

Essential Parts of e-Trike

The electric tricycle or e-Trikes is a three-wheeled electric vehicle that is used to ferry a few passengers in short distances in side streets. Although the current design of the e-Trikes used in Mandaluyong can carry eight passengers, the Land Transportation Office only allows tricycles to carry a maximum of 6 passengers.



Figure 1: ADB e-Trike

The parts of the e-Trikes can be classified into three groups, the chassis, shell and electro-mechanical drive system. Some components are classified between two groups. The list below provides a simple grouping of the parts.

1. Chassis – this forms the base frame and the platform where all the other components are mounted. This included the suspension part such as the wheels, axles, shock absorbers, leaf springs and braking system. This part can be standardized for mass production.
2. Shell – this part provides the visual character of the vehicle with its shape, color, and decals. Included in this group are parts that are attached to the shell such as the head lights, signal lights, interior lights, seat and upholstery, rain cover, side and rear mirrors, handle bars, baggage compartment, roof rack, the dash board with the speedometer, odometer, battery gauge and other indicators.
3. Electro-Mechanical drive–this group of components that provides locomotion to the e-Trikes composed of the motor, controller (with regenerative breaking option), throttle, key switch, forward/reverse switch, signal wand, wind shield wiper and switch, battery, Battery Management System (BMS) with high & low voltage cut-off, and the charging system that can be part or separated from the rest of the group.

For the purpose of bidding the e-Trikes per component, a sample set of specifications is provided in the next pages.

Chassis		Specifications (example only)
	wheels	Diameter, width
	axles	
	shock absorbers	
	leaf springs	
	braking system	Disc brake with caliper, hydraulic system with piston
Shell		
	Body	Material, shape, color, and decals
	Floor	skid-free GI sheet
	Head lights	12V 10W white LED with cover and adjustable head
	Signal lights	12V 1W LED in orange plastic cover with blinker for left and right turns, brake lights
	Interior lights	12V 1W white LED with cover and switch
	Seat and upholstery	Foam covered with black leather
	Rain cover	Transparent plastic schedule 16 with snap-ons
	Side view mirrors	Left and light adjustable
	Rear view mirrors	wide angle
	Handle bars	as illustrated in the plan
	Baggage compartment	as illustrated in the plan
	Roof rack	as illustrated in the plan
	Dash board	
	speedometer	0 to 100kph with 0.1 resolution
	Odometer	resetable trip and non-resetable total
	Battery gauge	E-F indicator with 10LEDs with audible alarm before motor cut-off
	Signal light indicators	blinking LED
Electro-Mechanical drive		
	motor	3kW brushless 36 to 72V DC motor with sensors
	Motor controller	48V 500A for brushless DC motors with regenerative braking and BMS interface for low voltage
	Throttle	0-5k ohms handle bar mounted with 2m wire
	Key switch	
	Line contactor	500A 48V
	forward/reverse switch,	Three position rocker switch 48V 15A
	Signal wand	Left/right turn
	Wind shield wiper and switch	
	Battery	LiFePO4 48V, 70AH, 2000 cycles at 80% DOD
	Battery Management System (BMS)	For 15cell LiFePO4 battery with high & low voltage cut-off output
	DC-DC converter	48VDC to 12VDC 300W with fuse protection
	Charging system	On board Input: 100-260VAC Output: 48V 25A switch mode with high voltage input from BMS

Table 1. Sample Specification of the e-Trikes.

Drawings and illustrations:

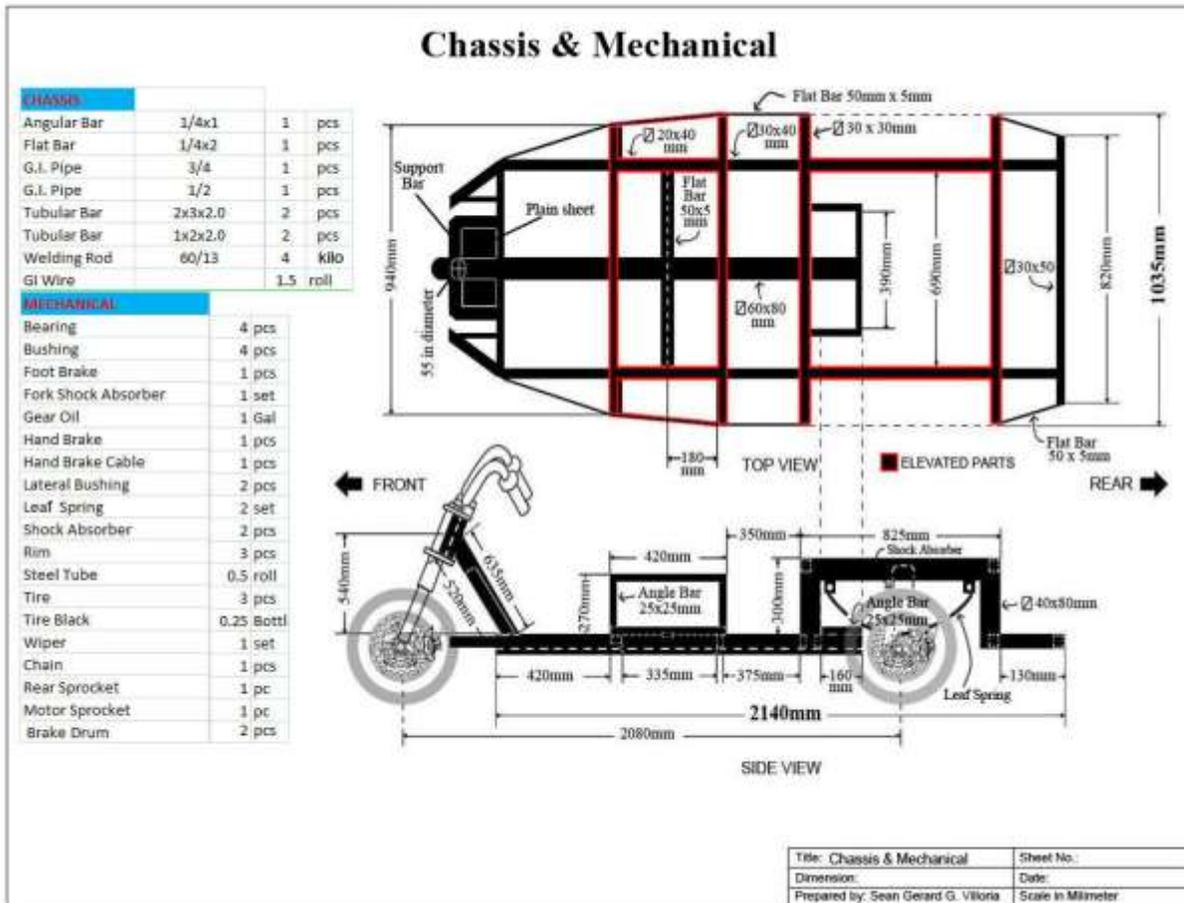


Figure 2. e-Trikes Chassis Design



Figure 3: 3D rendering of the Chassis

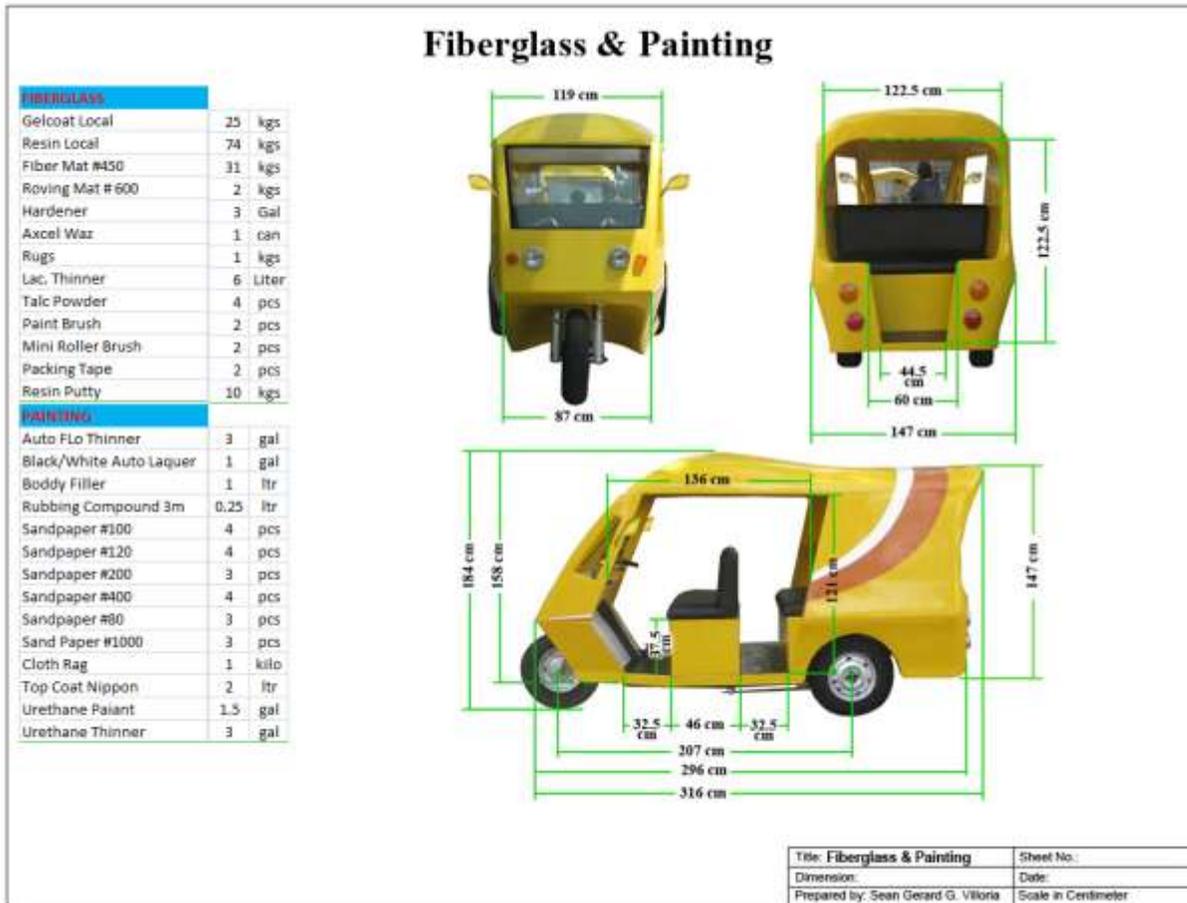


Figure 4. Detailed Etrike shell design.

Etrike Design Contest

The Department of Energy (DOE) launched an electric tricycle design contest to promote the innovation and ingenuity of the Filipinos in creating the Philippine version of the e-Trikes. The contest was open to all Filipino citizens of legal age, whether individual or group residing in the Philippines. The contestants were required to submit 2D and 3D computer-aided drawings of the best aesthetic and functional design in AutoCAD format. The design shall accommodate a maximum of six (6) passengers excluding the driver for the three (3)-wheeled electric vehicle.



Figure 5. Top three winning e-Trike designs

e-Trike Design Development

From the three winning e-Trike designs, the design consultant evaluated these designs on the basis of international safety requirements and manufacturability to come up with the consolidated design that will be referenced for mass production. The general design process is shown below.

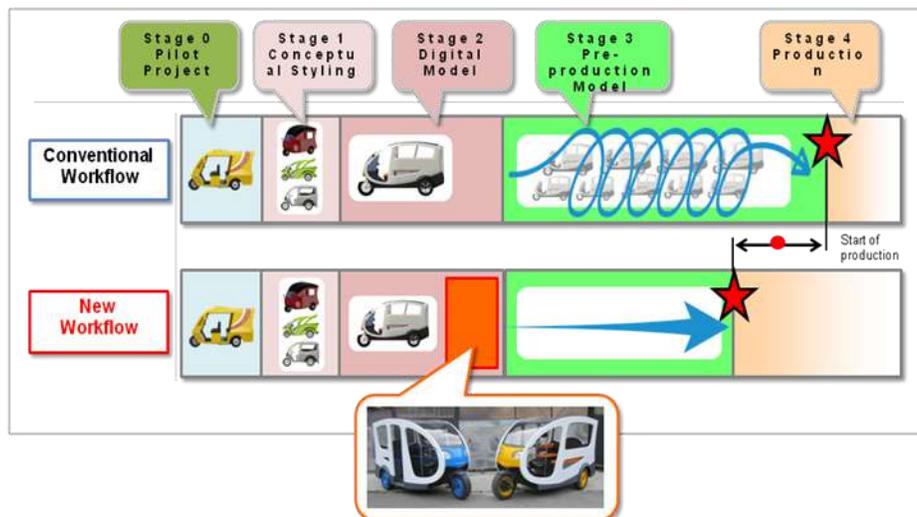


Figure 6. e-Trike body design process flow

The Mandaluyong e-Trike design was also evaluated for the features that can be adapted based on the feedback of the driver and passengers from the actual models that are physically operating in Mandaluyong. The “character” of the three winning design from the contest was incorporated into the resulting design with additional features to comply with the safety standards and manufacturability.



Figure 7. New e-Trike design

The driver's seating position and passengers' cabin layout were modified for the driver to seat the driver comfortably and safely, maneuver the vehicle better and communicate with the passengers effectively.

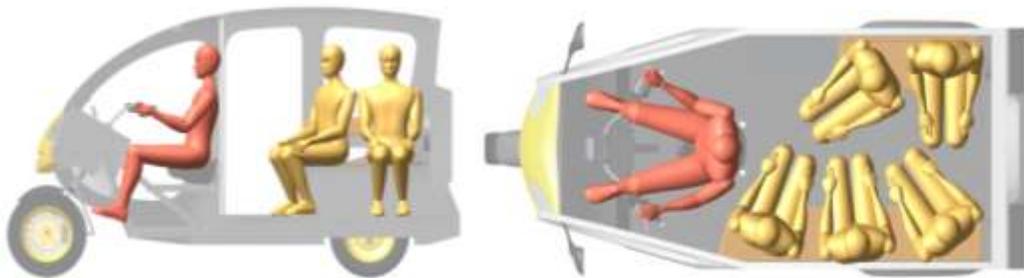


Figure 8. Modified Driver's seating position and passenger cabin lay-out

The new lay-out intends to create an open air feeling for ease of communication between the passengers as well with the pedestrians outside of the vehicle.



Figure 9. Communication between passengers and pedestrians

For safety requirements, the door for the passengers was positioned on the side of the vehicle instead of the back as adapted by the jeepneys. This will keep the passengers safe on the pedestrian side coming from the sidewalk into the vehicle and getting off the vehicle back to the sidewalk without stepping on the road. This also provides the driver better management with the passengers having the door nearer compared to the door at the rear of the vehicle.

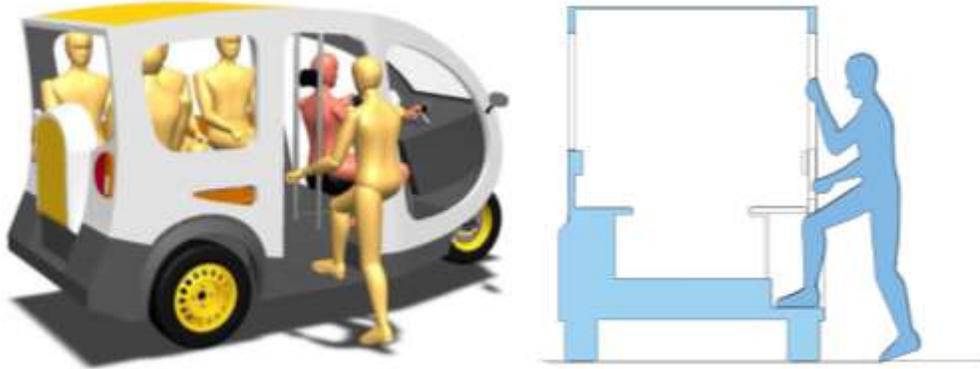


Figure 10. Passenger door at the pedestrian side for safety

To accommodate luggage, the rear gate can be opened for loading from the back and carrying long items. The passenger roof can also be rolled to carry tall items loaded from the back. The back door has a utility compartment to hold tools, emergency first aid kits and other similar items. Rear access can also accommodate a wheel chair that is not usually possible in any public utility vehicles.



Figure 11. Rear door access and rolled roof for extra large luggage



Figure 12. Rear access for wheelchair

Picture Models

To accelerate the development of the e-Trike design, two picture models were built. The picture models are not fully functional e-Trikes but mock-up vehicles to physically show the actual appearance and feel of the vehicle based on the design. The picture model is not the final design but will a basis for the pre-production models after incorporating comments and recommendations taken from stakes holders such as the drivers, passengers; particularly women, manufactures, equipment suppliers, and others.



Figure 13. Two picture models

These two picture models were built from the design illustrated below. This design evolved from the initial e-Trike model that are being piloted in Mandaluyong, incorporating the character and combination of the three winning designs from the DOE e-Trike design contest and adapting the safety and other features of the design consultant in preparation for the pre-production model.

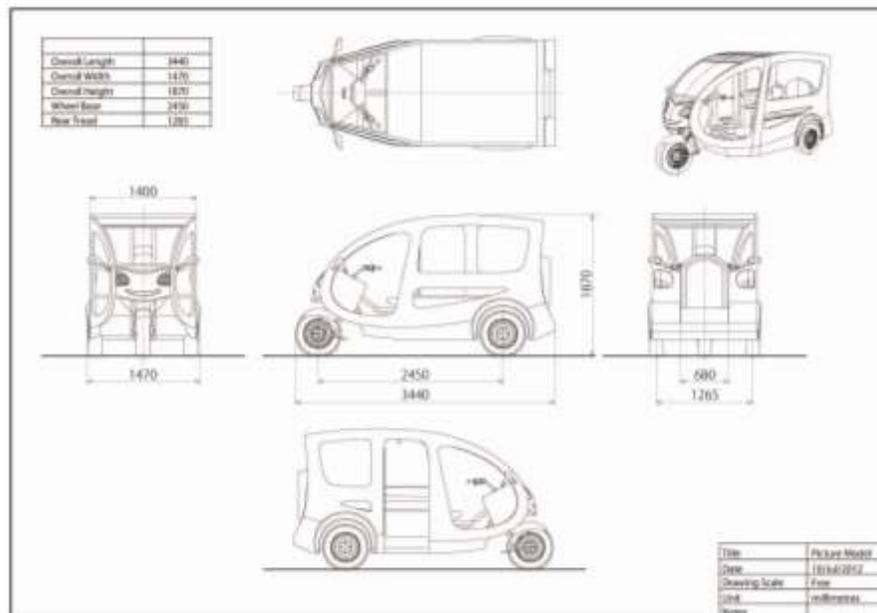


Figure 14. Detailed design of the picture model

The materials used in the picture models are shown below that can be a basis for the pre-production models.



Figure 15. Materials used in the picture models

Power pack and battery lay-out

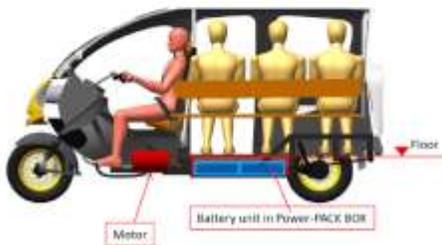
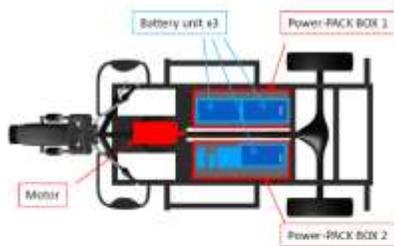


Figure 16. Battery and Power pack lay-out

The e-Trike drive train composed of the motor, controller, on-board charger and related accessories will be packed together with the batteries below the floor. These will be secured and accessible only to qualified personnel for security reasons and to protect the warranty of the parts by the manufacturer. The compartment is also protected from flooding.



Figure 17. Flood protection