

# Design, Analysis & Fabrication of Efficycle: A Hybrid Tricycle

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**Abstract** - Any innovation or technology cannot be possible until and unless the work is not done by a team. In such a manner members of Team PRAVARA HAWKS (participants of SAE-NIS 2018), who are highly motivated individuals are recklessly working towards the realization of this goal since its very inception. This paper provides in detail, about the design considerations, and methodology used in designing and developing it. The designing of the vehicle has done on CATIA V5R21 while the design analysis has done on ANSYS-2015. Various lightweight approaches like a lightweight seat, monster wheels, telescopic suspension were se for more stability, Human powered hybrid vehicle presents the new milestone in the realm of "Green technology".

**Key Words:** SAE, Efficycle, Hybrid Vehicle, Electric drive, Green Technology, Tri-Wheeler.

## 1. INTRODUCTION

There is increasing concern over congestion and pollution associated with the use of motor vehicle for personal transport. This project aims to design a vehicle that could be viable alternative to cars for short distance journeys. The designed vehicle is an Light Vehicle. It is powered by a hybrid human-electric drive system. Different technologies were analyzed and based on the research factors such as turning radius, stability, handling, and ease of maneuvering, tadpole design was adopted with 2WF and 1WR. The vehicle has an innovative tadpole design, which is ergonomically engineered and easy to manufacture. The vehicle provides the user with the best performance, easy maintenance, and safety, at very reasonable prices. The design was simulated and analysed on SOLID WORKS and analysis software, ANSYS, where we analysed it by various tests like front impact side impact, rear impact and rollover impact test [1].

## 2. DESIGN METHODOLOGY

Care was taken to accurately define the goals and constraints of the project before we engineer the solution to meet these goals. The basic design procedure followed is as below.

### 2.1 Assumptions

Here basically considering the constraints of dimensions we first of all assumed the dimensions of the vehicle.

### 2.2 Ergonomics

After assuming the dimensions our main area of interest was to make the vehicle ergonomic for an average adult person.

### 2.3 Design

Here we actually designed the vehicle in modelling software CATIA V5R21.

### 2.4 Analysis

The analysis of the design was carried out by FEM analysis software ANSYS 2015 in order to ensure that the designed vehicle is safe.

### 2.5 Modification in design

Based on the results obtained from analysis modifications were done in the existing design.

### 2.6 Design

Again the analysis was done of the modified design and it was found to be safe.

### 2.7 Manufacturing

During manufacturing various parameters like serviceability, craftsmanship and cost reduction were considered.

### 2.8 Aesthetics

In order to make the vehicle more attractive and convincing its aesthetic considerations like appearance were given the importance.

### 3. Vehicle Specification & Dimensions[1]

- Motor: BLDC of 600 watts, 48 V, 300rpm
- Frame material: AISI 4130
- Weight of driver: 65 kg each,
- Wheel configuration: Front-2 Rear-1,
- Steering:
- Turning Radius: 3.3m with 40 degree turning angle,
- Braking: Front & Rear-Disc Brakes,
- Max. Length:1878.73mm,
- Height 1266.9mm,
- Wheel base: 1183.13 mm,
- Ground clearance: 228.6 mm.

### 4. Manufacturing of Vehicle

#### 4.1 Material used

Effi-cycle frame can be fabricated from various types of materials with varied cross section and sizes. The selection of material can matter a lot in reducing or increasing the weight of the vehicle. Use of lighter material available without compromising on strength and safety can prove beneficial. The range of material start from the thin and light alloy steels to aluminium and carbon fibres. Material such as AISI 4130, commonly known as chromyl, exhibit higher yield strength as compared to other carbon steel.

Material- AISI 4130 [2] .

Welding type- Electric Arc welding [2].

Material properties:

OD: 25.4 mm

ID: 20.32mm

Density: 7.85 g/cc

#### 4.2 Tyres & Wheels

Keeping in mind the vehicle may have to deal with maneuverability challenges; the wheel set chosen is were of MTB type. Which gave good Momentum & Stability.

#### 4.3 Brakes

We use mechanical disc brakes, which has mounted on all three wheels. Disc brakes are used because of its high heat dissipation.

#### 4.4 Suspension

For road holding and braking, suspension is required. Now, from different research and topology we found that the coil suspension is required on the rear wheels and telescopic suspension were suspension are required on the front wheel. [6]

#### 4.5 Drive Train

Both the driver and co-driver were provided with individual power train to power the vehicle in both single passenger and dual passenger mode. The mode of power transmission in effi-cycle is through chain drives (where in the power from prime mover is transmitted to wheels by a system of sprockets (on prime mover and the wheel hub) connected through a metallic chain, in its simplest form).

#### 4.5 Electrical specification of vehicle

The efficycle basically comprises of the following parts:

Energy storage - Battery bank of 48V and 12Ah

Driving motor - BLDC of 600 watts, 48 V, 300rpm.

Kill switch=the battery will be disconnected from the motor as soon as kill switch is passed and rendering the completely electric system dead.

#### 4.6 Design of Seats

From safety point of view design of seat is also very important part the vehicle. In effi-cycle side by side seating arrangements were provided. The seats have been properly designed in order to provide best possible comfort to the drivers with 15degree of inclination. Seat belts have also been employed to provide safety to the drivers.

### 5. Resources required

#### 5.1 Fabrication Workshop

- Electric Arc welding machine.
- Pipe bending machine (hydraulic)
- Hydraulic Press
- Grinding Machine

#### 5.2 Sheet metal Workshop

- Shearing Machine
- Pressing Machine
- Lathe machine

### 5.1 Shaping Machine

- Drilling machine
- Sawing machine
- Metrology lab
- CAE/CAD/CAM lab

### 6. Safety Feature

There should be protection from the impacts due to the presence of shocks. Torso support to both the drivers. There should be kill switch on easy reach to both driver. Overhead and side protection member should be provided. Seat belt is one of the important safety feature.

### 7. Feasibility of Vehicle

#### 7.1 Silent Features of Vehicle

- Highly efficient Hybrid system and simplified power transmission system
- Rear disc brakes
- Lighter in weight

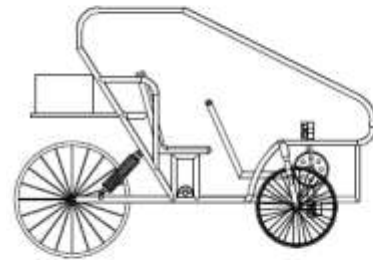
#### 7.2 Field of Application

- Can be used for charging electrical appliances
- Can be used for long journey travel
- Can be used by all age groups.

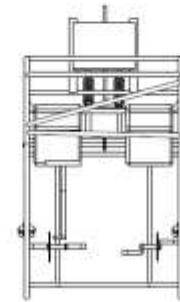
### 8. Unique Selling Point

- The hybrid system used is extremely reliable an can be used for charging battery or any other appliance.
- Ease of handling as the structure and handling is similar to that of normal bicycle.
- Disc brakes are used which are mounted directly on the axle which make it more simple and reliable even in monsoon season.
- High acceleration can be achieved due to its light weight.

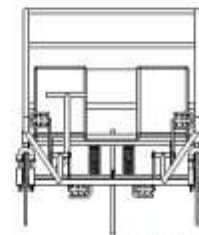
### 9. 3D Model of Vehicle



**Fig.1 Side view**



**Fig.2 Top view**



**Fig. 3 Front View**

### 10. Actual Model of Vehicle



**Fig.4**

**Fig.5**

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## 11. CONCLUSIONS

Pollution being the emerging issue all over the world, there should be an alternative for transport. Efficycle could be the appropriate answer for the issues regarding the same. Design & Analysis becomes easier with the use of software like ANSYS, CATIA. etc.

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