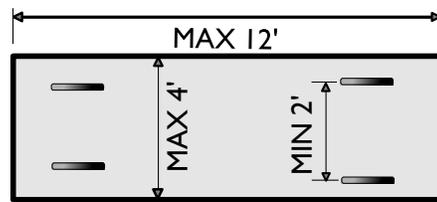


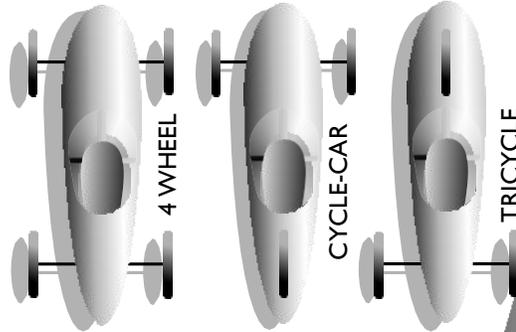
## 1 DIMENSIONS

1. Minimum track (the distance the tires are apart) on at least one axle, is 2 feet center to center.
2. Maximum vehicle width is 4 feet at its widest point when the steering system is positioned as if driving in a straight line.
3. Maximum vehicle length is 12 feet.



## 2 CONFIGURATION

1. All vehicles must be three-wheeled (cycle-car or tricycle) or four wheeled. Any configuration is allowed. All wheels must be load bearing, and remain in contact with the ground at all times, even under hard cornering conditions.

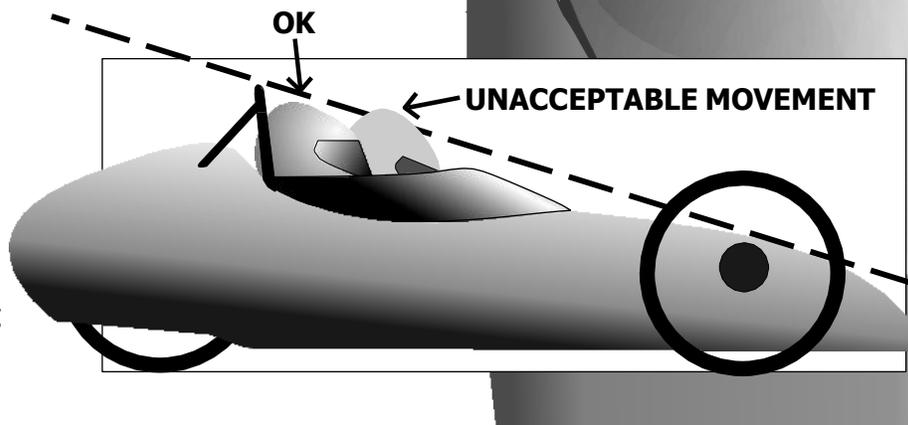
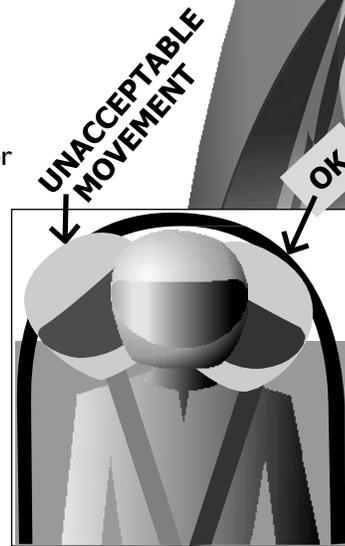


## 3 FRAME / FRAME MEMBERS

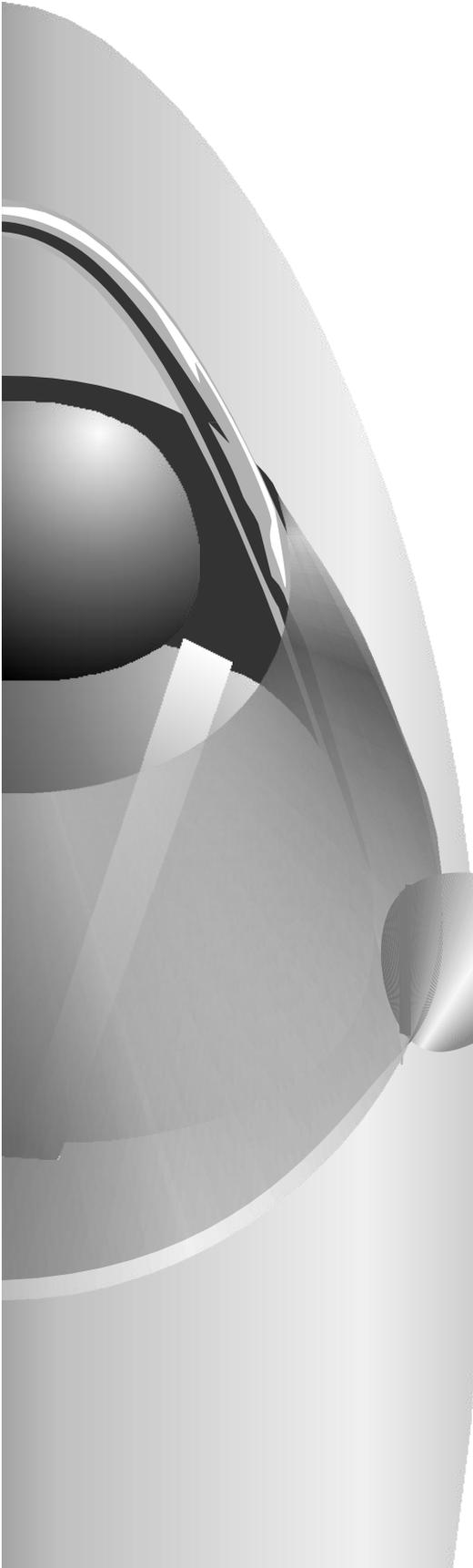
1. All vehicles must have frame members that protect the driver in the event of collisions from any direction.
2. Frames may be constructed of various materials and styles providing that the material(s) or methods provide adequate structural strength for protection/safety. The design will need to be structurally sound in the opinion of inspectors and/or race officials.

## 4 ROLL BAR

1. The roll bar must protect the driver's head/helmet in the event of a roll-over. It must be tall and wide enough to do this considering the full range of possible movement. (See drawing.)
2. The roll bar structure must be triangulated with at least three legs or panel equivalent. Triangulated bracing can be either forward or rearward. With three legs bracing must extend from the top of the roll bar and securely attach to the vehicle structure, with four legs, each of the braces must extend to within 4" of the top. Any roll bar that is constructed from more than one continuous piece must be reinforced and braced triangularly from all junctions/joints in addition to the top.
3. The roll bar structure must appear to be sturdy enough to withstand the vehicle being dropped, upside down, from an altitude of one foot, with the driver inside without failure.



4. The driver's helmet must be below a straight line drawn from the top of the roll bar to the top of the highest structural point when the driver is securely belted in driving position. (see drawing).
5. Composite or monocoque vehicles with integral rollover protection must meet comparable strength and clearance requirements.



## 5 VEHICLE BODY

1. All vehicles must provide a body/chassis structure sufficient to protect the driver from impact from any side. A suitable structure or shell is required to provide a barrier between the driver and any contact with another vehicle or the ground.
2. This body or structure needs to protect the driver's legs, feet, and side up to shoulder level protecting the rib cage from side impact.
3. The legs and feet must be enclosed to prevent them from leaving the vehicle in an accident and provide protection against a frontal impact.
4. If the chassis contains a structural shell sufficient to protect the driver, then any body provided need not be structural. However, under no circumstances is the body to be made of cardboard, paper or any material that becomes weak when wet. Materials that are brittle, or produce sharp edges when broken (e.g. Plexiglas or brittle acrylic panels) are also not allowed.
5. A body is not required if the frame or chassis shell will prevent the driver's arms and legs from leaving the vehicle and prevent another vehicle's parts from entering the vehicle during an accident.
6. The vehicle must not have any sharp edges, corners or protrusions that could cause injury. Any questionable exposed portion of the vehicle should be cut off, rounded off or blunted with durable padding.
7. The nose area must have a minimum radius of 3 inches (6 inch diameter) in at least one direction and not be dangerously pointed in the other direction.
8. The vehicle must have a fixed floor pan of solid-rigid material that prevents any part of the driver's body from contacting the ground.

## 6 STABILITY

1. All vehicles must demonstrate stability at rest, while cornering, braking and at top speed.
2. Driver contact with the ground cannot be used for stability.
3. Vehicles must be positively balanced and stable at all times while moving and at rest. Stability is critical for safety and must be maintained in off- camber turns, high-banked corners and in windy conditions.

## 7 LEANING VEHICLES

1. Leaning vehicles are permitted provided the driver is not required to balance the vehicle and stability requirements are met.
2. Leaning vehicles must use a mechanical device for actuation.
3. Vehicles which lean must have the ability to lock out the leaning capability of the vehicle for driver access and exit.

## 8 STEERING

1. Steering must permit a turning circle diameter of less than 50 feet curb to curb.
2. Any steering system must be well constructed and provide reliable steering action without looseness or binding.

## 14 MOTOR and TRANSMISSION

1. Vehicles must only be powered by electric motors.
2. All gears, chains, and sprockets must be covered if they could cause injury to the driver or others in the event of mechanical failure.

## 15 MOTOR CONTROLLER

1. Any type of power (speed) controller is allowed.
2. Power to the motor must be controlled by the driver, and turn off automatically when the driver releases the accelerator ("dead man" cut-off).
3. Remote control of a vehicle is not permitted.
4. Computers on or off the vehicle are legal systems if they present information only. The driver must have complete manual control of the vehicle and make all operational adjustments.

## 16 NUMBERS

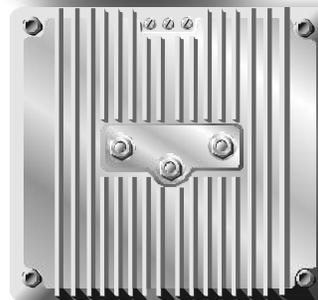
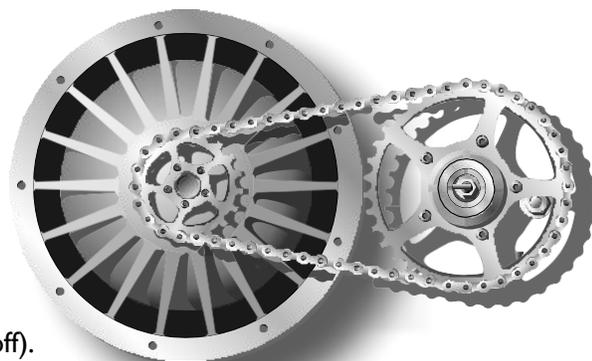
1. All vehicles must display assigned vehicle competition numbers.
2. Vehicle numbers must be least 6 inches in height.
3. Numbers must be clearly visible on both sides of the vehicle.
4. The numbers must be in a contrasting color to the vehicle or number background. Out of state vehicles must also display their state abbreviation following the vehicle number in 3 inch high letters.
5. Numbers or letters can be purchased when registering on membership form or by contacting the Treasurer of Electrathon America.

## 17 MIRRORS

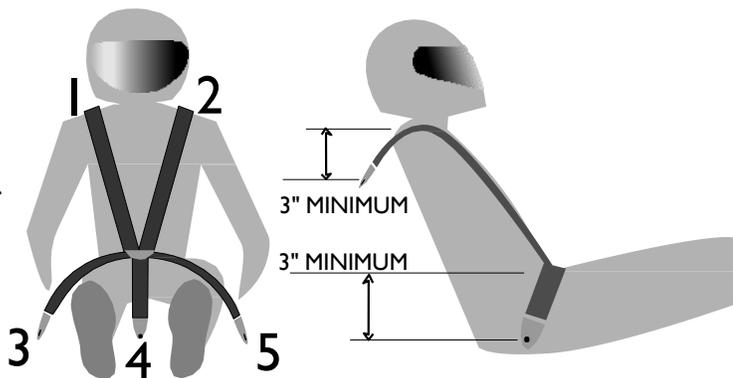
1. Vehicles must be equipped with a minimum of 8 square inches of total usable mirror surface area. This may be one or two mirrors.
2. The mirror(s) must allow the driver to see clearly to the rear on both sides of the vehicle. This will be tested in a manner deemed appropriate by the inspector and race steward.
3. The driver must be able to see clearly to the front and both sides of the vehicle.
4. Electronic sensing devices, such as video cameras and monitors, may not be used as a substitute for rear view mirrors.

## 18 SAFETY BELTS

1. All vehicles must be equipped with a five-point automotive seat belt system.
2. All five belts must be securely attached to the vehicle frame structure by mechanical fasteners such as nuts, washers and bolts. Questionably small fasteners, zip ties and tape are unacceptable. The harness must be capable of lifting the entire vehicle from the ground with driver and batteries in place.
3. Each waist belts must be mounted to a structural point at least 3 inches below the top of the drivers waist.
4. The shoulder harness must be attached to a structural point at least 3 inches below the driver's shoulder without interference from the seat or other items.
5. The seat belt, shoulder harness and crotch strap must be able to hold the driver in a position that does not allow any excessive movement. The shoulder harness must be installed so that it can't slip off the driver's shoulders while driving. In the event of a sudden stop, it must prevent the driver from sliding forward and maintain the driver's shoulders in the "driving position". The seat belt must be able to hold the driver securely in place if the vehicle rolls over.



*\* With the available option for purchasing sanctioned numbers this rule will be strongly enforced with possibility of denial to race until standards are met to race host approval.*





## **19 HELMETS**

1. All drivers must wear a DOT approved full face hard shell helmet during competition. Bicycle and skateboard helmets are not acceptable.
2. Chin straps on helmets must be properly and securely fastened while operating an Electrathon Vehicle.

## **20 DRIVER ATTIRE**

1. Drivers must be fully clothed during competition.
2. Long sleeve shirts, pants and shoes are required (water socks and wrestling shoes are acceptable).
3. Gloves are required for open cockpit vehicles. Gloves are optional for enclosed canopy vehicles. Fingerless gloves are allowed.
4. All drivers must wear eye protection while operating an Electrathon vehicle. Safety glasses with a Z87 rating, goggles, or a full face shield helmet are acceptable.
5. Hair must be contained in such a way that all of it is unable to reach the drive train.
6. Necklaces, wrist and ankle bracelets, and large ear rings must be removed.

## **21 CELL PHONE/COMMUNICATION DEVICES**

1. Push to talk radios are permitted as long as the driver is not distracted by the action of Push To Talk.
2. Cell phones are permitted only when vehicle is at a stop (such as a breakdown) or when in hands free mode on an open line (no dialing).
3. Texting is banned whenever the driver is physically in the car.
4. Penalty for violation of the rules 21.2 or 21.3 is the offending car and driver's immediate removal (disqualification). After 2 violations in same calendar year the driver will be banned from using any electronic form of communication for the rest of the year.

## **22 DRIVING POSITION**

1. Drivers must be in a sitting or recumbent (reclining) position. A kneeling, or prone (head first) position is not permitted.
2. Arms and legs must remain within the vehicle body structure during competition.

## **23 EXITING THE VEHICLE**

1. Drivers must be able to exit their vehicle as it is driven in competition, unaided in 20 seconds. This includes any external method of securing canopies.
2. Handicapped participants will be allowed up to 2 minutes aided exit.

## **24 DRIVER**

1. All Electrathon America drivers must be at least 16 years old, but a driver's license is not mandatory. If lacking a driver's license they must pass approval by race host or official appointed by race host which requires demonstration of ability to perform at race conditions (including similar speeds and track parameters) either during a test prior to the race or on the day of the race in a special session for testing participants only for a minimum of 10 minutes. The approval must come from the event Steward, or someone appointed by the event Steward, who is not affiliated by team or familial ties to the driver.
2. All drivers must sign a liability release prior to each event. Drivers under the age of 18 must have a parent or legal guardian co-sign their liability release on their behalf.

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## 25 COMPETITOR MEMBERSHIP CARD

1. To compete in a sanctioned event, all vehicles must be accompanied by an Electrathon America Competitor Membership Card. This card will be made available by Electrathon America and can be presented as proof of current year paid membership. The Event Organizer may request a computer roster of current competitor members to verify memberships.

## 26 BALLAST

1. Drivers must weigh a minimum of 180 pounds. This includes race clothing and helmet. Drivers under this weight limit must provide non-liquid ballast to increase their weight to the legal limit.
2. Ballast cannot be performance related items such as communication equipment or computers. However, non-performance items such as cameras or music systems may be permitted as ballast provided they do not present a safety risk to the driver or other competitors.
3. Ballast must be removable for weigh in. Ballast must be securely attached to the vehicle in such a manner to withstand an impact or roll-over. If a vehicle loses its ballast during competition, it will be black flagged and disqualified.
4. Each driver is responsible for providing the correct amount of ballast.

## 27 SOLAR CLASS

All other Standard Class rules apply with the following additions:

1. Solar panels are permitted provided they are an integral part of the vehicle body and do not protrude to the front, sides or rear.
2. Wings or trailers are not permitted.

*The Solar Class allows the use of photovoltaic cells to provide additional power during a race. In most cases that additional power will be more than offset by the increased weight and aero drag of the cells, and while the cost of PV cells is usually prohibitively expensive, they are often donated to schools. It was also felt that solar power offers a sustainable alternative to conventional energy sources, and fit the general objectives of Electrathon.*



## 28 ADVANCED BATTERY CLASS

*The Advanced Battery Class is intended to foster experimentation on with newer battery technologies that offer higher energy density than the more traditional lead-acid, and reflect the rapidly expanding availability and usage in the transportation industry. The weight limits are meant to keep the available power under **one kw/hr**, or about the same as the current Standard Class. This list will be reviewed and updated periodically.*

All other Standard Class rules apply with the following exceptions:

1. Any type of the following sealed production batteries may be used as long as their weight does not exceed:

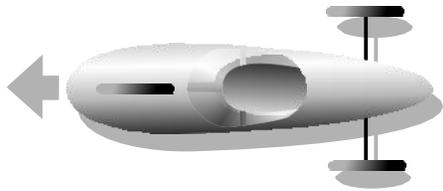
2. Maximum output of any battery combination used may not exceed a one-hour rating of one kilowatt/hour according to the manufacturer's data.

- Nickel-Metal-Hydride **41 lb.**
- Silver-Zinc **23 lb.**
- Nickel-Zinc **44 lb.**
- Nickel-Iron **58 lb.**
- Lithium-Ion **15 lb.**
- Lithium-Iron-Phosphate **29lb.**

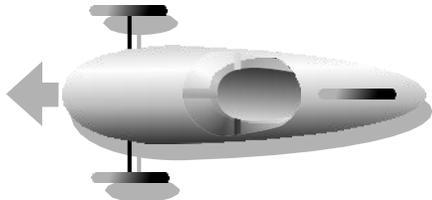


## 29 COMPLIANCE

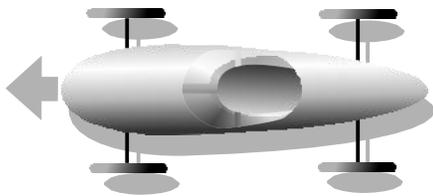
1. All vehicles must meet all Vehicle Design Rules to drive at any Electrathon America sanctioned event. This is true for competition, practice or testing and includes driver's clothing, safety equipment, batteries, battery securing systems, seat belts, etc.



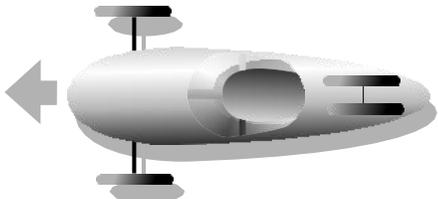
The **tricycle** offers a single wheel steering like a bicycle, and the opportunity to try front wheel drive or rear wheel drive.



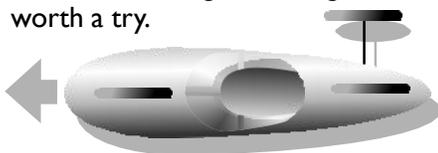
The **cycle car** steers with both front wheels, but requires a complex steering system. It offers a simple power train driving the rear wheel.



The **auto car** layout shares the weight among four wheels, and is less sensitive to placement of weight within the vehicle; but it has the added weight, complexity and rolling resistance of the extra wheel.



A **hybrid** variation. The increase in stability would come with the cost of additional drag, but it might be worth a try.



**Side car?** Here's an interesting variation that might have some advantages, but achieving the proper balance and stability might be difficult. Not for the beginner!

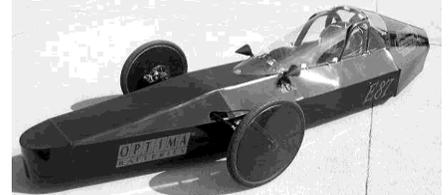
## BUILDING YOUR ELECTRATHON

An Electrathon vehicle is much like a full size RC model car, except that you can get in and drive it. Since you are the driver, it is important to make it stable and safe for your protection, as well as the safety of the other drivers and spectators at the track. Building a competitive and safe vehicle is the challenge. The Electrathon rules have evolved over many years to help builders construct a well-designed and safe vehicle. An Electrathon competition combines speed, aerodynamics, handling and lightweight design to create a balanced performance formula. These guidelines offer suggestions to assist you in achieving that goal.

## TESTING

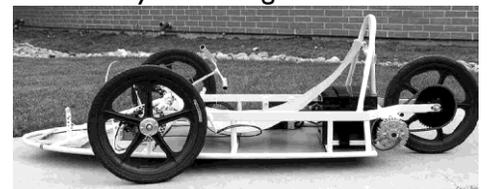
This is where races are won or lost. Reliability is the single biggest factor in winning. You don't know what will break until you've tried to break it.

Testing on the bench will give you "benchmarks" and help you chose components. Simple coast down tests can be used to compare and evaluate tires and aerodynamic changes. Testing on a track will allow you to understand how various components work together. It will give you a chance to refine your chassis handling qualities and find your ideal gear ratios. With testing will come the winning edge.



## CHASSIS DESIGN

The chassis is the backbone of your vehicle. Unless you are a veteran builder, you should try to keep your first chassis as simple and straight-forward as possible. While weight is a prevalent concern, it is actually only one of several factors that contribute to a successful Electrathon. Reliability is the key to winning. Most Electrathon courses are level, and acceleration is only a small part of the race. Although you will not want to build an overly heavy vehicle, concentrate on building a safe vehicle. Most Electrathons weigh over 350 pounds with driver, ballast and battery, so 10 to 20 extra pounds will be minor. It is more important that the design be strong.



Electrathon vehicles can be configured in a variety of layouts. Each design has disadvantages that you want to minimize, and advantages you want to optimize.

## MONOCOQUES

(frameless, or unibody vehicles)

Experiments with a one-piece body/chassis could result in lighter vehicle designs. Like boats and aircraft, they can be very strong. This is an advanced technique using composites (fiberglass, Kevlar or carbon fibers with epoxy or polyester resins). Materials can be expensive, but the drawback is usually the cost and time to engineer a shell properly. Simple but effective designs have been built from wood and fiberglass using small boat construction methods. Some community colleges offer courses in composites.



## STABILITY

A well-designed vehicle should be stable under all conditions and situations that might be encountered in a race. Competition places very high loads on a vehicle during tight cornering, even at relatively low speeds. It is therefore very important that the center of gravity of your vehicle be located below the axles. You need only a couple of inches of ground clearance on most race courses. Two to three inches is usually adequate, but make sure that you have clearance even if one, or all, of the tires are flat ( this is a rule requirement).

Position the driver, batteries and motor so that the weight is carried low (to prevent flipping over), and near the center of the car (to reduce the tendency to spin). Each wheel should be equally weighted for best handling and control, but a bias toward the front will increase stability. This is easily measured (with driver and batteries on board) with bathroom scales, and can be adjusted by proper placement of the driver's ballast.

Lift an outboard wheel with driver on board. Your vehicle should not tip over at 33 degrees. (This is not necessarily the minimum angle, even steeper banked courses exist) A vehicle that doesn't tip at 33 degrees when static may do so under dynamic conditions typical during racing. Parking lots have potholes, streets have curbs, and when the pavement ends at a racetrack there is usually a little drop-off. All of these can flip a fast moving vehicle.

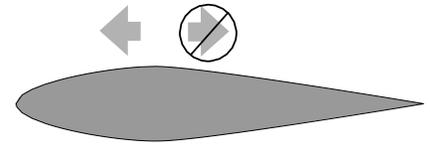
## BODIES

### AERODYNAMICS

Aerodynamic drag increases rapidly the faster you go, enough to be a deciding factor over the duration of the race. Wind resistance has a noticeable effect above 15 mph, and grows exponentially as the speed increases. Aerodynamic drag is the result of speed, frontal area and length of the vehicle and the shape of the body shell. At Electrathon speeds rounded fish-like teardrop shapes are very functional. Avoid abrupt bends, and flat surfaces. Make sure you can get in and out, and see well from inside the vehicle. Be sure you can get to the chain, tire and other adjustable components. Secure the body panels to the vehicle well, loose panels can create a lot of wind drag.

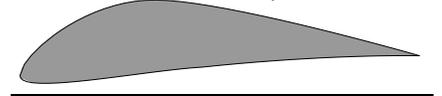


Creating a body shell is a challenge much like building a fiberglass boat or large model airplane. Work in the materials you know and ask around for advice on materials and techniques from plastic suppliers and fiberglass supply shops. Bodies have been made of fiberglass, fabric, steel and aluminum and plastic sheets, even light plywood. A shell is very functional in protecting you from other vehicles and the ground and, is one of the attractive features that make Electrathon distinctive. It can also help attract sponsors for your vehicle.



*Up in free air the ideal shape to strive for, looking from the side or from the top, is an airfoil, or teardrop. Note that forward and backward are not the same.*

*Close to the ground the ideal shape looks like this in side view,*



*but if it is very close to the ground, this shape works nearly as well.*



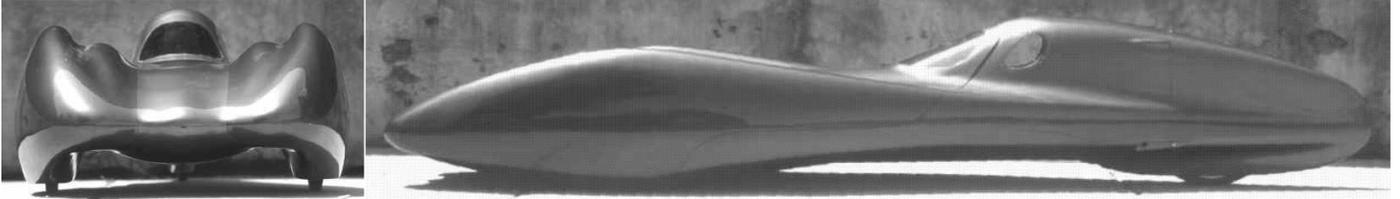
*There is a practical limit to ground clearance, though, so it may be better to lift the body high enough to let the air escape.*

### WIND POWER

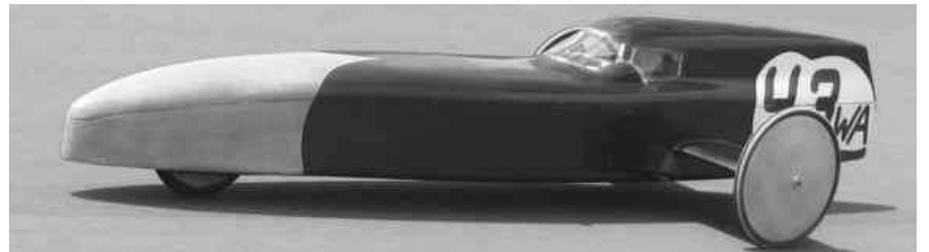
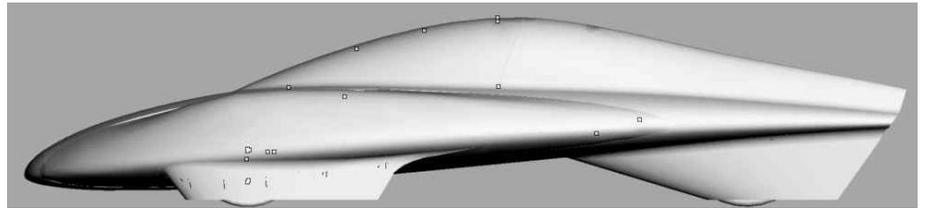
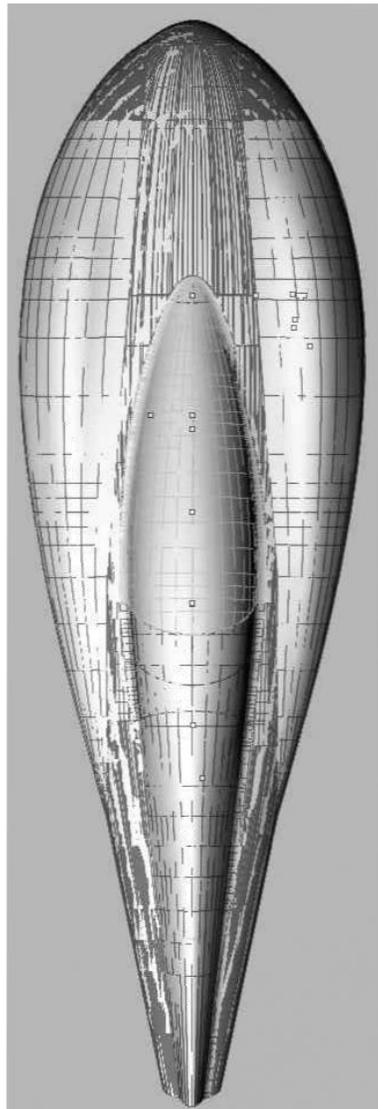
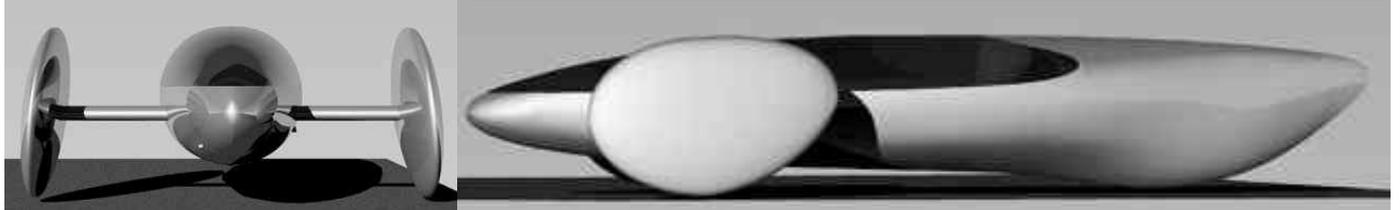
*It may be possible to capture extra energy from the wind. In fact, we may already be sailing. Engineers have calculated that the net effect of a light wind from any direction will add noticeably to the speed of an aerodynamic vehicle traveling in a circle (or oval). The head wind is cancelled out by the tail wind, and the rest of the time you are on what sailors call a 'reach'.*

*While EA has approved the design concept, it has yet to be proven effective in practice.*





Frontal area, the size of the hole made in the wind, should be reduced as much as possible. Swept, or Wetted Area, the total amount of body in contact with the wind, should also be minimized. An open wheeled car may have less frontal area than a fully enclosed body, but that advantage could be offset by the increase in swept area.



### CANOPIES

A windshield is an important part of your body shell. Depending on your design, you can use clear plastic creatively bent to fit (sheets of acrylic and polycarbonate are readily available in various thicknesses), motorcycle fairings, or buy canopies from a variety of suppliers. Most commercial canopies are molded from these same materials, but this is a difficult process. Acrylic is cheaper, but more brittle and will shatter. It molds at a lower heat, but it doesn't bend as well as polycarbonate, which is also more scratch resistant.

