

Project Description

ABSTRACT

Urban concept vehicle is the final year capstone project for engineering department. This vehicle will be used as a showcase at Northern Arizona University and has shown its participation for Shell Eco-Marathon competition which was held annually in Houston, Texas.

The team's contribution to the final vehicle was the final finished fairing and interior system which was implemented into the vehicle's chassis and suspension systems. The fairing determines the attraction of the vehicle and covers the chassis and control systems. The interior design of vehicle was done based on the ergonomics factors providing driver and passenger comfort and their ease of access to the control systems. The vehicle was tested at the Shell Eco-Marathon competition for the safety factors and efficiency of the energy.

INTRODUCTION

The interior team is a part of five sub-groups of urban concept vehicle. These sub-groups include chassis and suspension, interior and fairing, drive train and motor control, steering and braking system, and electrical engineering team. The interior team's contribution was to build the well finished fairing which is the body of the vehicle and interior components providing driver interface. Together, the urban concept vehicle team worked to build an eco-friendly electric vehicle which represents the skills and knowledge of the students from engineering department. This vehicle took participation for Shell Eco-Marathon competition which was held on the end of March, 2012 at Houston, Texas and passed all the technical inspection to get into the track. The vehicle will be used as a showcase at Northern Arizona University under the name of the client, Dr. John Tester.

PROBLEM STATEMENT

Urban concept vehicle project was the client's goal to create a flagship project which demonstrates the abilities and skills of the Engineering department. The vehicle was designed based on the requirements of client and Shell Eco-Marathon, manufactured, and tested by NAU Engineering senior students. The end result was an electric vehicle designed for fuel efficiency with an urban design using electric motors as the energy source to drive the vehicle and well finished interior including driver interface.

The complete urban concept vehicle was divided in five subgroups: chassis-suspension, drive train, electrical, safety-braking-steering, and fairing-ergonomics. In addition to completing their own analysis, each subgroup integrated their designs with the complete car by working with every subgroup. This team's contribution to the final vehicle was the design, manufacturing and implementation of the vehicle's fairing and interior. The fairing was manufactured to cover the chassis and control systems of vehicle and to provide better aerodynamic performance. Moreover, the fairing determines the looks and impression of the vehicle. The interior design was done based on the ergonomics factors to provide driver and passenger comfort and their ease of access to control systems. This vehicle has enough space for two people (including driver and passenger) which also represent practical design for driving in urban cities. The effectiveness of the vehicle

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was tested at the Shell Eco-Marathon competition. The team followed a certain procedure and had milestones for each phases.

SHELL ECO-MARATHON

The Shell Eco-Marathon Americas is an engineering competition held in downtown Houston, Texas, in early April, and hosted by Shell Oil Corporation. Started in 1939, it was a competition between scientists to create a vehicle with the highest mile per gallon capability. The current form of the competition is to encourage science and engineering students to explore new technological possibilities. Multiple schools participate in the prototype and urban concept divisions while aiming for the highest fuel efficiency using gasoline, diesel, hydrogen or electricity as energy sources. Shell hosts two competitions, the prototype and the urban concept. The prototype competition focuses on vehicles achieving the absolute maximum efficiencies possible for a vehicle that will transport a person on wheels with minimal size restrictions. The current overall record for a prototype vehicle is held by the Polyjoule team from Polytech Nantes University of France with equivalent miles per gallon of 11,516.34 using a fuel cell power source. The urban concept competition is a more practical event, where vehicles are designed around use within an urban setting. The vehicles must complete two parking periods, where the vehicle comes to a complete stop for three seconds, during ten laps of the course. At the finish, officials measure the total fuel/energy used and rank the vehicles in a comparable miles per gallon value. The current overall record for an urban concept vehicle is 1,757.52 equivalent miles per gallon using a fuel cell power source from the Hydro Cruisers team from the De Haagse Hogeschool of the Netherlands. The current America's competition record is 437.2 equivalent miles per gallon by the Mater Dei High School's Supermileage team from Evansville Indiana using an internal combustion engine. The UCV participated in the urban concept division.

Requirements and Specifications

Eco-Marathon Rules

- Dimensions
 - The total vehicle height should be between 100 cm and 130 cm.
 - The total body width is required to be within 120 cm and 130 cm.
 - The total vehicle length must be between 220 cm and 350 cm.
 - The driver's compartment must have a minimum height of 88 cm and a minimum width of 70cm at the driver's shoulders.
 - The vehicle weight should not exceed 205 kg excluding the driver.
- Vehicle body
 - The fairing/body should be covering all mechanical parts excluding the wheels and suspension whether the vehicle is viewed from front, top, rear or side views.

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- The wheels and suspension must be fully covered by the body when seen from the top view.
- Access to the vehicle by the driver must be as easy and practical as typically found in production type passenger cars which have a specific dimension requirement of minimum 500 x 800 mm and it is verified by rectangular template.
- The vehicle must have a roof covering the driver's compartment.
- A windscreen with effective wiper(s) is required.
- Any access opening mechanisms (e.g. doors) must be firmly attached to the body of the vehicle by means of hinges, sliding rails, etc.
- Luggage space should be included with dimension of 500 x 400 x 200 mm (L x H x W).
- Sharp edges, points should be avoided so that it won't cause any harm to people working and testing for the vehicle.
- A towing hook or ring is mandatory so that it can be towed with a cable by another vehicle and this hook or ring must resist a traction force of 2000N (~200 kg).

These were the requirements classified especially for fairing/body and interior. However, for the entire vehicle including chassis and suspension, drive train, motor, steering, brake system, and other electrical components; there were specific rules classified in Shell Eco-Marathon official rules 2012, chapter I.

Client-specified Requirements

Prior to starting on any project, the team needs to value the client's requirements for the product. Similarly, in this project; the client has some specific requirements which are classified as below:

- All systems must be constructed from commercial off-the-shelf parts or fabricated by the team.
- Systems must stay under the budget specified by NAU SAE
- The fairing/ body material should be composed of light and strong materials that protect the interior and the driver inside the vehicle. Moreover, the shape of the fairing should have innovative and creative design which could be proudly used as a showcase at Northern Arizona University.

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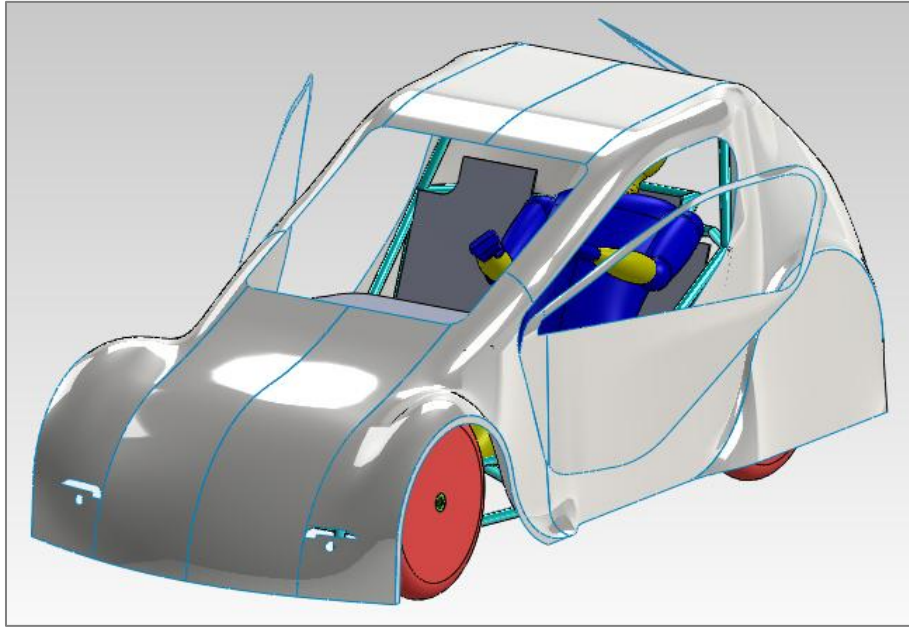


Figure 1 – CAD assembly model.

The following table shows the status of each requirement with the specifications which gives the brief detail about the result obtained in the project.

Table 1 – Results presented as specification chart.

Specification/Requirement	Met/Not met	Results/Commentary
The total height must be between 100cm and 130cm. The total body width, excluding rear view mirrors, must be between 120cm and 130cm. The total vehicle length must be between 220cm and 350cm.	Met	The height obtained for the fairing was 108 cm and the ground clearance was 15 cm, so the height dimension was satisfied. Also, the body width and length was 127 cm and 308 cm respectively.
The track width must be at least 100 cm for the front axle and 80 cm for the rear axle, measured between the midpoints where the tires touch the ground.	Met	This requirement was satisfied by the frame and suspension team.
The wheelbase must be at least 120 cm.	Met	The wheelbase location and dimension was determined by frame team and was satisfied.
The driver's compartment must have a minimum height of 88 cm and a minimum width of 70 cm at the Driver's shoulders.	Met	The driver had enough room space in the vehicle to satisfy these requirements.

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The ground clearance must be at least 10 cm.	Met	The ground clearance is more than 10 cm.
The maximum vehicle weight (excluding the Driver) must be 205kg.	Met but not 100% satisfied	The total vehicle weight was approximately 180 kg. The fairing weight was around 65 kg after attachments of glasses and doors. This weight requirement was met as per the shell rules but it still came out to be over-weight according to client.
The body must cover all mechanical parts excluding wheels and suspension, whether the vehicle is viewed from the front, the rear, and the sides or from above.	Met	The fairing covered all the sub-parts of the vehicle while viewing from different view.
The wheels and suspension must be fully covered by the body seen from above and up to the axle center line when seen from front or rear. The cover of wheels and suspension must be a rigid integral part of the vehicle body.	Met	The fairing had fenders to cover the wheel and the body itself covers the suspension system.
The door opening must have a minimum dimension of 500 × 800 mm. This means the door opening will be verified with a rectangular template of 500 x 800 mm.	Met	The driver was successful to get out of vehicle in 7 sec. which was tested in competition. So, the door was large enough for accessing.
Any access opening mechanisms (e.g. doors) must be firmly attached to the vehicle body (e.g. by means of hinges, sliding rails, etc.). Adhesive tape, Velcro, etc. are not permitted for this purpose.	Met	2 zinc plated pin hinge were attached in each door to fulfill this requirement.
The vehicle must have a roof covering the Driver's compartment.	Met	The fairing had all surfaces enclosed to fit the requirement.
A windscreen with effective wiper(s) is mandatory.	Met	Lexan was used as a windscreen and it was big enough for clear visibility. The wiper was attached by Electrical team but it did not cover the whole windscreen. So, bigger wiper would have been better.

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<p>Luggage space must be available for a suitcase-like object with dimensions of 500 x 400 x 200 mm (L x H x W). This space must be easily accessible from the outside and must include a floor and sidewalls to hold the luggage in place when the vehicle is moving. A competitor supplied suitcase-like object must be placed in this space during any competition. For drivers requiring ballast this suitcase-like object must contain the ballast.</p>	<p>Met</p>	<p>The dimension of luggage compartment was not very critical. But still the requirement was met. The luggage compartment in this vehicle also covers and protects the electrical board.</p>
<p>Vehicle bodies must not include any external appendages that might be dangerous to other Team members; e.g. sharp points must have a radius of 5 cm or greater alternatively they should be made of foam or similar deformable material.</p>	<p>Met</p>	<p>Sharp edges were avoided by sanding the edges using template having radius of 5 cm.</p>
<p>A towing hook or ring is mandatory on the front of the vehicle, so that it can be towed with a cable by another vehicle. This hook or ring must resist a traction force of 2000 N (~200 kg).</p>	<p>Met</p>	<p>Towing hook was attached in the frame and this hook supports the whole body system.</p>
<p>EPS foam material required to make the mold should be within the dimension of the overall fairing by a clearance of 10 cm in each direction (x,y,z). The width must be at least 129 cm and length 310 cm and height 110 cm.</p>	<p>Met</p>	<p>A 2D CNC machine was used to cut the foam. The overall dimension of the foam block was 315 cm X 130 cm X 114 cm (L X W X H).</p>
<p>The vehicle should meet the entire safety requirement to be able to drive in the road.</p>	<p>Met</p>	<p>All safety devices were positioned properly making driver accessible for it.</p>