

GNG5140 Design Requirement and Project Plan

Assignment C Modular Ultralight eV Prototyping

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Abstract

UO Super mileage is a student organization at the University of Ottawa that competes in the highly regarded Shell Eco-Marathon program. The aim of the club is to design and build the most energy-efficient electric vehicle possible and to provide undergraduate and graduate students with the opportunity to enhance their engineering skills through hands-on experience. Over the years, the team has taken part in the prototype car category, which involves creating smaller vehicles that only require functional components and don't have any added features. However, more recently, they have stepped up to the urban concept category, where they face new design and production challenges such as optimizing the manufacturing process to create the chassis frame adapters. The process must be robust, economical and efficient in terms of material usage, among other important factors.

Our group, which is part of the Engineering Design course (GNG5140) at the University of Ottawa, will be providing support to the UO Super mileage club in selecting the most suitable manufacturing process for their vehicles. In this report, we begin by clearly defining the design problems and presenting some examples of existing solutions for reference. Additionally, we provide comprehensive technical information on the various manufacturing processes that will be evaluated and compared in order to determine which is the best fit for the club's needs in terms of design, mechanical requirements, and budget constraints.

Table of Contents

Abstract	i
Table of Contents	ii
List of Tables	iii
List of Acronyms	iv
1 Introduction.....	5
2 Design requirement and project plan	6
2.1 Metrics to Define the Quality of Future Product.....	6
2.2 Existing Design Features and Flaws	7
2.2.1 Dragon Plate	7
2.2.2 Leevalley	7
2.2.3 Kesoto	8
2.3 User-testing Results.....	8
3 Revised Prototype requirements, Problem Statement and Prototype Definition	9
3.1 Design Fixes and Improvements Based on User Needs.....	9
3.2 Improved Design Requirements.....	9
3.3 Updated Problem Statement.....	9
3.4 Prototypes.....	10
4 Test Plan.....	11
5 Conclusion and Recommendations.....	12
6 Bibliography	13

List of Tables

Table 1: Metrics 6

Table 2 : Technical Benchmarking 6

Table 3 : Revised Requirements 9

List of Acronyms

1 Introduction

The University of Ottawa's SAE Supermileage team has constantly worked to improve its energy-efficient automobiles. We have been tasked with finding alternate ways of spare part production that are cost effective, time efficient, and simple to learn. We are focused mostly on traditional manufacturing techniques, from which we will methodically seek inspiration and work towards the needs of our Super mileage team. We gathered public materials from multiple SAE Supermileage teams and determined the processes employed, such as water jet cutting, CNC machining, Additive fabrication, and casting. Some pieces must be extremely exact, and their production will be beyond the scope of this project. We had a thorough discussion with our team members and decided to focus more on casting processes (with possible future development) and, secondly, the process of additive manufacturing. We will be able to best develop a better solution and bring about a revolutionary change in low-cost manufacturing using the information gained from the collected resources.

2 Design requirement and project plan

2.1 Metrics to Define the Quality of Future Product

Table 1: Metrics

Metrics		Units
1	Strength	N/mm2
2	Impact Resistance	N/mm2
3	Total Mass	Kg
4	Cost	\$
5	Maximum Speed of vehicle	Km/h
6	No. of tubes that need to be joined.	No.
7	Diameters of tubes	mm

Technical Benchmarking

For this project we do not have any previous prototype and haven't carried out any tests. So, to go further we use our benchmarking from previous deliverable to understand better the existing design requirement and project plan.

Table 2 : Technical Benchmarking

#Metrics	Metrics	Units	Dragonplate [1]	leevalley [2]	Kesoto [3]
1	Strength	N/mm2	Aluminum 310	PVC 52	316SS 580
			Plastic56-60	-	-
2	Impact Resistance	N/mm2	276	8	240
3	Total Mass	Kg	0.5	0.2	0.8
4	Cost	\$	22	20	17
5	Maximum Speed of vehicle	Km/h	<100	<80	<90
6	No. of tubes that need to be joined.	No.	7	6	6
7	Diameters of tubes	mm	-	-	-

2.2 Existing Design Features and Flaws

2.2.1 Dragon Plate [1]

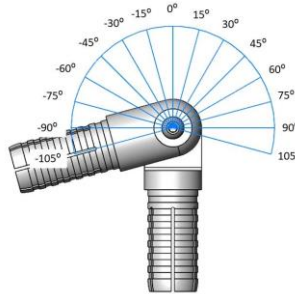


Figure 1: Working Angle



Figure 2 : Dragon Stone Joint Design

Features

1. Modular
2. Flexible to pipe orientation.
3. Quick and easy to assemble.

Flaws

1. Once joint is assembled (using epoxy) to tube, unable to reuse it.
2. It doesn't have the facility of mounting features.

2.2.2 Leevalley [2]



Figure 3 : Tube Connector

Features

1. Facility to add mounting features.
2. Light Weight and comparatively cheaper.

Flaws

1. Specific design for each joint.
2. Stress concentration at junction, which consequently weaken the joint.

2.2.3 Kesoto [3]



Figure 4 : Stainless Steel Split Connector

Features

1. The joint is strong.
2. The joint facilitates maintainability.

Flaws

1. Too heavy
2. Pressure is non uniformed (screw on the red circles) on the tube surface in the vicinity of the joint.

2.3 User-testing Results

At this stage we didn't have any user testing results and the analysis is carried out for benchmarking products to better understand the problem.

3 Revised Prototype requirements, Problem Statement and Prototype Definition

3.1 Design Fixes and Improvements Based on User Needs

1. Two category of joints
 - 1) Permanent Joint
 - 2) Non-Permanent Joint
2. Impact Resistance to prevent joint failure while sudden breaking.
3. Material Properties of joint material
4. Design of mounting features

3.2 Improved Design Requirements

Based on our benchmarking and data verification with client the following improved design requirements should be needed.

Table 3 : Revised Requirements

1	Strength	> 580 MPa
2	Diameter	1/2", 5/8"
3	Max Speed	45 Km/h
4	Maximum Weight of Vehicle	300 Kg
5	Recommended Weight of Vehicle	100 Kg
6	Diameter of Break Lines	3/16"
7	Diameter of Electrical Winding	Maximum 3 cables, 3/8" each
8	Cost	< \$200
9	Maximum No of tubes at joint	< 8
10	Corrosion Resistance	✓
11	Electrical Conductivity	✗

3.3 Updated Problem Statement

Design of a tube joints to facilitate transition from monocoque design to frame base design for vehicle, to provide easy assembly for upcoming students and to reduce the carbon footprint.

Revised Prototype requirements, Problem Statement and Prototype

Definition

3.4 Prototypes

As shown in the figure,

First, prototype of two categories of joints will be tested, which will be followed by the addition of mounting features.

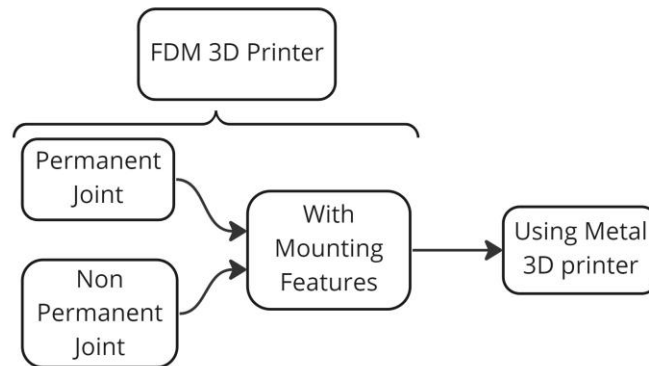


Figure 5 : Flow Chart of Prototypes

Revised Prototype requirements, Problem Statement and Prototype

4 Test Plan

The project plan is updated based on our current standing,

1. Different prototypes were added in the subtask of prototype.
2. Dates and time for the future tasks were modified.

Modular Ultra-light EV prototypes					
<div> <div>List</div> <div>Board</div> <div>Table</div> <div>...</div> <div>+</div> </div> <div> <div>All tasks</div> <div>By Name</div> <div>Expand/Collapse</div> <div></div> <div></div> </div>					
	Name ↑	Assignee	Status	Start date	Due date
1	Modular Ultra-light EV prototypes		New		
2	1.Initiation				
3	Team Contract	Anuj Shah	Completed	11/01/2023	20/01/2023
4	2.Planning				
5	2.1Setting up Project and Goals	Sina Ghazali	Completed	24/01/2023	26/01/2023
6	2.2Budget	Tony Tsang	Completed	24/01/2023	26/01/2023
7	2.3Communication Plan	Vishwadath Ayyappan	Completed	20/01/2023	23/01/2023
8	2.4Risk Management plan	Anuj Shah	Completed	24/02/2023	27/02/2023
9	2.5Project Plan(PD A)	Sina Ghazali	Completed	13/01/2023	19/01/2023
10	3.Execution				
11	3.1 PD A:Client Meeting Preparation	Anuj Shah	Completed		18/01/2023
12	3.2Client Meet1	Vishwadath Ayyappan	Completed	23/01/2023	25/01/2023
13	3.3PD B	Tony Tsang	Completed		06/03/2023
17	3.4 Client meet 2	Anuj Shah	Completed	16/02/2023	16/02/2023
18	3.5 PD C	Sina Ghazali	In Progress		16/03/2023
22	3.6 PD D	Vishwadath Ayyappan	New		09/03/2023
35	3.7 Client meet 3	Anuj Shah	New	08/03/2023	10/03/2023
36	3.8 PD E	Anuj Shah	New		22/03/2023
39	3.9 PD F: Final Project Presentation	Tony Tsang	New		29/03/2023
40	Design Day	Sina Ghazali	New		03/04/2023
41	4.Monitoring and Control		New		
42	4.1 Project objectives	Tony Tsang	New		
43	4.2 Quality of deliverables	Vishwadath Ayyappan	New		
44	4.3 Project performance and cost	Anuj Shah	New		
45	4.4 Schedule status	Sina Ghazali	New		
46	5.Closing		New		
47	5.1 PD H: Video and user manual	Tony Tsang	New	04/04/2023	18/04/2023

5 Conclusion and Recommendations

The report has provided a comprehensive analysis of the design requirements and project plan for the Modular Ultralight eV Prototyping project. The review of existing metrics, technical and user benchmarking, and user testing has been instrumental in identifying design fixes, improvements, and revised design requirements. The report has provided a new prototype definition and updated the problem statement to reflect the changes in the revised solution. Overall, the report has demonstrated a deep understanding of the project requirements, and the proposed solution is well-aligned with the project goals.

To ensure the success of the Modular Ultralight eV Prototyping project, it is recommended that the following actions be taken:

1. Finalize the Revised Requirements: The revised requirements proposed in the report should be reviewed and finalized to ensure that it meets all client needs and is feasible to implement.
2. Review and Update the Project Plan: The project plan should be reviewed and updated to reflect the changes in the revised solution. The timeline, budget, and resource allocation should be adjusted accordingly.
3. Collaborate with Experts: It may be necessary to collaborate with experts in various fields, such as electrical engineering, materials science, and transportation design, to ensure that the revised solution are designed and constructed to the highest standards.

By following these recommendations, the Modular Ultralight eV Prototyping project can be completed successfully, with a high-quality, safe, and sustainable final product.

6 Bibliography

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- [2] LeeValley, "PVC Three-Way Branch Connectors," LeeValley, [Online]. Available: https://www.leevalley.com/en-ca/shop/garden/planting/greenhouse/67332-pvc-three-way-branch-connectors?item=EA260&utm_source=free_google_shopping&utm_medium=organic&utm_campaign=shopping_feed&gclid=CjwKCAiAuOieBhAIEiwAgjCvcjlL127a6_PdKwbjKjs_4VJflis3N3MexE. [Accessed 30 1 2023].
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