# CAD & CAE of Plug-In Hybrid Electric Two-Wheeler by Autodesk Fusion 360

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**Abstract:**Now days, pollution is a major problem. Most of the pollution is released from internal combustion engine vehicles. Internal combustion engines produce certain emissions like hydrocarbon, carbon monoxide, carbon dioxide, oxides of nitrogen due to the burning of fossil fuels and a Hybrid vehicle is defined as a vehicle with two different power sources. Hybrid vehicles produce less pollution when compared to internal combustion engine vehicle. Hybrid vehicles have more efficiency and better fuel economy.

The main motto of this project is to design and analysis the different components of the plug-in hybrid electrical two-wheeler. This project is to implement the most efficient and less polluting vehicle. In our project the hybrid electric vehicle model combines the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle, resulting in twice the fuel economy of a conventional vehicle.

## INTRODUCTION

CAD/CAE Computer-aided design or CAD has a very broad meaning and can be defined as the use of computers in the creation, modification, analysis, and optimization of a design. CAE (Computer-Aided Engineering) is referred to computers in engineering analysis like stress/strain, heat transfer, and flow analysis. CAD/CAE is said to have more potential to radically increase productivity than any development since electricity. CAD/CAE builds quality from concept to final product. Instead of bringing in quality control during the final inspection, it helps to develop a process in which quality is there through the life cycle of the product. CAD/CAE can eliminate the need for prototypes. But it required prototypes that can be used to confirm rather than predict performance and other characteristics. CAD/CAE is employed in numerous industries like manufacturing, automotive, aerospace, casting, mold making, plastic, electronics, and other general-purpose industries. CAD/CAE systems can be broadly divided into low-end, mid-end, and high-end systems.

## ADVANTAGES OF CAD

- Time and error reduction for the design of engineering ensembles and independent components.
- Possibility to make corrections early in the engineering conceptualization and design phases.
- Dramatic cost reduction associated with the physical testing of prototypes.
- Keeping the established deadlines in different phases of the engineering workflow.
- Radical improvement of product quality and enriching the customer satisfaction level.
- Increasing the competitive advantages associated with a quicker time to market better quality and customer retention.

## OBJECTIVES OF PROJECT

The objectives of this project are:

- To design wheels, rim, wheel drum, body, and motor of the vehicle.
- To calculate the modal frequency of wheel plate.
- To observe the thermal stresses on the motor.

## ABOUT THE SOFTWARE

**Fusion 360** is a cloud-based CAD/CAM tool for collaborative product development. **Fusion 360** enables exploration and iteration on product ideas and collaboration within a distributed product development team. **Fusion 360** combines organic shapes modeling, mechanical design, and manufacturing in one comprehensive package.

**Parametric** models use feature-based, solid, and surface modeling design tools to manipulate the system attributes. ... Before the advent of parametric, editing the shape was not an easy task for designers. For example, to modify a 3D solid, the designer had to change the length, the breadth, and the height.

### Table1- Parameters linked to the software

| Name | Unit | Expression | Value |
|---|---|---|---|
| | | | |
| Length | mm | 1761 mm | 1761.00 |
| Width | mm | 710 mm | 710.00 |
| Height | mm | 1158 mm | 1158.00 |
| Saddle_Height | mm | 765 mm | 765.00 |
| Ground_Clearance | mm | 153 mm | 153.00 |
| Wheelbase | mm | 1238 mm | 1238.00 |
| Kerb_Weight | kg | 109 kg | 109.00 |
| Wheel_Size | mm | 254 mm | 254.00 |
| Brake_Diameter | mm | 130 mm | 130.00 |
| Wheel_width | mm | 90 mm | 90.00 |
| Tire_radius | mm | 217 mm | 217.00 |

## COMPONENTS:

The major parts that are effectively employed in the design of the hybrid vehicle are described below:

- Motor
- IC engine
- Wheels
- Vehicle body
- Battery

## MOTOR:

Hub motors are typically **brushless motors** (sometimes called brushless direct current motors or BLDCs), which replace the commutator and brushes with half a dozen or more separate coils and an electronic circuit. The circuit switches the power on and off in the coils in turn creating forces in each one that makes the motor spin. Since the brushes press against the axle of a normal motor, they introduce friction, slow it down, make a certain amount of noise, and waste energy. That's why brushless motors are often more efficient, especially at low speeds. Getting rid of the brushes also saves having to replace them every so often when friction wears them down.
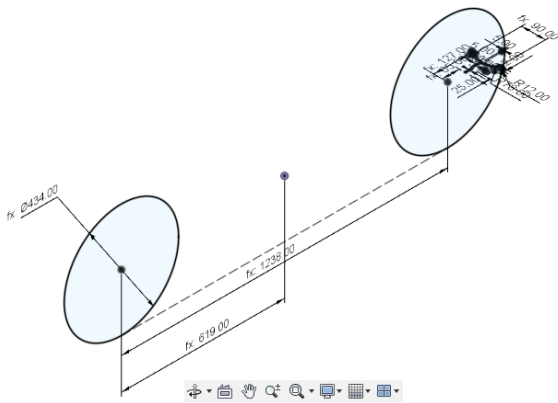
**Figure-1:BLDC Motor**

## IC ENGINE:

IC engine is a heat engine where the combustion of the air-fuel mixture occurs inside the combustion chamber that produces high temperature and high gas pressure. This gas pressure pushes the piston over a distance and transforms the chemical energy into thermal energy which **is used** for performing the mechanical work.

## WHEELS:

A drive wheel is a wheel of a motor vehicle that transmits force, transforming torque into tractive force from the tires to the road, causing the vehicle to move. The power train delivers enough torque to the wheel to overcome stationary forces, resulting in the vehicle moving forwards or backwards.



**Figure-2: Isometric view of the wheel**

## VEHICLE BODY:

The body is the super-structure for all vehicles. It may either be constructed separately and bolted to the chassis or manufactured integral with the chassis (i.e. Frameless construction). The chassis and the body make the complete vehicle.

## BATTERY:

A battery is an energy source consisting of one or more electrochemical cells and terminals on both ends called an anode (-) and a cathode (+). Electrochemical cells transform chemical energy into electrical energy. Inside the battery is an electrolyte, often consisting of soluble salts or acids, it serves as a conductive medium, allowing the electric charge to travel through the battery.

## SKETCH

This Fusion 360 update brings new 3D sketching behavior to the following sketch features:

Line, rectangle tools, point, Spline tools, circle tools Conic Curve and ellipse.

**Sketch Constraints Supported by 3D Sketch:**

3D Sketches also support the use of the following sketch constraints:

- Horizontal/Vertical
- Coincident
- Tangent
- Equal
- Parallel
- Perpendicular
- Fix/Unfix
- Midpoint
- Concentric
- Collinear
- Curvature

## FULLY DEFINED SKETCH:

The sketch is fully defined if the lines on the sketch are all black. This means that there can be no unexpected changes within the model due to all the geometry of the sketch being fully defined.



**Figure-3: Rim profile and guide way**

**Figure-4:Wheelbase Sketch**

## PART DESIGN

### CREATING THE FILE:

If you start Fusion 360, it will automatically create an empty new design for you. But if you have already opened up Fusion, you should create a new one.

### STRUCTURING THE PARAMETERS:

Once you created your new file, you can start with structuring the parameters, which is the most essential part of parametric modeling. Think about the model you are going to create and define variables that you want to change afterward without modeling from scratch again or fiddle with draft dimensions.

### SKETCHING WITH PARAMETERS:

Once you've set up all the parameters, you can start designing with them. Create a sketch on any plane and draw. Instead of typing in the numerical values as you'd normally do, you just type in the parameters you've set up before by using the corresponding words.

Use extrude, press pull, revolve, loft, and sweep to create a 3D part from the sketch you have drawn.



**Figure-5:Orthographic view**



**Figure-6: Exploded view**

## FORM TOOL WORKBENCH:

Work with vertices and points to adjust their position, making changes to your form.

Tweaking multiple vertices while working with T-spline surfaces can quickly become tedious. It can also be difficult to get the desired results. That is why Fusion provides tools that are specifically designed to deal with vertices.

You can use the Weld Vertices tool to join and merge multiple vertices into one. This can have a dramatic effect on your surfaces. On the ribbon, expand the **MODIFY** panel and select **Weld Vertices**. The first step is to select the points to weld. Select two of the center points on the top face of the box. As soon as you do, the edges adjust to combine the chosen points.

With the **Vertex to Vertex** option selected, the two points simply merge, moving the first selection to merge with the second selection. If you choose **Vertex to Midpoint**, the program welds and merges the two selected points at the exact middle point along the surface between the two points. With **Weld Tolerance**, you can select multiple points with a window, even invisible ones, and weld only the ones within the specified tolerance.

By using the **Flatten** tool, which you can also find on the **Modify** ribbon, you can project points, moving them to the same plane and creating a condition of flatness for the selected point. Expand the **Direction** drop-down. The options include **Fit**, which allows Fusion to decide the best fit; and **Selected Plane**, which allows the user to define the plane. The third option**, Select Parallel Plane**, moves all of the selected vertices to their parallel plane. When you have the points set as you wish, click **OK** and click **Finish Form** to complete the T-Spline.Return to **Sculpt** by selecting **Create Form**.
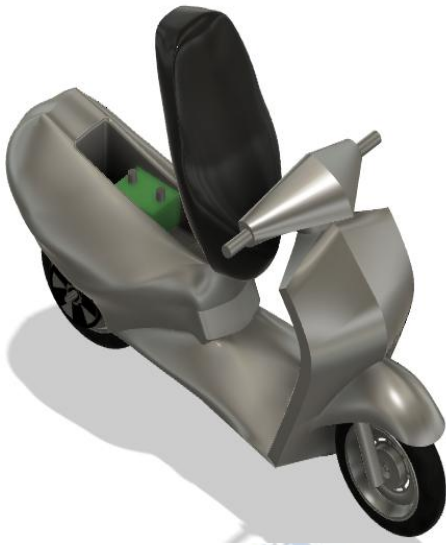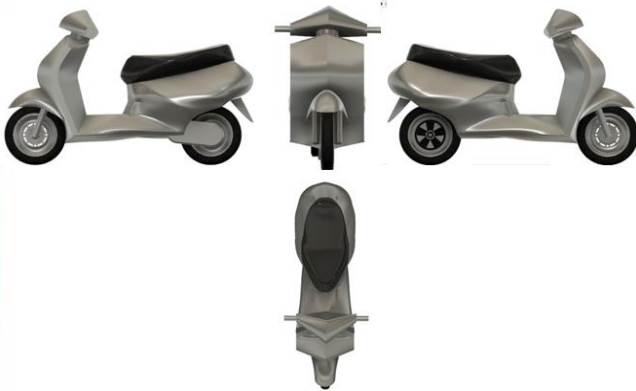
Figure-7: Battery location for the motor



Figure-8: Orthographic view

## COMPUTER-AIDED ENGINEERING

### MESHING:

**Meshing** is the process in which the continuous geometric space of an object is broken down into thousands or more of shapes to properly define the physical shape of the object. The more detailed a mesh is, the more accurate the 3D CAD model will be, allowing for high fidelity simulations.

A **Coarse Mesh** may provide an accurate solution if the solution is a constant, so the precision depends on the particular problem instance. One can selectively refine the mesh in areas where the solution gradients are high, thus increasing fidelity there. A fine mesh is used only in the region of high stress gradients, and a coarse mesh is used elsewhere.
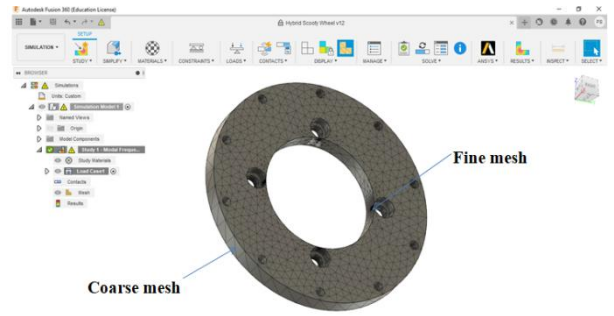


Figure-9: Meshing

### MODAL FREQUENCIES:

Determine the modal frequencies of the model. Structural Loads and Boundary Conditions can be included. The Results include Vibration Mode shapes, corresponding Frequencies and their mass participation factors.
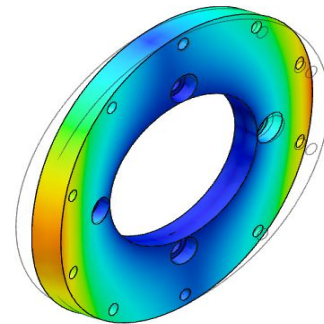


Figure-10: Wheel plate simulation

### THERMAL STRESS:

Determine temperatures and stress distributions on the model resulting from both thermal and structural loads. The stress-free reference temperature is defined in the Study Settings.
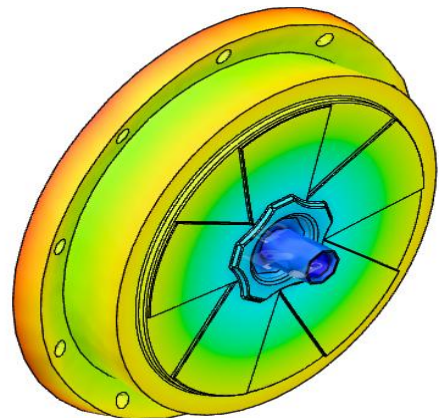


Figure-11: Deformation of motor due to thermal stresses

## CONCLUSION

This project is an attempt to reduce our dependency on foreign oil and reduce the tailpipe emission from automobiles and this was an attempt to design and implement this new technology that will drive us into the future. Use of production hybrid vehicles will reduce smog-forming pollutants over the current national average. By 3D modeling and analysis the failure of parts identified and can be modified easily, cost of the product also reduces.

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