Project Deliverable H: Prototype III and Customer Feedback

University of Ottawa

GNG1103: Intro to Engineering Design

Group 8 - BOOM

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November 24, 2024

Abstract

Deliverable H documents the group's production of Prototype III, which is derived from pre-existing user requirements, the group's expected metrics, and user feedback from Client Meeting II and III. This deliverable also outlines the prototype test plan for the following prototype. Throughout the testing phase, the group validated the project's feasibility based on the group's initial designs and received feedback from the client and peers alike. An additional emphasis on budget constraints, time constraints and resource management are placed in this deliverable and will remain a key emphasis for upcoming production.

Introduction

Group 8 has completed a list of deliverables, which focused on interpreting user needs, deriving design requirements from such needs, conceptualizing the requirements into concrete ideas, and planning for prototyping.

Taking feedback from the client in Client Meeting II, the group has adjusted the initial global concept into a more suitable idea for the project, with Deliverable F providing a low fidelity, digital prototype (Prototype I) in each of the four aspects: storyboarding, CAD modelling, Robomaster coding, and laser cutting. For Prototype II, such digital prototypes were attempted to be produced as physical models. However, due to technical errors and time constraints, some physical prototypes were not made in time for Deliverable G.

Such physical prototypes and related testing will be documented in this deliverable.

1.1 Related Work

Seven deliverables have been completed prior to Deliverable H, with certain deliverables imperative to the current stage in development, these include:

Deliverable B: This deliverable list user requirements we have collected during the Client Meeting. With further interpretation on the requirements, we also included additional ones to ensure the quality of the final product. Additionally, a problem statement is created to summarize the general requirements.

Deliverable C: This deliverable adds on to Deliverable B by assigning expected metrics to design requirements. The requirements are then ordered in a priority list to generate major focus points of the group's design. Benchmarking is also expanded by evaluating existing products with the group's expected metrics. This allows us to better understand whether it is reasonable to set such standards for the group's final product.

Deliverable D: This deliverable focuses on generating conceptual ideas from existing design requirements and criteria. Such ideas revolve around four major subsystems: storyline, interaction between players, players' interaction with the game, and the implementation of Robomaster S1. Three global concepts are then generated by creating amalgams of the group's respective concepts, and one final concept is subsequently chosen.

Deliverable E: This deliverable focuses on the group's plan for the following weeks and method of executing the project with consideration to budget constraints and time limitations. Risks, contingency plans, and expenses are also included in this deliverable.

Deliverable F: This deliverable transcribes the steps and results of Prototype I, a digital and low-fidelity representation of the group's conceptual idea.

Deliverable G: This deliverable transcribes the steps and results of Prototype II, a semi-physical and high-fidelity representation of the group's conceptual idea.

Previous deliverables are available here.

Appendix I, II, III: Since Deliverable G, the group has received feedback and updates in schedules and budgeting. To keep the most updated information available, such updates are included in appendixes. These appendixes consist of the link to the group Trello board, the updated task schedule, and the bill of materials.

Appendix IV: The fourth appendix consists of a handwritten Fishbone diagram derived from the group's Predictive Failure Modes and Effects (PFME) analysis. This demonstrates the potential aspects of the production that may lead to critical failure, allowing the group to have a more focused baseline for future prototyping.

Prototype III

2.1 Prototyping Objectives

- Create laser cutting MDF prototypes for props
- Test for Robomaster code functionality and compatibility with Character Cards
- Measure assembly speed and storage volume of the components

2.2 Prototype

2.2.1 Props (Laser Cutting)

In Prototype II, the laser cutting for the props was unsuccessful. However, it has been since completed for Prototype III. The physical props were then put under physical testing and passes the group's standards.

2.2.1.1 First Trial

Criteria	Metrics	Test and Result	Pass/Fail
Can the MDF pieces withstand the average weight of a player?	Weight (kg)	When average human male (50-60 kg) steps on the MDF pieces for 3 times, there is no observable damage.	**PASS**
Do the MDF pieces easily get scratched from sharp objects?	Boolean	When the pieces are scratches with sharp nails and keys, there are no observable changes.	**PASS**

Table 1: Trial 1 test results for props

2.2.2 Robomaster Testing

In Prototype II, the Robomaster was tested with early prototype codes and without a physical prop. Soon afterwards, the group discovered limitations with the Robomaster, most notably its limitation with detecting Vision Markers. The group then pivoted to printing the actual Vision Marker as provided by DJI, and glue them to the Character Cards.

In Prototype III, the Robomaster's scanning function is put to test. The results exceed the group's expectations and the Robomaster was able to detect the Vision Markers on the Character Cards. However, there were some inherent limitations, specifically the range and glare. Nonetheless, such limitations are insignificant and can still facilitate a smooth gaming experience by adjusting the set-up to fit such limitations.

2.2.2.1 Second Trial

Criteria	Metrics	Test and Result	Pass/Fail
Can the Robomaster detect the character cards, if so, does it	Boolean	The Robomaster works exactly as the DJI Edu Hub simulation. However, distance and glare	**PASS**

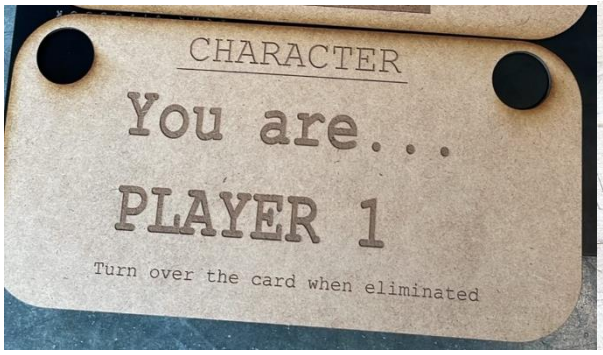
continue to run its following code?		are major factors in whether the cards are recognised.	

Table 2: Trial 2 test results for Robomaster Testing

2.2.3 Assembly and Storage

With prototypes of props and character cards produced, the group attempted to set up a storage package. As expected, all equipment is capable of fitting in a backpack, if not a smaller container.

2.2.3.1 First Trial



Figures 1 and 2: Character Card and Event Card Prototypes

Criteria	Metrics	Test and Result	Pass/Fail
How long does it take to assemble the components for the experience?	Time (s)	Set up time depends on personnel and their expected experience area (experience area is flexible, if it lies within the 3-metre range of the Robomaster S1 scanner). It ranges from 1 minute to 3 minutes.	**PASS**
Do the components fit in an average backpack?	Boolean	The package is capable of fitting in an average paper bag. While an actual backpack is not used, a backpack is significantly larger than the said paper bag.	**PASS**

Table 3: Trial 1 test results for assembly and storage test

2.3 Evaluating Prototyping Objectives

Create laser cutting MDF prototypes for props	Successful ☑
Test for Robomaster code functionality and compatibility with Character Cards	Successful ☑
Measure assembly speed and storage volume of the components	Successful ☑

2.3.1 Skills Acquired/Improved in Prototyping

2.3.1.1 Props

- **Mass produce**: As the number of parts is of a considerable amount, the group designed a format for parts to be repeatedly replicated for future designs.
- **Predicting outcome**: The Inkscape software is only capable of showing black and white lines and cannot display the appearance of the final product. As a result, the group must use knowledge from previous lab sessions to assume whether the design would be feasible.

- **Method of Testing:** In the testing phase, the group made use of different approaches to test for the durability of the MDF boards. When one approach fails to yield expected results, the group pivots to a second trial that can provide information the group needs.

2.3.1.2 Robomaster

- **Predicting outcome**: While the DJI Edu Hub includes a simulation feature, allowing the code to be run through a simulated environment of the Robomaster S1, the functionality of the code remains uncertain. As a result, the group is needed to trace the code manually after the simulation to ensure the execution meets the expected outcome.
- **Debugging**: During the coding process, the group encountered several logical obstacles. However, with repeated testing, the group soon became more familiar with the coding environment of the DJI Edu Hub. This allows following coding to be much smoother.
- **Mass produce**: The Robomaster testing and the Character Card production are closely related. When one batch of prototypes fail to work properly, the group makes use of the format for cards to be repeatedly replicated for future designs.

Client and User Feedback

To gather feedback, the group gave a presentation to other groups and instructor, as well as interviewed potential users.

Among the feedback, most are concerns over the production process. Many questioned whether printing the Vision Markers are a viable method for the Robomaster to recognise. Some feedback also went to the durability of MDF boards. However, such concerns were alleviated by testing in Prototype III.

1. **Vision Markers:** While many raise their concern on whether the printed vision markers can be recognised the Robomaster, the group did extensive testing with a prototype. The group concluded that the replicas work properly, albeit with range limitations. However, gathering feedback from peers, the range limitations seem to be inherent, and remains regardless of the quality of the vision markers.
2. **MDF Boards:** Some were concerned whether the MDF boards can withstand regular wear and tear. However, the group did physical experimental testing with the prototypes. It came to the conclusion that the MDF boards can properly withstand dropping, stepping, and the weight of the Robomaster S1.

Project Plan

The following includes the detailed tasks and work distribution between team members. The following tasks are completed as of this deliverable. Future work for the group will be listed under “Future Tasks”.

Task	Description	Duration	Group Member(s)	Status
Prototype I				
Storyboarding	Storyboard on the existing storyline in Prototype I	2 hours	I. Chan	Completed

Robomaster Coding	Draft a prototype code for the Robomaster and test through DJI Edu Hub simulations	2 hours	A. Nasimi	Completed
CAD Model Sketch	Sketch the CAD for the props that will be produced in future prototypes	2 hours	T. Lo	Completed
Laser Cutting	Design character, elimination, and event cards on Inkscape	1 hour	I. Chan	Completed
User Feedback	Create a Google Form to collect feedback from potential users and analyse the result	2 hours	S. Irwin	Completed
Prototype II Test Plan	Create a test plan that outlines the following prototype	0.5 hours	A. Nasimi	Completed
Update Project Plan	Update task schedules to accurately demonstrate the week of Prototype I	0.5 hours	I. Chan	Completed
Prototype II				
Purchase materials on Bill of Materials	Consult TA and purchase materials	2 hours	S. Irwin	Completed
Find suitable audio files	Find suitable audio files (gunshots, explosions, robot moving) in the public domain	0.5 hour	S. Irwin	Completed
Laser Cutting (Cards)	Create physical prototypes from pre-existing Inkscape documents for character and/or event cards	1 hour	I. Chan	Completed
Robomaster Testing	Test whether the program works properly on the physical Robomaster	1 hours	A. Nasimi S. Irwin	Completed
Props	Create laser cutting document of prop parts	1 hours	T. Lo	Completed
Prototype III				
Laser Cutting (Props)	Create physical prototypes from pre-existing Inkscape documents for props	2 hours	I. Chan T. Lo	Completed
Assembly and Storage	Create an assembly package and test if it meets design requirements	1 hours	I. Chan T. Lo	Completed
Aesthetics	Modify prototypes into products	2 hours	A. Nasimi S. Irwin	Completed
Future/Non-Prototype Tasks				
Presentation Material	Create materials for presentation on Design Day	2 hours	I. Chan	Completed
Write Instruction Manual	Create a prototype instruction manual that explains the actual operation of the game	2 hours	S. Irwin	Incomplete

Final Modifications	Modify products to ensure durability and quality	2 hours	I. Chan S. Irwin T. Lo A. Nasimi	Incomplete

Table 4: Task List

Conclusion

In conclusion, Deliverable H allows Group 8 to observe the physical products and modify designs to further fit requirements and aesthetic expectations. Group 8 has been able to adhere to the budget constraint of $25 without deviating much from the group's digital prototypes, with only suitable changes done to reflect user and client feedback.

During the production of Prototype III, three major aspects of the product is further discussed: props, Robomaster and assembly package. The production and testing of the prototype allowed each member of Group 8 to have an opportunity to have a physical understanding of whether the designs are feasible in the group's case, and whether potential users give positive comments on such designs. It is believed that this understanding paves the way for a product of higher quality.

Deliverable H also focuses on gathering as much feedback from clients and potential users as possible. From surveys, the group received feedback from potential users, with this deliverable adjusting certain aspects of the project to further fit their expectations. Deliverable H serves as a final benchmarking point in the production of "The Grand Extraction" before Design Day. Not only did it assist Group 8 in ensuring the quality of products but also solidify the group's concepts into physical products.

Appendix I – Trello Link

Click here for the link to the Group 8 Trello board.

Appendix II – Updated Task Schedule

The following table lists the upcoming tasks that Group 8 in the following weeks. The list begins in the week of October 20 – 26, and includes deliverables, client feedback, and prototyping steps. Aside from the order of tasks, their dependencies, due date, duration, and the group member-in-charge (only for certain tasks) are also included. For simplicity, the order of tasks listed below are in order of the due date.

#	Task	Dependencies	Due Date	Duration	Group Members
0	*Deliverable D*	*Deliverable D is done prior to the range of this table*			
1	Client Meeting #2	Task 0	2024-10-24	1 session	Everyone
2	Adjust Global Concept	Task 0, 1	2024-10-26	2 days	Lo
3	Deliverable E: Project Plan & Cost	Tasks 0, 1, 2	2024-10-27	7 days	Everyone
4	Build Prototype I	Task 3	2024-10-31	4 days	Everyone
5	Customer Feedback (Prototype I)	Task 4, 5	2024-11-02	1 day	Chan
6	Deliverable F: Prototype I and Customer Feedback	Tasks 4, 5	2024-11-03	7 days	Everyone
7	Client Meeting #3	Task 0	2024-11-05	1 session	Everyone
8	Build Prototype II	Task 7	2024-11-08	5 days	Everyone
9	Customer Feedback (Prototype II)	Task 8	2024-11-09	1 day	Nasimi
10	Deliverable G: Prototype II & Customer Feedback	Tasks 7, 8, 9	2024-11-10	7 days	Everyone
11	Deliverable J: Project Presentations	Task 10	2024-11-15	4 days	Everyone
12	Build Prototype III	Task 10	2024-11-22	12 days	Everyone
13	Customer Feedback (Prototype III)	Task 12	2024-11-23	1 day	Irwin
14	Deliverable H: Prototype III & Customer Feedback	Tasks 12, 13	2024-11-24	14 days	Everyone
15	Deliverable I: Design Day Presentation Material	Task 14	2024-11-27	3 days	Everyone
16	Design Day	Task 15	2024-11-28	1 session	Everyone
17	Deliverable K: User & Product Manuals	Task 14	2024-12-03	14 days	Everyone

Table A: Plan for Upcoming Tasks from October 20 to December 7, 2024

Appendix III – Bill of Materials

The following table outlines the required materials for the final product, how such materials will be incorporated in the product, the source for the purchase, and the price of the material. The total budget is of $25.

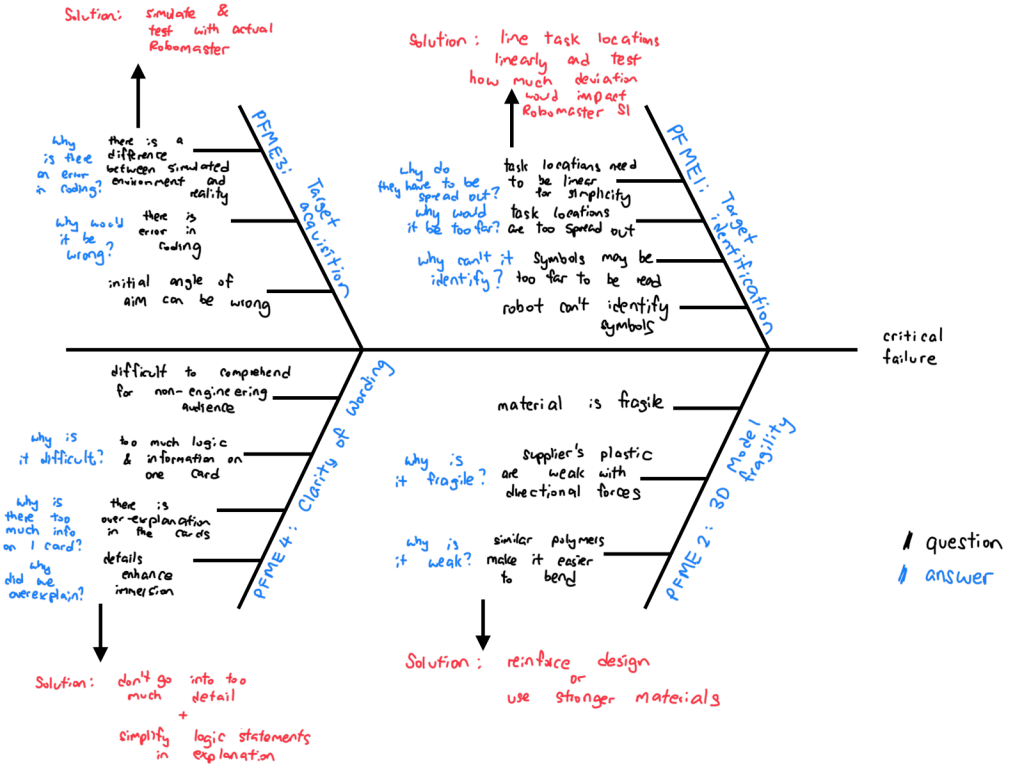
Material	Description	Quantity	Source	Price (CAD)
Card Material (MDF)	Character and Event Cards	5	Makerspace	Free
Rope	Used for Cards	1	Home Depot	$8
Super Glue	Used for glueing 3D prints and player cards	1	Home Depot	$6
Scissors	Used for cutting rope and other materials	1	Home Depot	$3
Markers (Black Sharpie)	Used for outlining and defining shapes	1	Home Depot	$3
Printed Poster	Design Day material	1	DocU Centre	$3

Table B: Bill of Materials required for final product

Appendix IV – PFME Analysis

The following consists of a Fishbone diagram derived from the group's Predictive Failure Modes and Effects (PFME) analysis. The Fishbone diagram narrows the potential risks down to four major PFMEs: target identification, 3D model fragility, target acquisition and clarity of wording. Each aspect is then further discussed to pinpoint the root problem.

With a clear idea of potential risks, each of the PFME is then given a score from 1 to 4 in terms of effect and mode. A table is then drawn to demonstrate which PFME, and its aspects are of utmost importance and should be a priority in prototyping.



PFME	Effect	Mode
①	4	3
②	3	2
③	2	4
④	4	4

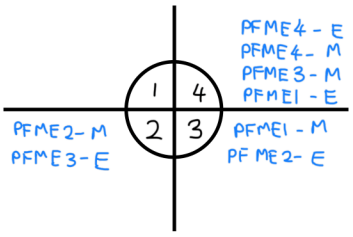


Figure A: Fishbone Diagram derived from PFME analysis