جامعة الأمير محمد بن فهد
PRINCE MOHAMMAD BIN FAHD UNIVERSITY

College of Engineering

Department of Mechanical Engineering

Fall 2020-2021

Senior Design Project Report

Design and Manufacture of Light Weight Vehicle

In partial fulfillment of the requirements for the Degree of Bachelor of Science in Mechanical Engineering

Team Members

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Project Advisors:

Advisor Name: Dr. Mohamed Elmehdi Saleh

Abstract

Light weight vehicles such as buggies and go karts are used in races and for recreational activities. This type of vehicle may also be powered by an electric motor, not only with gasoline. These light four-wheeled vehicles are designed for off-road use or for recreational use.

The purpose of this project is to design and build a buggy. Buggy has become more and more popular sport in these days, the performance of buggy depends a lot on the chassis design. Thus, the project takes the investigation of chassis design majorly.

Acknowledgement

First of all, we would like to express our appreciation to our advisor Dr. Mohamed Elmehdi Saleh for his continued support in our project and his sincere encouragement. Also, we express our sincere thanks to our professors in the faculty of Engineering for their expertise and guidance. We would like to extend our thanks and appreciation to Dr. Faramarz Djavanroodi, chair of the Mechanical Engineering Department at PMU, for his continuous encouragement and to believe in us and our abilities to carry out such a project that clearly tests us and challenges us to hone and use our gained knowledge through the year. Lastly, we thank our parents for the unceasing encouragement, support, and attention as because of their moral support we are able to stand tall at such a position.

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Chapter # 1: Introduction

1.1 Project Definition

This project is intended to design and manufacture a buggy. Current buggy design is made to be driven on off-road terrain. This type of vehicle is considered a light vehicle and is very popular in places of entertainment or off-road. A petrol engine will be used in this project capable of delivering a speed of 40 kilometers per hour.

1.2 Project Objectives

The main objective of this final year project is to plan and design a single-seat 4-wheel off-road vehicle for the local market. The vehicle will
be competent of giving a secure and comfortable ride to its user.

1. To complete the plan of the vehicle with details in ten days. A budget of SAR 500 is assigned for this activity.
2. To complete the vehicle parts purchase and installation in forty days. A budget of SAR 4,500 is assigned for this activity.
3. To assemble and arrange the vehicle with a structure that incorporates a seat. It will be of high importance to follow safety standards while finalizing this structure to avoid any injuries to the user of the vehicle.
4. The design of the vehicle should cover aspects like engine, transmission, suspension, braking, electric, etc., whereas giving solidness and rollover resistance.
5. To supply a comfortable ride through the plan of suspension and breaking frameworks
6. To choose the vehicle motor and transmission frameworks, able of delivering sufficient control and torque to drive at a run of 35 to 40 mph, climb slopes, and viably run through sloppy roads.
7. To supply the taking after off-road vehicle characteristics: common sense, fun-to-drive, versatility, and durability.
8. To guarantee quality through broad testing of secured parts.

1.3 Project Scope/Specifications

The scope of this project is divided into:

1. Search, Review and collect information about the available resources.
2. Conceptual Design.
3. Selection of different suitable dimensions, and parts. Analysis of data gathered on all possible scenarios
4. Documentation of the Results
5. Analysis of the result.
6. Recommendations.

Chapter # 2: Literature Review

2.1 Project Background

The origin of the dune buggy is still foggy to the current day but the available evidences points to its birth being made around the 1950's. Prior to the introduction of the buggy, people used to modify their cars into simpler versions to be used on beaches. In 1958, an individual named Pete Beirning of Oceano CA took a vehicle and stripped it down to create the very first dune buggy. The structure of this vehicle was kept shortened purposely. Although the design of the vehicle was very basic but the idea attracted a lot of attention from thrill seekers and racers looking for something different.

The idea behind this project is also connected to beaches to some extent. Even in Saudi Arabia, people use their 4X4 Jeeps, Land cruisers and Pick-ups when they approach sand dunes or beaches. These vehicles pose a safety threat to the public at the beach. Therefore, in order to eliminate this safety threat and replacing road vehicles – we are designing a dune buggy. The Dune Buggy is built in a workshop using construction steel strong enough but cheap for a chassis, a small but power appropriate engine as prime mover. Few options will be considered and the one yielding suitable design and economic overall cost will be chosen.

2.2 Previous Work

In the previous works we talked about the definition of the project and the bright side of the project, and the details have been made in all points and we have talked about where this bike should be, it should be on bumpy roads and so on, and the background of this project has been clearly detailed.

2.3 Comparative Work

Road Buggy: Lightweight, efficient buggies with drop handlebars and narrow tires for recreational riding on pavement. Styles include race and endurance

Rugged buggy: The rugged buggy has other advantages such as that it has four wheels and can be driven on difficult and bumpy roads and can be driven in normal roads.

Chapter # 3: System Design

3.1 Design Constraints and Design Methodology

3.1.1: Geometrical Constraints:

Since the project our team is working on is to keep the weight of the buggy as low as possible for it to be considered safe for daily usage and in places where normal and large sized vehicles are considered as a health and safety risk, there has been a consideration towards the amount of constraints encountered. First, the gross weight of the buggy must not exceed more than 200 kg. Secondly, since the buggy will be light the speed must be balanced and optimized where it does not exceed more than 120 km/h. Thirdly, the center of mass for the vehicle must be kept as low to the ground as possible to avoid excessive body roll since the roll cage itself could pose a potential risk hazard if not designed and altered properly on the frame of the buggy.

3.1.2: Sustainability:

Considering the project as whole, it may almost seem like a whole new design of a buggy. However, there are things to consider mechanically. When the weight of the buggy will be lighter, it would run longer than its heavy weight counterpart. Since, mechanical components like shock absorbers, steering linkages, rubber bushings and engine and drivetrain components will be under far less stress and fatigue. Based on such criteria, we can safely claim the sustainability of our project and its design.

3.1.3: Environmental Concern:

Similarly, relating the sustainability and overall physical dimensions and properties of the vehicle there is a lesser amount of environmental risk from the project vehicle than there is from normal vehicles. To simply put it into an expression, if the vehicle's weight was heavy, it would burn more fuel which in turn will release more emissions into the atmosphere. However, since the vehicle's weight is the key feature to maintain, as low as possible, it simply implies that there will be less engine drag, body drag and less amount of fuel will be burn over long distances releasing very little carbon emissions. Moreover, the fuel quality will not even exceed 91 RON.

3.1.4: Social Impact:

Buggies are easily available in the market, of every shape and size. However, most of them are used for recreational and sports activities among the local youth.

Moreover, not many people buy them and then use them regularly because of many concerns like ease of usage (traffic laws violation), maintenance and parts availability, a risk on the roads and streets for the rider and the common public. Therefore, considering all the aspects, introducing some safety features like a roll cage and necessary road use safety elements, there is an expectation for this project to gain some popularity in the civilized youth.

3.1.5: Economic:

In terms of economic impact, the project is strictly set to follow a certain amount of prescribed budget, anything more than the budget will be considered as something of least importance or a custom feature based on the rider's/ owner's wish. Since, it won't have all the fancy gizmos and gimmicks like the latest buggy's have, it sure will have all the necessary safety and road worthy options installed in it. But, other than that, it can say to be cost effective if considered its usage in the long run including maintenance costs and running costs.

3.1.6: Safety:

The safety is kept as number one priority to keep the riders and the public on the road and streets safe. The body of the vehicle will have a hollow tubular framework with a roll cage incorporated to the frame and of course will have seatbelts. These basic yet important features will keep the occupants safe if in-case there appears to be an incident due to unforeseen circumstances. Moreover, reflective tapes on the body panels will be fitted with other safety features to provide awareness of other vehicle owners of the presence of the lightweight buggy on the road.

3.1.7: Ethics:

The project will be based completely off of a design and methodology of our own since we will be able to proceed and carry out the necessary manufacturing and fabrication works by our own. This does involve mentioning all the personnel who participated in making it possible while respecting and giving credits to the ideas gained from previous projects.

3.2 Engineering Design Standards

The components for the lightweight buggy that will be used are mostly borrowed from a spare buggy whose framework and some necessary components will be used which

follow ASTM and SAE standards. The major components and there engineering standards are given:

Components	***Engineering Standards***
Body Panels	ASTM: 5052-Al
Body Frame/ Chassis	ASTM: AISI-302 (Steel)
Plastic Body Panels	ABS Plastic

Table # 1: Engineering Standards

3.3 Product Subsystems and selection of Components

The project is designed to use materials and components based on parts available/ existing beforehand which saves the trouble of manufacturing a custom part and is easy to maintain in the long-run. Additionally, parts related to body panels to be used are mostly of plastic of aluminum where necessary to avoid the occupants from debris and foreign objects into the cabin and the essential components like the engine and electronic equipment. Making sure that the weight is kept to the least value as possible, all parts and components will be carefully selected based on how much it adds to the curb weight of our vehicle in the end. However, since most of the prominent in the vehicle will be of the engine and the chassis, the expected curb weight might be somewhere between 200 to 220 kg.

3.4 Manufacturing and Assembling (Implementation)

As mentioned earlier, the parts and components will be mostly scavenged or acquired from a spare buggy. The perishables will obviously be purchased new from the market as their usage in our vehicle could pose a risk to the operating components and the rider.

As far as manufacturing work is concerned, it will be carried out in a workshop facility designated away from local population while ensuring that the personnel including our team works in accordance to proper safety and environmental protocols. The fabrication job, if needed, will be performed at the workshop basically in reducing the chassis components to manage the weight overall stresses as equally as possible to assist the weight of major components like the engine and rider as well as under fatigue loading without considerable effect on the chassis itself.

In order to give a perspective of what can be expected from the team's on going lightweight buggy project, Fig. 1 below indicates a sample of what the buggy would look like but not the same of course.

Fig. 1: Sample Lightweight Buggy

Chapter 4: System Testing and Analysis

4.1 Experimental Setup, Sensors and data acquisition system

4.1.1: Weighbridge:

According to the objective of senior year project, the aim was to build a light weight buggy. In order to compare the weight and assure our objective's satisfaction. We made use of a commercial grade weighbridge that we requested to use at Alaa for Industry's (AFI) Facility in Dammam. The weighbridge had following specifications:

- Size: 6x3m
- Capacity: 30 Tons
- Platform made out of steel.

Figure # 2: Weighbridge

4.1.2: Tachometer:

Speed comes as another factor in determining the acceleration and how quickly a certain speed is achieved after a certain amount of time. This led towards the usage of the buggy's inbuilt tachometer and comparing the time it takes to reach a top speed of 110 kilometers per hour.

4.1.3: Tape measure

The buggy after fabrication needed to be measured in its overall dimensions that includes the wheelbase, ground clearance and the front and rear wheel tracks. In order to properly measure it, a precision tape measure was utilized to record the dimensions mentioned earlier.

- Dimensions: 16 x 10.3 x 2.9 cm;
- Weight: 100 grams
- Measuring Capacity: 3000 mm or 10 feet.

Figure # 3: Tape Measure

4.2 Results, Analysis & Discussion

Physical Dimension:

The results obtained for our light weight buggy prototype are displayed in the figure given below:

Dimension Type	Dimension
Length	2588 mm
Front and Rear Wheel Track (Width)	1250 mm
Wheel Base	1800 mm
Ground Clearance	150 mm
Weight (without passenger)	212 kg
Engine Power	18 Horsepower @ 6500 rpm
Torque	22 Nm @ 500 rpm

Table # 2: Physical Dimensions

Speed:

The speed of the buggy before weight shedding and after weight shedding did gave a little upper hand in accelerating to the top speed. Since the weight was reduced, so did the drag and below are the numbers obtained from the analysis.

Top Speed		Time Taken	
Heavy Weight	**Light Weight**	**Heavy Weight**	**Light Weight**
40 km/h	40 km/h	94 seconds	68 seconds

Table # 3: Speed Results

Chapter 5: Project Management

5.1 Project Plan

The project consists of many different tasks which were assigned almost equally to every member of our team. Each member of the team was given a benchmark and a specific time in order to successfully accomplish their part in the project for prosperous results. The following table.

S. No.	Tasks		Start	End	Duration
1.	Chapter # 1: Introduction		4 Sept. 2020	5 Sept. 2020	1 Day
2.	Chapter # 2: Literature Review	Project Background	5 Sept. 2020	13 Sept. 2020	8 Days
		Previous work			
		Comparative Study			
3.	Chapter # 3: System Design	Design Constraints and Design Methodology	09 Oct. 2020	20 Oct. 2020	12 Days
		Engineering Design Standards			
		Product Subsystems & Selection of Components			
		Manufacturing & Assembly			

4.	Chapter # 4: System Testing & Analysis	Experimental Setup, Sensors and Data	01 Nov. 2020	20 Nov. 2020	20 Days
		Results, Analysis & Discussions			
5.	Chapter # 5: Project Management	Contribution of team Members	21 Nov. 2020	25 Nov. 2020	5 Days
		Project Execution Monitoring			
		Challenges and Decision Making			
		Project Bill of Materials and Budget			
6.	Chapter # 6: Project Analysis	Impact of Engineering Solution	25 Nov. 2020	27 Nov. 2020	3 Days
		Contemporary Issues Addressed.			
7.	Chapter # 7: Conclusion & Recommendation	Conclusion	5 Dec. 2020	10 Dec. 2020	5 Days
		Future Recommendation			
8.	Design of Prototype		22 Sept. 2020	15 Nov. 2020	24 Days
9.	Parts Purchase		01 Nov. 2020	20 Nov. 2020	20 Days
10.	Manufacturing		10 Nov. 2020	03 Dec. 2020	23 Days

11.	Testing	24 Nov. 2020	5 Dec. 2020	13 Days

Table # 4: Tasks and their Duration

S. No.	Task	Assigned Members
1.	Chapter # 1: Introduction	Everyone
2.	Chapter # 2: Literature Review	Hani & Bander
3.	Chapter # 3: System Design	Yousef, Bander & Osama
4.	Chapter # 4: System Testing & Analysis	Osama & Yousef
5.	Chapter # 5: Project Management	Yousef & Bander
6.	Chapter # 6: Project Analysis	Everyone
7.	Chapter # 7: Conclusion & Recommendation	Hani
8.	Design of Prototype	Yousef & Hani
9.	Parts Purchased	Osama & Bander
10.	Manufacturing	Yousef, Osama & Bander
11.	Testing	Everyone

Table # 5: Assigned Members for Tasks

5.2 Contribution of Team Members

Since our team has played a role in fulfilling the requirements for the project, each of the members contributed their amount of effort and time depending on the ability of their work and their efficiency. The table below illustrates about how much contribution was made by each team member.

S. No.	Tasks		Assigned Member	Contribution
1.	Chapter # 1: Introduction		Everyone	100%
2.	Chapter # 2: Literature Review	Project Background	Yousef	33%
		Previous work	Hani	35%
		Comparative Study	Bander	33%
3.	Chapter # 3: System	Design Constraints and	Bander	50%

	Design	Design Methodology		
		Engineering Design Standards	Hani	20%
		Product Subsystems & Selection of Components	Osama	40%
		Manufacturing & Assembly	Yousef	60%
		Experimental Setup, Sensors and Data	Everyone	100%
4.	Chapter # 4: System Testing & Analysis	Results, Analysis & Discussions	Everyone	100%
		Contribution of team Members	Everyone	100%
5.	Chapter # 5: Project Management	Project Execution Monitoring	Yousef & Hani	100%
		Challenges and Decision Making		100%
		Project Bill of Materials and Budget		
		Impact of Engineering Solution		
6.	Chapter # 6: Project Analysis	Contemporary Issues Addressed.	Everyone	100%
		Conclusion	Everyone	100%
7.	Chapter # 7: Conclusion & Recommendation	Future Recommendation	Everyone	100%
		Abdul Moiz, Hesham, Abdul Aziz & Mohammad		
8.	Design of Prototype		Hani & Bander	100%
9.	Parts Purchase		Yousef, Osama & Bander	100%

10.	Manufacturing	Everyone	100%

Table # 6: Contribution of Tasks

5.3 Project Execution Monitoring

In order to keep our project at a developing stage, we had to participate some meetings with our supervisors and also among our team members. Moreover, since there were feedback reports and presentations during our developmental stages, those were all managed and executed in timely fashion which is depicted in the table below.

Time/Date	Activities/Events
Once in week	Assessment Meeting
Weekly	Meeting with the group members
Bi-Weekly	Online Meeting with the Advisor
26 October, 2020	First Finished Prototype
12 November, 2020	Midterm Presentation
15 November, 2020	First Test of System
20 November, 2020	Finishing Final Prototype
28 November, 2020	Test of the System
18 December, 2020	Final Submission of Report
17 December, 2020	Final Presentation

Table # 7: Dates of Activities & Events

5.4 Challenges and Decision Making

While working in developing our project to its final stages, we incurred some problems which effected the progress of our project and acted as a hurdle to overcome. However, after successions of different suggestions and review, they were eventually rectified. The problems we faced were some of the following:

5.4.1: Equipment and Device Problems

- **Body Frame**

Considering the objectives of our project, we faced some difficulty in optimizing the weight of the body frame as it was too heavy and exceeding the required lightweight configuration. In order to solve this problem, we actually had to fabricate the frame just a tiny bit to avoid compromising structural rigidity.

- **Electrics**

  As we intended on keeping only the necessary electrical switches and buttons, i.e., for the headlights, horn and tail lights, the team was involved in managing electrical wirings and to properly ground all the connections so we don't have any live wire posing a risk of an electric shock since the whole body has metal exposed and little to no insulation was incorporated as it would be requiring most financial resources and time.

5.4.2: Testing & Safety Issues

The testing of out lightweight vehicle was a matter to consider, as it has a considerable size and weight which is dangerous for any one in close vicinity to it while it is being used, the testing was actually carried out on an abandoned road outside the city. Helmet and seatbelts were used at all times to prevent injuries in case of an unfortunate mishap, since the team required the testing of top speed in a certain time as compared to what it had before shedding weight. This was a huge safety concern since momentum the vehicle carried was still quite lethal to humans.

5.4.3: Design Problems

The first prototype design was heavy, since the chassis had many trusses and safety crash proof beams. This was a huge problem as 60% of the weight of the buggy was just due to the body frame and rest containing engine, transmission, tires and rims. So, the body frame was reduced in its height which gave a lower center of gravity and decreased the weight as well. But, it was ample to provide safety against rollover cases to prevent the occupant from neck and head injuries.

5.5 Project Bill of Materials & Budget

The table below illustrates the parts we purchased and the amount given to the third party for manufacturing some of the intricate parts for us. It includes the total amount spent in our project in Saudi Riyals (SAR) inclusive of 15% Value Added tax (VAT).

Materials	Cost (SAR)
Body Frame (Chassis) [Contains engine, suspension and battery]	2000
Plastic Body Panels	250
2 Side Skirt Beam	50 x 2 = 100
4 Tires with Rims	150 x 4 = 600
Steering Wheel	250
2 Bucket Seats with Three-point Harness	150 x 2 = 300
Labor Charges (including fabrication and manufacturing)	1000
Total	**4500**

Table # 8: Project Bill of Materials

Chapter 6: Project Analysis

6.1 Life-Long Learning

Since we were working as a team in the progress of our project, we had one aim completely firm in our minds and that was to achieve all the goals we had set in the beginning of project. Of course, in order to achieve that, we were prone to use and utilize some software and hardware by using our time in a very efficient manner and also to manage all of these things, we had to setup and prescribe a pre-planned schedule which really gave us a boost in every aspect we worked on and we would like to share some of that experience.

6.1.1: Software Skills:

To design our prototype, we first had to refer to the internet and then try out the constraints on Solid-works Simulation. There we were to design and simulate the necessary components for our system to ensure proper operation according to our need of using less material but sufficient enough to be able to put into our system so that it can run smoothly. It all went extremely well by our contribution and assistance since one of us was able to solve a hurdle much quicker depending on the way he thought.

6.1.2: Hardware Skills:

In order to perform experimentation and testing, we actually had to use the buggy itself and perform test drives as well as endurance drives to observe the mechanical components if they had suffered significant wear and tear. Quite fortunately, as the whole team was eagerly involved during the fabrication and assembly processes, we got to learn a variety of tools and their proper usage as well how to perform welds and remove a broken or a rusted nut and bolt.

6.1.3: Time Management:

Since we had about 3 months of total time to be given to the project, we really needed to manage time in an efficient manner in order to be ahead of time for predicted problems and hurdles we thought we would face. Although, we were still falling short of that as days were

passing by, our team really worked on it in every spare time they had available in order to accomplish a heap of milestone that was set for us.

6.1.4: Project Management:

To carry out the whole schedule of developing our project, we needed a plan to execute and follow it step by step. By conducting weekly meetings with our team mates, we were able to assign tasks based on the time one is comfortable and available. This mutual communication and understanding led to a properly managed progress flow related to our project which we are proud of.

6.2 Impact of Engineering Solutions

6.2.1: Society:

We started our project on the basis of how it would serve to the society and what the society needs to be careful about. Renewable energy is our motto for this project and we are in an urge to educate the society that by simple mechanisms we can reduce our dependence on excessive usage of electricity from the grid and try to utilize a renewable energy source wherever possible as it would be healthy for us and our planet.

6.2.2: Economy:

Economically speaking, we have also mentioned in our project about the expenses we put in and the considerations we took in which would make this whole project economically affordable. We mostly used scrap materials that were laying around with no use and their disposal would affect the atmosphere and economy negatively if we take a wider perspective. What's more is that, after ensuring our prototype can work by such materials, for the sake of being presentable we had to give our prototype a much more of a refined and civilized appearance which had to break the bank a little bit.

6.2.3: Environment:

Since sustenance of fuel resources is our motto for the project, it is completely environmentally friendly and has a lower carbon emission than a normal car would produce.

However, using an expensive and high quality three-way catalytic converter would produce a very insignificant number of emissions and noise while being drive. So, it is safe to say that this will lead to a much-improved fuel consumption as well benefit the environment on having a very small carbon footprint.

6.3 Contemporary Issues Addressed

There is a global run towards the fact on going green in terms of using resources and decreasing pollutants which would help in saving the earth's atmosphere, influencing the economy towards being healthy and decreasing the risks which could be a negative sign towards the community in case of health. Moreover, since the Kingdom of Saudi Arabia has a complete dependence on fuel resources, the by-products being produced are unfavorable for the environment, economy and the people. So, to play a part in helping out with the cause of saving the planet and its people from the dreadful risks such kinds of projects should be looked into at a much bigger scale to promote less dependency on vehicles which are of bigger engine and size as it will consequently yield more emissions, more fuel consumption and more damage to the environment.

Chapter 7: Conclusion & Future Recommendations

7.1 Conclusion

To sum up, we have managed to achieve our project and the prototype within the time frame specified to us as a group. Moreover, this led to the conclusion of successful completion and build of the light weight vehicle based on the defined objectives. These objectives were prosperously achieved by maintaining the financial budget of the project well under 4000 Saudi Riyals inclusive of 15% value added tax (VAT). Additionally, the team also achieved to retain the safety features in the chassis structure to avoid any mechanical failures, which can lead to injury or death upon any mishap. Moreover, this also led towards one of the biggest aims of the project which was to assist light weight of the vehicle to allow for better performance and fuel consumption.

7.2 Future Recommendations

Considering the time frame and the world pandemic crisis of 2020. The light weight vehicle's design and built was not as refined as the team initially intended. However, it led to a tradeoff against time and give up some in-cabin comfort and features for both the driver and passenger. In order to recommend some additions to this project in the future:

- The vehicle could benefit with added in cabin features which can lead towards the ease and comfort while riding and being ridden in. For instance, a GPS system, cup holder, etc.
- Addition of foldable roof top for weather proofing against sun and rain with a polycarbonate windshield.
- A steering wheel that can be adjusted according to the driver's bodily aspects like tilt and telescopic movements to accommodate drivers of different body shapes and sizes.

Any additional creative features that would not compromise the performance and safety of the vehicle are most welcomed and appreciated for its refinement and daily usage in future.

Appendix A: Prototype Development Pictures

Appendix B: Final Prototype Pictures

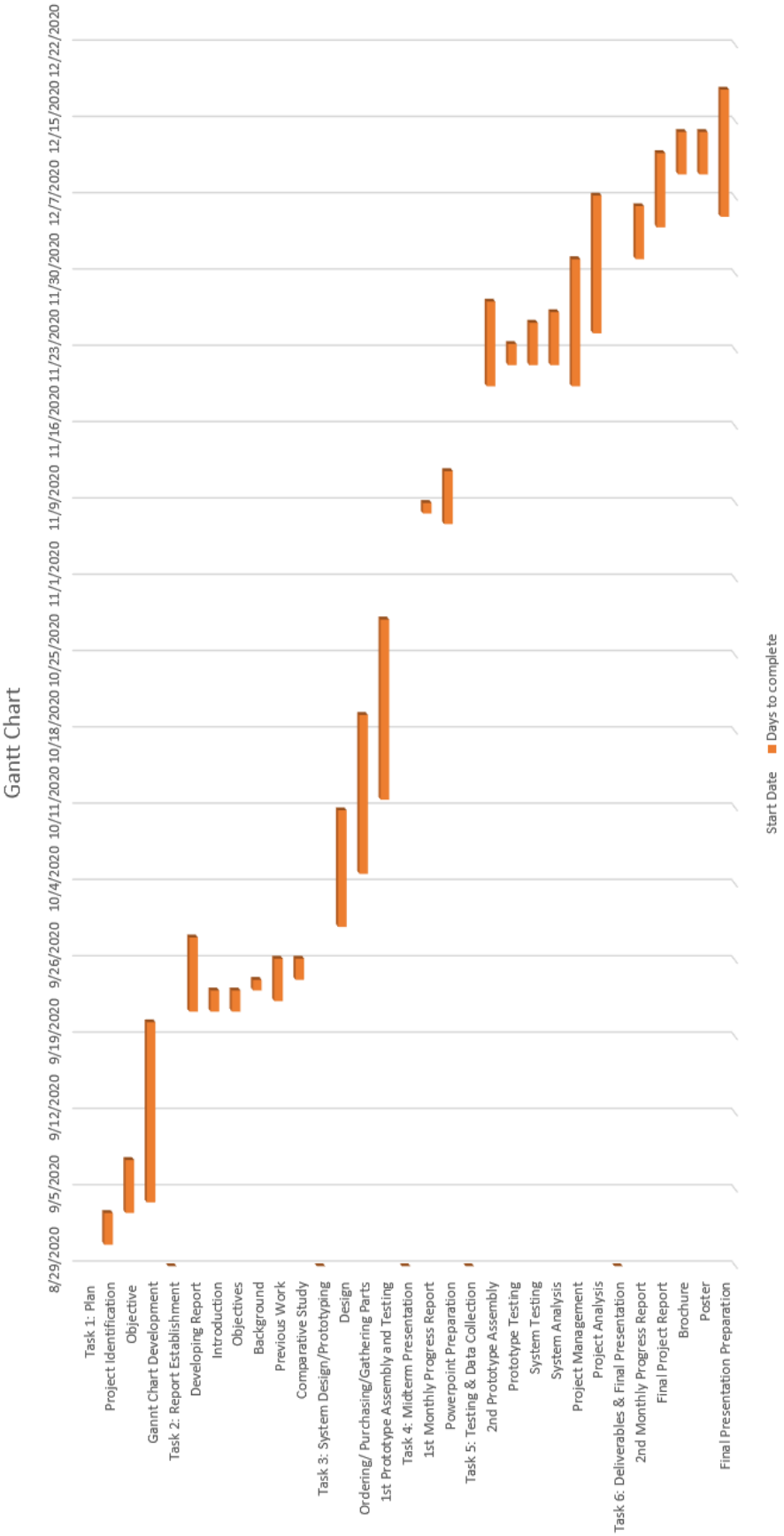
Appendix C: Engineering Standards

Components	***Engineering Standards***
Body Panels	ASTM: 5052-Al
Body Frame/ Chassis	ASTM: AISI-302 (Steel)
Plastic Body Panels	ABS Plastic

Appendix D: Prototype Specifications

Dimension Type	Dimension
Length	2588 mm
Front and Rear Wheel Track (Width)	1250 mm
Wheel Base	1800 mm
Ground Clearance	150 mm
Weight (without passenger)	212 kg
Engine Power	18 Horsepower @ 6500 rpm
Torque	22 Nm @ 500 rpm

Appendix E: Gantt Chart



Team # 4 - Fall 2020			
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Yousef Aldhafeeri	*201302104*		
Osama Althagafi	*201400404*		

Task	Start Date	Days to complete	Responsible
Task 1: Plan			
Project Identification	8/31/2020	3	Hani & Yousef
Objective	9/3/2020	5	Hani & Bander
Gannt Chart Development	9/4/2020	17	All Team Members
Task 2: Report Establishment	**Start Date**	**Days to complete**	**Responsible**
Developing Report	9/22/2020	7	All Team Members
Introduction	9/22/2020	2	Hani
Objectives	9/22/2020	2	Yousef
Background	9/24/2020	1	Bander
Previous Work	9/23/2020	4	Yousef & Hani
Comparative Study	9/25/2020	2	Osama & Bander
Task 3: System Design/Prototyping	**Start Date**	**Days to complete**	**Responsible**
Design	9/30/2020	11	Yousef
Ordering/ Purchasing/Gathering Parts	10/5/2020	15	Hani & Osama
1st Prototype Assembly and Testing	10/12/2020	17	Yousef & Bander
Task 4: Midterm Presentation	**Start Date**	**Days to complete**	**Responsible**
1st Monthly Progress Report	11/8/2020	1	All Team Members
Powerpoint Preparation	11/7/2020	5	All Team Members
Task 5: Testing & Data Collection	**Start Date**	**Days to complete**	**Responsible**
2nd Prototype Assembly	11/20/2020	8	Hani & Yousef
Prototype Testing	11/22/2020	2	Hani & Bander
System Testing	11/22/2020	4	Osama
System Analysis	11/22/2020	5	Yousef
Project Management	11/20/2020	12	Hani
Project Analysis	11/25/2020	13	Bander
Task 6: Deliverables & Final Presentation	**Start Date**	**Days to complete**	**Responsible**
2nd Monthly Progress Report	12/2/2020	5	Bander & Osama
Final Project Report	12/5/2020	7	All Team Members
Brochure	12/10/2020	4	Hani
Poster	12/10/2020	4	Hani & Osama
Final Presentation Preparation	12/6/2020	12	All Team Members