

**EG1000**

**Engineering Design and Innovation**

**Project MPRC**

**Design Proposal for Team 16**

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# Abstract

This document presents the design proposal for Team 16, focusing on the SunRay Speedway. The proposal outlines two design concepts and provides a detailed analysis of the advantages and disadvantages of each. The document concludes with a recommendation for the most promising design concept based on the evaluation criteria.

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# 1 Introduction

Transportation is a crucial part of modern society. However, current personal transportation is based on petrol, which is not sustainable. In Australia, road vehicles made up 84 percent of full fuel cycle greenhouse gas emissions from all domestic transport modes in 2022-23, compared to 9 percent from aviation [1].

Many people are concerned about the environmental impact of transportation. Some people will choose to use electric vehicles, but the electricity used to charge the batteries of these vehicles is still mostly generated from thermal power plants, which is also an unsustainable method. The needs for transportation are increasing, and the environmental impact of transportation is becoming more severe.

Hence, it is high time to develop a sustainable transportation system. Solar power is a promising renewable energy source that can be used to power vehicles. The SunRay Race Car is a proposed solar-powered transportation system that aims to provide a sustainable and efficient mode of transportation for the future.

The most constraints of the current SunRay car are the speed and the strict use conditions. For the speed, our team will focus on minimizing the inner friction and the weight of the car and maximizing the efficiency of the solar panels. For the use conditions, our team will use capacitors to store the energy from the solar panels and use the energy stored in the capacitors to power the car. This method can make the car run in the rainy and cloudy days.

This design aims to address the increasing transportation demand while minimizing environmental impacts. By utilizing solar energy, the SunRay Race Car provides a reliable, eco-friendly solution that meets both current and future transportation needs

## 2 Problem Formulation

The design goal is to develop a prototype that uses solar energy as its main power, optimizes instantaneous energy utilization, achieves maximum speed over the shortest distance, achieves high energy efficiency, and adapts to all kinds of weather. The car requires a range of 10 meters, an efficient energy management system, and fast start and acceleration.

### 2.1 Requisite Knowledge

To complete the solar car project, in theoretical design part, we need to understand the knowledge of **capacitors, solar panels and circuits**, including the energy storage and discharge characteristics of capacitors under different load conditions, and design efficient circuits to achieve optimal energy transfer. In practical design part, we need to obtain the knowledge of **CAD, Laser cutting, and 3D printing**.

The basic knowledge of capacitor is available, but the discharge rate in the actual circuit requires a further testing. At the same time, it is also vital to select and optimize the Angle and position of efficient solar panels to adapt to varying lighting conditions and ensure energy storage and management in bad weather. While there is a basic understanding of solar panels, it is necessary to further optimize their placement and integration. The CAD, laser cutting, and 3D printing knowledge are also necessary to manufacture the car. We have a basic understanding of these technologies, and we will have some further practicing on the specific requirements and constraints of the project.

### 3 Conceptual Design

#### 3.1 System Overview

### 4 Design Evaluation

### 5 Project Planning

#### 5.1 Gantt Chart

Here is the Gantt Chart of our project planning to help you understand our project planing better.

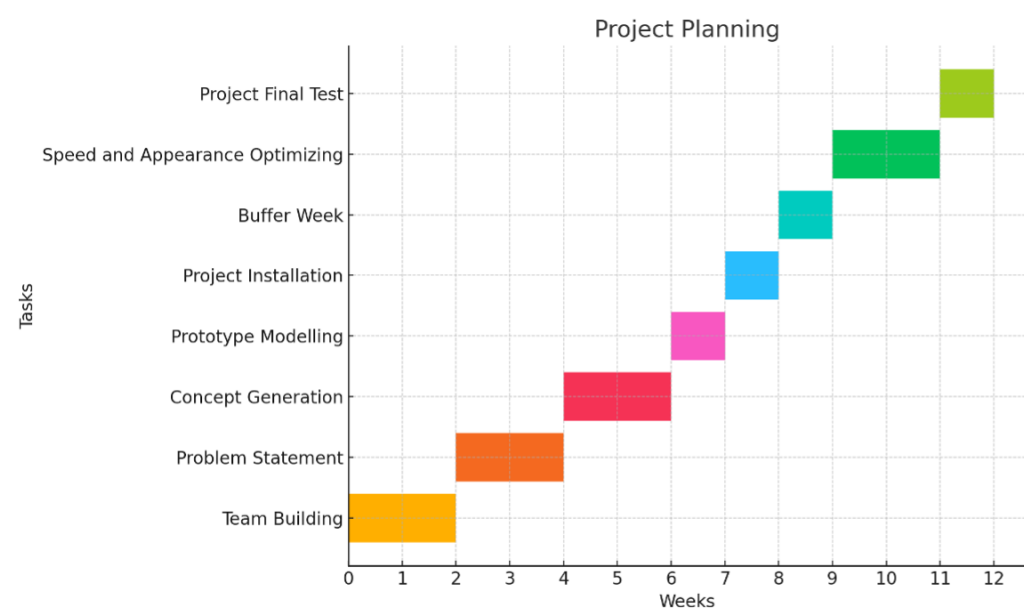


Figure 1: Gantt Chart

#### 5.2 Previous Work

In the first six weeks, we completed three theoretical parts: Team Building, Problem Statement, and Concept Generation. In Week 1, team members got to know each other and held the first group meet-

<b>Responsibility</b>	<b>Assigned Members</b>	<b>Description</b>
3D Printing Design Map	Chi-En Peng, Yung-Ching Liang	Accelerates project development and helps achieve precise design outcomes.
Gearbox	Yaran Zhang, Shenglin Wang	Contains gears, bearings, input shaft, output shaft, and housing. Provides torque amplification and load distribution.
Power System	Weijia Xiao	Ensures continuous power supply from solar panels to power the car efficiently.
Organizing & Laser Cutting	Cheong Zhang	Organize the team and assign tasks & Ensures accurate splicing of frames and reduces material waste.
Measurement	Yaran Zhang, Yixuan Wu, Chengrui Jiang	Ensures components fit together correctly and machines operate efficiently through precise measurements.

Table 1: Roles and Responsibilities in Solar-Powered Car Project

ing, where everyone presented their understanding of the problem statement. In Week 3, the problem statement facilitated more productive group discussions, as the outcomes were more comprehensive and feasible than individual solutions. By Week 5, the team delivered a presentation on concept generation, exploring various materials, power sources, and transmission methods to optimize performance by balancing efficiency, cost, and weight.

### 5.3 prototype modeling

Using a well-equipped car for simple tests was impractical, so we started with temporary substitutes. The body and bottom plate were made of cardboard, with a motor, solar panels, and wheels installed. While the car ran successfully, its speed was unsatisfactory. Additional materials were acquired, and further testing led to design optimizations to reduce weight and improve speed.

### 5.4 Project installation

To install the car, we have decided the components that may be used in our solar panel car. Such as the solar panel, DC Motor, wheels, base, the shell, gears, transmission shaft and some wires to transfer electric energy. Careful selection and placement of components, such as the solar panel, motor, wheels, and transmission system, is important to ensure a balanced and smooth-running car[2].

### 5.5 Speed and Appearance optimization

To achieve high speed, we focused on reducing weight and minimizing components. After building the first version, we removed or replaced parts to make it lighter and faster. Friction within the power system, including the gearbox and transmission shaft, was minimized. On cloudy days, capacitors will

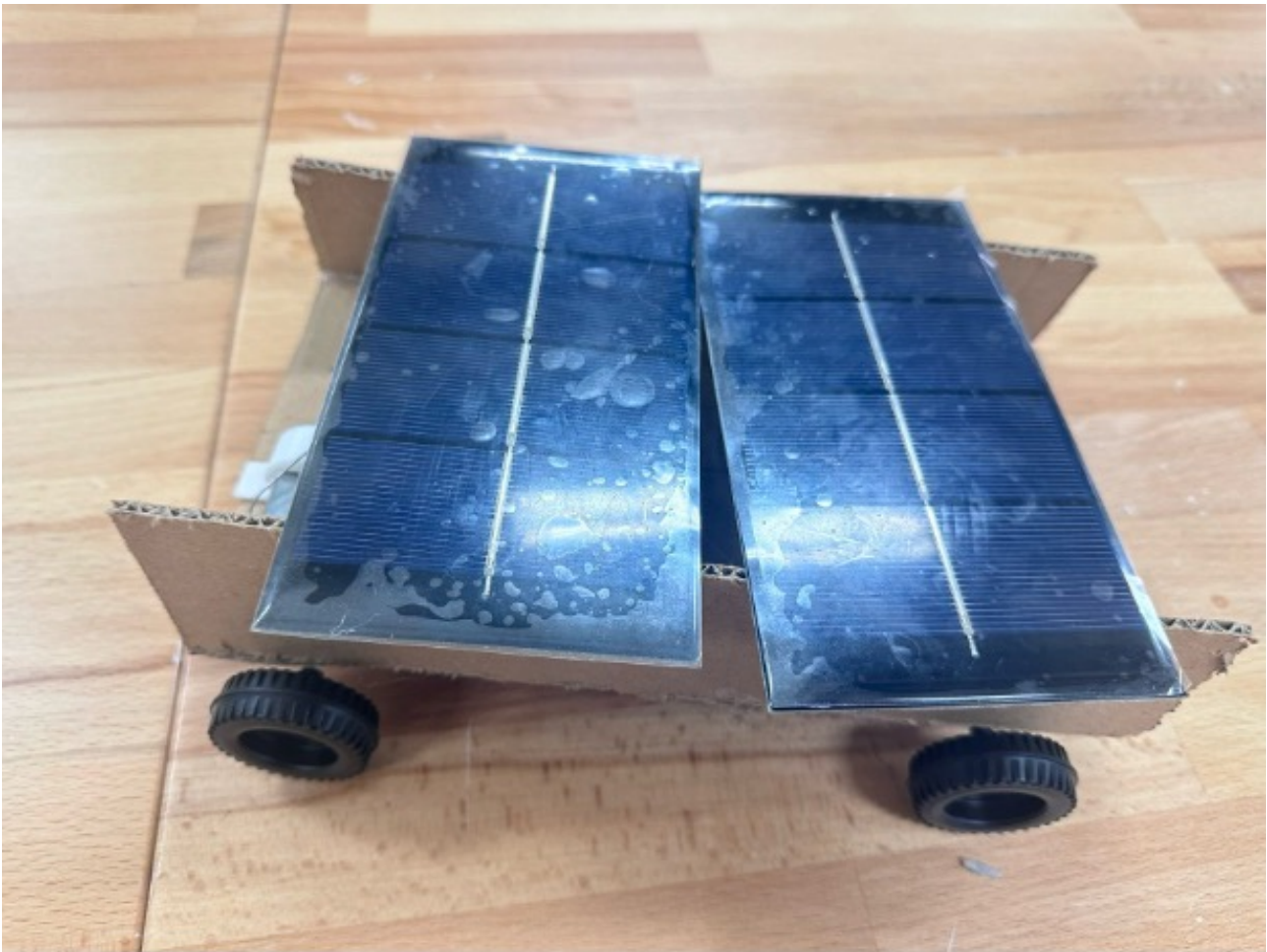


Figure 2: Tested Car prototype

power the car, requiring resistor optimization. We will also test and adjust the gear ratio to maximize speed. Additionally, the car's appearance will be refined to enhance market appeal.

## 5.6 Project Final Test

In the final test, we aim to have a high speed within competitors. Under the full support of previous test and optimization, we believe our car will have a high speed.

## 5.7 Risk Management

The main risk are **shortage of makerspace resource(equipment and material), unexpected installation detail and weather condition during optimization**, which could delay the project. To mitigate the first two risks, we will have a buffer week between the *Project Installation* and *Speed and Appearance optimization*. This week will be used to address the problems and unexpected detail that may occur in the "Project installation" part. Buffer week can also partly address the last risk, which is the weather condition during testing and optimization. However,we will also have a back up solution, which is to simulate solar panels using batteries with variable voltage and current during test and optimization period.

## 5.8 Budget

Parts	Total Qty	Total \$
wheels - 40mm	4.0	1.40
Motor F18	1.0	2.20
Toggle switch two way blue	1.0	3.00
Pinion Gear 10Tooth	2.0	0.60
Pinion Gear 12Tooth	2.0	0.60
Spur Gear 36 Tooth	5.0	2.75
Spur Gear48Tooth	4.0	2.20
Spur Gear54Tooth	4.0	2.20
Spur Gear60Tooth	3.0	1.65
Spur Gear 48/12 Tooth	1.0	0.60
Motor Mount 3D printed - Basic	1.0	1.00
Motor Mount 3D printed - F13 & F18	1.0	1.00
Solar panel 2v	2.0	17.00
Corflute 400 x 400	1.0	4.00
Capacitor	2.0	7.30
Axle Collar/bush	5.0	0.70
F/Glass Axle 3mm x 167mm long	2.0	0.90
Other - Double sided tape, glue, bolts and washers	1.0	4.00
Total	45.0	52.70

Table 2: Budget Breakdown for Parts

## 6 Summary and Conclusion

### References

- [1] BITRE. *Australian Infrastructure and Transport Statistics Yearbook 2023: Transport Energy Environment*. <https://www.bitre.gov.au/publications/2023/australian-infrastructure-and-transport-statistics-yearbook-2023/transport-energy-environment>. Viewed 6 October 2024. 2023.
- [2] B. M. Hapuwatte, F. Badurdeen, and I. S. Jawahir. “Metrics-based Integrated Predictive Performance Models for Optimized Sustainable Product Design”. In: *Sustainable Design and Manufacturing 2017*. Ed. by G. Campana et al. Vol. 68. Smart Innovation, Systems and Technologies. Springer, Cham, 2017, pp. 801–811. DOI: 10.1007/978-3-319-57078-5\_79. URL: [https://doi.org/10.1007/978-3-319-57078-5\\_79](https://doi.org/10.1007/978-3-319-57078-5_79).