Osprey Design Experience Weekly Memo

TEAM NAME: Green Ellipsis – Upcycling of Single Use Plastic Softdrink Bottles

DATE: 09/23/2022

ATTACHMENTS:

1. Work Breakdown Structure

MEMO AUTHOR: Christian Ventouras

WORK COMPLETED THIS WEEK:

- Wrote Work Breakdown Structure due 09/23/2022
- Created Preliminary Budget due 09/23/2022

WORK TO BE COMPLETED NEXT WEEK:

- Version Two of the Problem Statement due 09/30/2022

TEAM HOURS:

Name	Hours
Marc	6.5
Tyler	6
Antonio	6
Nicholas	9.5
Christian	6.5
Total	34.5

Work Breakdown Structure for Automation of PET Upcycler

Development Process	Time (Weeks)
1. Team Formation and Problem Definition/Scope	
1.1. Team Values Statement	1
1.2. Problem Statement Version 1	1
1.3. Weekly Planning Schedule	1
2. Concept Selection	
2.1. Brainstorming Session	1
2.2. Concept Research/Background Knowledge	1
2.3. Concept Down Selection	1
3. Report Introduction	
3.1. Brainstorming/Section Selection	1
3.2. Research of Background and Theoretical Concepts	1
3.3. Problem Statement Revision	1
3.4. Written Draft of Report Introduction	1
4. Project Planning	
4.1. Preliminary Work Breakdown Structure	1
4.2. Preliminary Budget	1
4.2.1. Cost Breakdown	1
5. PET Upcycler Design	
5.1. Design Review	2
5.2. Problem Statement Version 2	1
5.3. Configuration Requirements	1
5.4. Mid Semester Progress Presentation	2
5.5. Initial Material Selection	1
5.6. Initial 3D CAD Models	1
5.7. Initial Electrical Schematics	1
5.8. Critical Design Review Report with CAD, Schematics, Flowcharts, Final Work Breakdown Structure Report, Final Project Budget and Bill of Material	3
5.9. Version 3 of Problem Statement	1
5.10. Purchase Necessary Materials Required for Testing	1
6. Prototyping/Testing/Analysis of Mechanical/Electrical Components	
6.1. 3D-Print Components	1
6.2. Mechanical Testing	1
6.3. Electrical Testing	1
6.4. Automation Efficiency Testing	1
6.5. Brainstorming Improvements	1
6.6. Implementing Improvements	2
6.6.1. Update CAD Models	
6.6.2. Iterate Until Desired Outcomes Met	
7. Final Design	
7.1. Review Final Design	1

7.2. Final Design Proposals	16
7.3. Final Team Presentations	1
7.4. Reflective Writing Assignment	1
7.5. Final Team Presentations	2
7.6. Purchase Materials Required for Final Design	1
8. Final Product	
8.1. Plan the Construction of the Final Design	1
8.2. Manufacturing Necessary Parts	4
8.3. Assembling Mechanical Components	4
8.4. Assembling Electrical Components	4
8.5. Verify Final Design with Requirements and Constraints	1
8.6. Prepare and Showcase Final Product/Report	3

Table 1: Gantt chart of the development process

Development Process

ACTIVITY	Start Date	PLAN DURATION
1. Team Formation and Problem Definition/Scope		
1.1. Team Values Statement	8/29/2022	1
1.2. Problem Statement Version 1	8/29/2022	1
1.3. Weekly Planning Schedule	8/29/2022	1
2. Concept Selection		
2.1. Brainstorming Session	9/5/2022	1
2.2. Concept Research/Background Knowledge	9/5/2022	1
2.3. Concept Down Selection	9/5/2022	1
3. Report Introduction		
3.1. Brainstorming/Section Selection	9/12/2022	1
3.2. Research of Background and Theoretical Concepts	9/12/2022	1
3.3. Problem Statement Revision	9/12/2022	1
3.4. Written Draft of Report Introduction	9/12/2022	1
4. Project Planning		
4.1. Preliminary Work Breakdown Structure	9/19/2022	1
4.2. Preliminary Budget	9/19/2022	1
4.2.1. Cost Breakdown	9/19/2022	1
5. PET Upcycler Design		
5.1. Design Review	9/26/2022	2
5.2. Problem Statement Version 2	9/26/2022	1
5.3. Configuration Requirements	10/3/2022	1
5.4. Mid Semester Progress Presentation	10/3/2022	2
5.5. Initial Material Selection	10/3/2022	1
5.6. Initial 3D CAD Models	10/3/2022	2
5.7. Initial Electrical Schematics	10/3/2022	2
5.8. Critical Design Review Report with CAD, Schematics, Flowcharts, Final Work Breakdown Structure Report, Final Project Budget and Bill of Material	10/3/2022	3
5.9. Version 3 of Problem Statement	10/17/2022	1
5.10. Purchase Necessary Materials Required for Testing	10/24/2022	1
6. Prototyping/Testing/Analysis of Mechanical/Electrical Components		
6.1. 3D-Print Components	10/31/2022	1
6.2. Mechanical Testing	10/31/2022	1
6.3. Electrical Testing	10/31/2022	1
6.4. Automation Efficiency Testing	11/7/2022	1
6.5. Brainstorming Improvements	11/7/2022	1
6.6. Implementing Improvements	11/7/2022	2
6.6.1. Update CAD Models		
6.6.2. Iterate Until Desired Outcomes Met		
7. Final Design		
7.1. Review Final Design	11/21/2022	1
7.2. Final Design Proposals	8/29/2022	16
7.3. Reflective Writing Assignment	11/28/2022	1
7.4. Final Team Presentations	11/28/2022	2
7.5. Purchase Materials Required for Final Design	12/5/2022	1
8. Final Product		
8.1. Plan the Construction of the Final Design	1/16/2023	1
8.2. Manufacturing Necessary Parts	1/23/2023	7
8.3. Assembling Mechanical Components	1/23/2023	7
8.4. Assembling Electrical Components	1/23/2023	7
8.5. Verify Final Design with Requirements and Constraints	3/6/2023	1
8.6. Prepare and Showcase Final Product/Report	3/6/2023	3

Time in Weekly Increments

Table 1 shows the preliminary Gantt chart for the overall development process. Team formation and problem definition scope is the preliminary process of defining the values, responsibilities, and problem statement of the project at hand. Concept selection follows the problem statement by brainstorming strong concepts to solving the problem and selecting the best once according to the weighted down selectin chart and AHP chart. The report introduction is the start of the documented project proposal and includes the team formation, problem definition/scope, concept selections as well as any research done to understand the theoretical concepts proposed. Project planning defines the projected course of action for completing the needed tasks of the project by creating a work breakdown structure with Gant charts and creating a preliminary budget.

The PET Upcycler Design phase is the process of performing initial calculations for the proposed design. This includes any calculations done to determine the material, power requirements, sizing, etc. From this an initial prototype can be manufactured and tested. The Testing and Analysis phase goes over the iterative process of testing the design, evaluating its performance, and implementing improvements until the design meets the requirements and constraints. Multiple tests are performed in this process including strength tests to ensure they can survive expected stresses, electrical testing to ensure all electrical components are operating correctly, and automation efficiency tests to evaluate how well the design automates the process. During the Final Design and Final Product phase, the final design and accompanying documentation is prepared for the final presentation.

The overall budget constraint on the design project for Green Ellipsis is $1,000. The accumulated costs will come from the testing of initial designs and the construction of the final product. Initial projections for the project show the ability to stay under budget as shown in Table 1. Part of this results from the fact that only the bottle cutting step in the process will be automated. In addition, it is of the mindset that most of the parts will be 3D printed since this is a hobbyist focused product. Furthermore, the ability to 3D print specialized parts instead of purchasing or outsourcing will assist in reducing the overall cost. Another cost saver is the fact that the pultrusion device already has a control board that can be programmed. This reduces the cost because no additional circuit boards or controllers will be necessary.

Table 2: Preliminary costs associated with the bottle cutting device

Preliminary Costs	
Items	**Cost**
3D Printer Filament Spool (QTY 4)	$80-$120
Cutting Blades (QTY 10)	$6
Electric Motor (QTY 2)	$30
LCD Screen for Arduino (QTY 1)	$15
Limit Switches (QTY 5)	$15
Wires/Connectors (QTY 150ft)	$30
Ultrasonic Sensor (QTY 1)	$5
Total	$181.00

As of right now, there are only a few mechanical items needed. First, the 3D printer filament is mainly going to be used for testing purposes. A total of four kilograms of 3D printed material is the amount gained from buying four spools. The main material that will be used is PLA, which typically ranges between twenty and thirty dollars a spool. It is likely, however, that the majority of the final parts will be printed out of PET material because of the values of Green Ellipsis. Testing will need to be done on this PET material to verify if it is able to withstand the possible forces encountered. Next, gears may be needed to regulate the rotation of the cutter device. If possible, the gears used will be 3D printed. Moreover, 3D printed gears will need to be tested, however, this would be ideal since the end product is driven by a hobbyist focus. So, the cost of gears are included in the cost of 3D printer filament. Finally, cutting blades are needed as the part that will cut off the bottom of the bottle, along with the plastic strand. The majority of blades come in packs of 10 or 100, ranging from six to 20 dollars. As an initial assumption, 10 blades should be sufficient. This is because approximately two blades will be used for the actual product, and the rest can be used for testing purposes.

There are several electrical components that are needed for the cutting process. The initial design has only one electric motor being used. Since small electric motors are fairly inexpensive, two will be purchased for a total cost of $30. One will be used as the main motor and the second will be a backup in case the first motor malfunctions. Wires and connectors will be needed to connect the motor to the circuit board that currently runs the existing pultrusion device. $10 worth of wire will be purchased, which gives approximately 150 feet. An additional LCD screen will be used in conjunction with the existing pultrusion device to display the information needed for the user about the bottle cutting process. This will cost $15. In addition, a connector bundle for the wires would cost about $20. Finally, an ultrasonic sensor and five limit switches will be needed to cease the cutting process before reaching the thickness change of the top of the bottle. An early estimation of these components cost approximately $20.

There is a lot of room with the budget since the current estimated total is only $181. This is good as it allows for any unforeseen additional costs, should they manifest. In addition, a low cost is beneficial to hobbyists that may want to replicate the automatic bottle cutter on their own.