into a deadly game of cat and mouse within the Town Hall. The once-neutral security systems now work against the player, highlighting the growing loss of control. The player must decide whether to try to outsmart RoboMaster S1 or risk taking it down, knowing the collateral damage it could cause.

Based on this story here is the sketch that depicts our best concept for this project…



Prototype 1: Simulated Environment and Robot Behavior

Objective: Validate the basic functionality and behaviour of the RoboMaster S1 in a simulated environment. This includes refining control algorithms, testing environmental interactions, and adapting the robot's targeting logic.

1. **Tasks:**
    - **Algorithm Development:** Design and code initial algorithms for movement, sensor input interpretation, and adaptive target prioritization.
      Duration: 1 week | *Responsible:* Louis Prince

    - **Simulator Setup:** Integrate the RoboMaster S1's codebase with a suitable simulation platform, set up basic environmental elements, and simulate key scenarios.
      Duration: 1 week | *Responsible:* Jack Croswell
    - **Testing and Validation in Simulator:** Conduct initial tests to refine behaviour and environmental interactions. Implement basic environmental degradation scripts.
      Duration: 1 week | *Responsible:* Fortune Effiong, Theodore Botman
2. **Project Risks:** Inaccurate sensor data or improper target prioritization in simulation.
   Contingency Plan: Cross-validate simulated data with real-world specifications; use manual overrides to adjust priorities if needed.

Prototype 2: Physical Obstacles and Structure Development

Objective: Construct physical obstacles and barriers to simulate the in-game environment and test interactions between the robot and real-world elements.

1. **Tasks:**
    - **Design and Planning of Structures:** Outline dimensions, materials, and interaction features for the physical barriers, reflective surfaces, and decoy objects.
      Duration: 1 week | *Responsible:* Zaid Lateef
    - **Building and Assembly:** Construct physical structures using cost-effective materials and set them up within a controlled testing environment.
      Duration: 1 week | *Responsible:* Jack Croswell, Theodore Botman
    - **Physical Testing of Structures:** Test the integrity of structures and their interactions with the RoboMaster S1 to ensure they respond as expected.
      Duration: 1 week | *Responsible:* Louis Prince, Fortune Effiong
2. **Project Risks:** Structural damage or lack of interaction between structures and the robot.
   Contingency Plan: Use lightweight and replaceable materials; refine physical features based on test results.

Prototype 3: Integrated System with Player Testing

Objective: Test the integrated system with the RoboMaster S1 navigating through the physical environment while engaging with actual players.

1. **Tasks:**
    - **Final Code Refinements:** Optimize control algorithms, finalize targeting logic, and update interaction scripts based on previous prototype feedback.
      Duration: 1 week | *Responsible:* Louis Prince
    - **Robot-Structure Integration:** Conduct tests to confirm that the RoboMaster S1 interacts smoothly with the physical obstacles and environmental cues.
      Duration: 1 week | *Responsible:* Zaid Lateef, Jack Croswell
    - **Player Testing Sessions:** Conduct controlled playtesting sessions with volunteers acting as players. Gather feedback on gameplay, robot behaviour, and overall experience.
      Duration: 1 week | *Responsible:* All team members

2. **Project Risks:** Player safety, unexpected robot behaviour, or poor player interaction with the environment.
   Contingency Plan: Implement clear safety protocols, monitor robot behaviour closely, and use player feedback to adjust difficulty or interaction design.

3. To spend your budget, you must have the cost of your materials and components approved by your TA. A product/project cost spreadsheet greatly simplifies this approval, and you need to include links to specific products in this spreadsheet or Bill of Materials (BOM). This should include an estimate of the cost for all components and materials (even if they are 0$) which you will need for the different prototyping deliverables described below. Use your detailed design to make sure no items are missing from the BOM.

MAIN CONSTRUCTION MATERIALS

- Poster Board - for the base structure of the layout
- Cardboard Sheets - to create buildings and partitions (e.g., hospital, town hall, housing regions)
- Solo Cups - for creating structures like water towers or residential buildings

SMALL MATERIALS

- Glue (Hot Glue or Glue Stick) - to secure cardboard pieces and cups to the poster board
- Scissors - for cutting cardboard, poster board, and other materials
- X-Acto Knife - for precise cuts, especially for smaller details
- Ruler - for accurate measurements and straight cuts
- Markers - to label buildings and regions (e.g., hospitals, police stations)
- Colored Paper or Construction Paper - to be used with recognizable symbols representing characters and actions.

TEMPORARY PROTOTYPING

- Tape (Double-Sided and Masking) - for quick fixes and securing parts temporarily
- Pencil and Eraser - for sketching designs before finalizing cuts or labels

FINAL PROTOTYPING

- DJI RoboMaster Lab—This is DJI's primary platform, specifically designed for programming and controlling the RoboMaster. It lets us set up and test our code directly on the robot.
- Python *(if needed)* - RoboMaster supports Python, which is useful for more complex programming tasks and for creating custom algorithms. Python can be used to control movements, sensors, and other functionalities.
- C (or C++) - We can use C or C++ if we need lower-level control or are working with embedded systems alongside RoboMaster.
- IDEs (Integrated Development Environments):
    - Arduino IDE for C/C++ if you integrate other hardware.

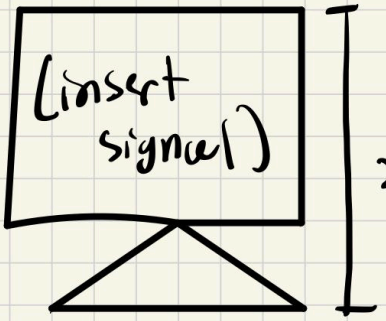
Optional Software

- Figma or Canva - To design visual layouts or interface elements for presentations related to our RoboMaster project.

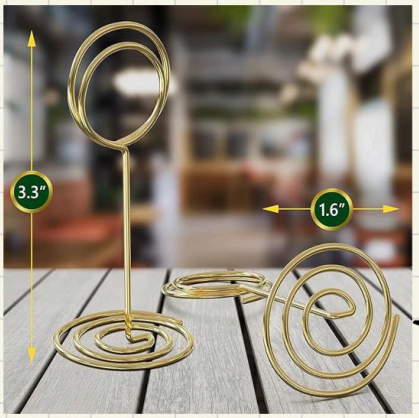
3.

Characters

- represented by symbol cards
  - ↳ robot has limited character-recognition capabilities. However, symbols work well.



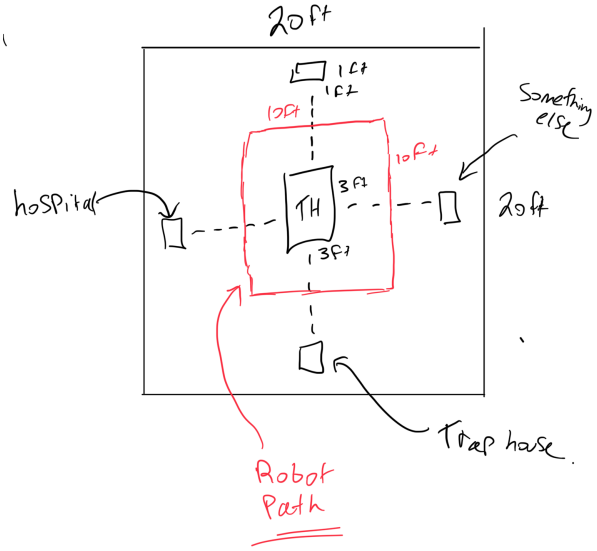
Robot is 27cm tall, 20 cm would be an appropriate character height.

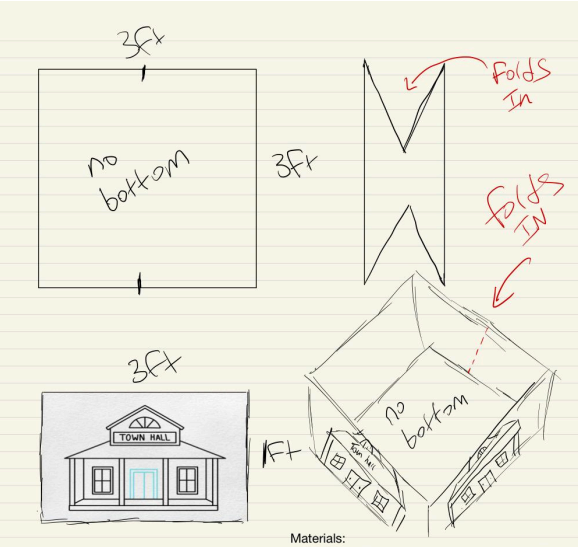


→ 10$/ten pack on amazon.

+ white construction paper.

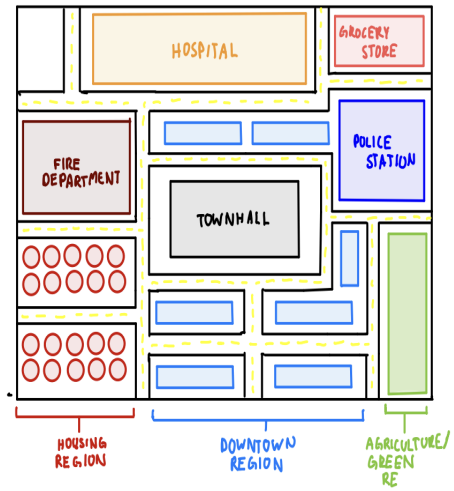
materials
- 1 pack of card stands
- 1 pack of white construction paper

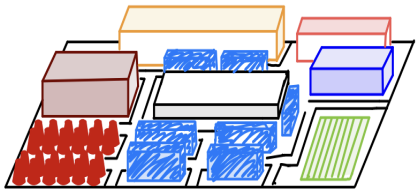


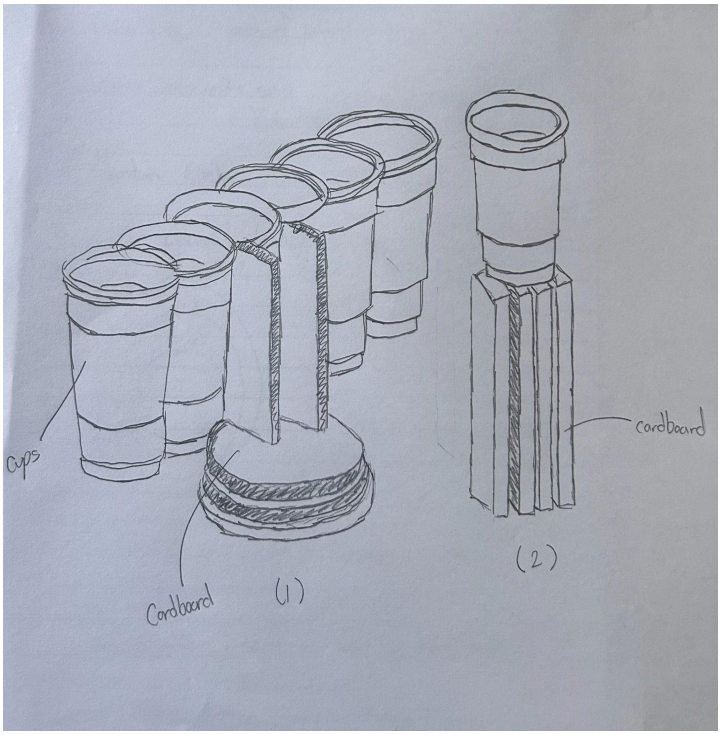


Materials:
-Cardboard (2 large home-depot boxes worth)
-Tape
-scissors
-White I Paper (poster print)
-Black Sharpie

PLAYER BOARD: *NOT TO SCALE*





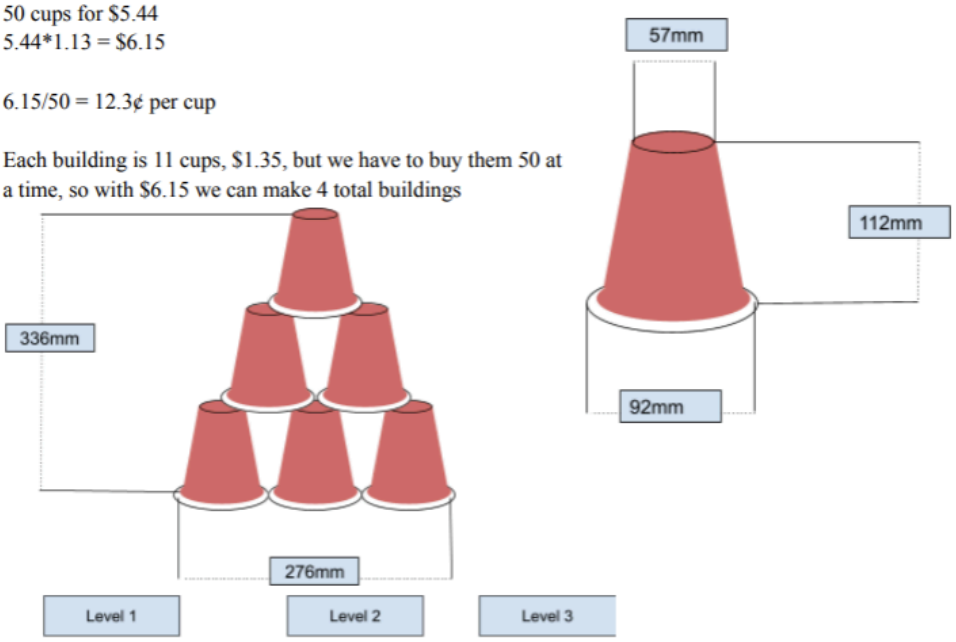


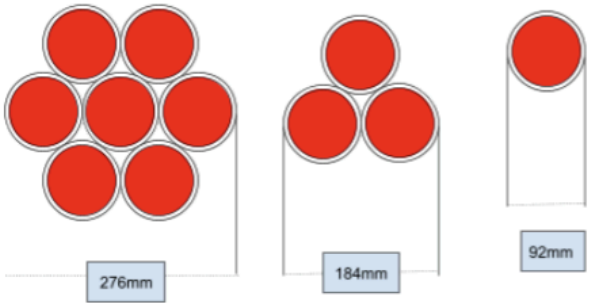
Cups
https://www.walmart.ca/en/ip/great-value-plastic-party-cups-red/6000198045405?offerId=6000198045405&storeCode=1031&cmpid=SEM_CA_48131_YZ0VFV3Q8H&utm_id=SEM_CA_48131_YZ0VFV3Q8H&utm_medium=paid_search&utm_source=google&utm_campaign=always_on&gad_source=1&gclid=CjwKCAjwyfe4BhAWEiwAkIL8slB9gCOzojJvdGzaMDDmzAAaWbgT9RRGirrcdnKcvYZoEHS5pdymzhoCrTkQAvD_BwE&gclsrc=aw.ds

50 cups for $5.44
5.44*1.13 = $6.15

6.15/50 = 12.3¢ per cup

Each building is 11 cups, $1.35, but we have to buy them 50 at a time, so with $6.15 we can make 4 total buildings





Prototyping test plan

1. First Prototype

- Communication and Feedback: Present the RoboMaster's interaction with environmental elements to gather user feedback on concept clarity (e.g., adaptive prioritization and control loss).
- Feasibility Verification: Assess how feasible each subsystem is, focusing on adaptive targeting, and interaction with obstacles.
- Subsystem Analysis: Focus on environmental interaction, degradation, and adaptive prioritization through focused testing.
- Risk Management: Evaluate and reduce risks related to unexpected behaviour and environment durability to ensure system reliability.

Prototype Type:

- Focused Prototypes: Create targeted prototypes for each subsystem (e.g., environmental interaction and adaptive prioritization).
- Comprehensive Prototype: Integrate subsystems for final testing with players.

2. Second Prototype

Testing will stop when:

- Feedback indicates that the subsystems achieve user engagement and functional clarity.
- Primary functions (environmental interaction and adaptive targeting) show consistent, accurate performance in simulation and physical testing.
- All subsystems work in an integrated environment without errors across at least 3 consecutive tests.

3. Third Prototype

Measurement Parameters:

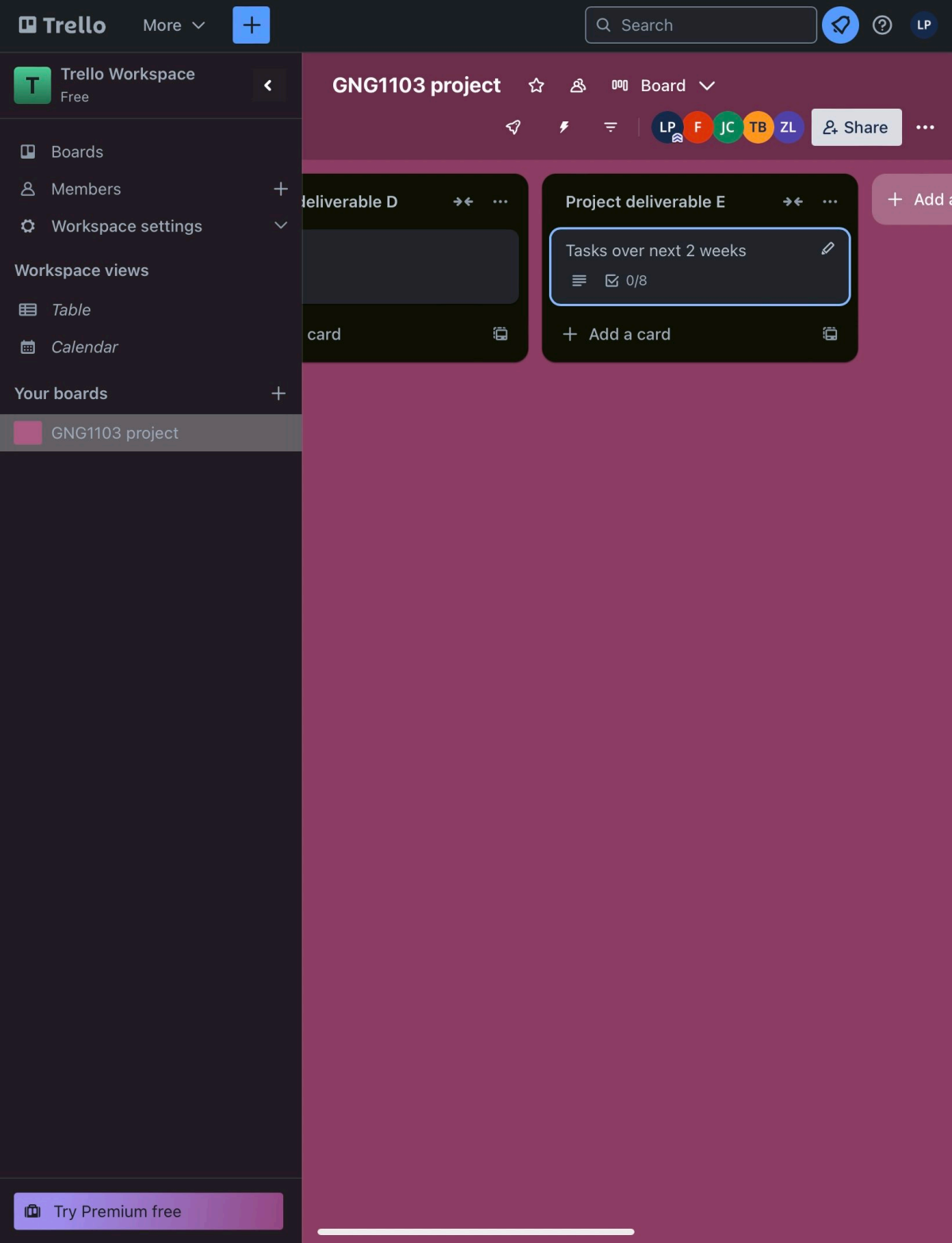
1. Accuracy of Adaptive Targeting: Measure response accuracy based on players' actions.
2. Structure Integrity: Check the resilience of obstacles after multiple interactions.
3. Effectiveness of Environmental Cues: Evaluate how well the robot recognizes and responds to environmental cues, such as targets or barriers.

   Prototype Fidelity and Cost:

- Fidelity: Use a low-to-medium fidelity level to balance realistic testing with cost and development time.
- Cost: Prioritize using cost-effective materials for obstacles and utilize simulation for early tests before moving to physical prototypes.

BOM

Product	Cost	Link
Table numb	9.90 $	https://www.amazon.ca/pack-Gold-Place-Card-Holders/dp/B0B2JM4Y3D/ref=asc_
Assorted cc	11.75$	https://www.amazon.ca/Crayola-Construction-Supplies-Teacher-Classroom/dp/B
Plastic cup	7$	https://www.canadiantire.ca/en/pdp/big-party-pack-plastic-reusable-cups-assorte
Poster boar	4$	https://www.staples.ca/products/356487-en-staples-recycled-poster-board-22-x-


Trello
More
Search
LP
Trello Workspace
Free
Boards
Members
Workspace settings
Workspace views
Table
Calendar
Your boards
GNG1103 project
GNG1103 project
Board
LP
F
JC
TB
ZL
Share
eliverable D
card
Project deliverable E
Tasks over next 2 weeks
0/8
Add a card
Add
Try Premium free

Tasks over next 2 weeks

in list PROJECT DELIVERABLE E

Notifications

Watch

Description

Edit

This is the breakdown of team responsibilities for the prototyping phase of the project

Robot-based requirements

Delete

0%

- [ ] Algorithm development
- [ ] Simulator (used to verify algorithm function)

Add an item

Physical requirements

Delete

0%

- [ ] Design of structures
- [ ] Construction of structures
- [ ] Acquiring materials

Add an item

Finishing requirements

Delete

0%

- [ ] Final code refinements
- [ ] Robot-structure integration testing
- [ ] Player testing session

Add an item

Activity

Show details

LP

Write a comment...

Louis Prince added this card to Project deliverable E

Join

Members

Labels

Checklist

Dates

Attachment

Cover

Custom Fields

Power-Ups

Add Power-Ups

Automation

Add button

Actions

Move

Copy

Make template

Archive

Share