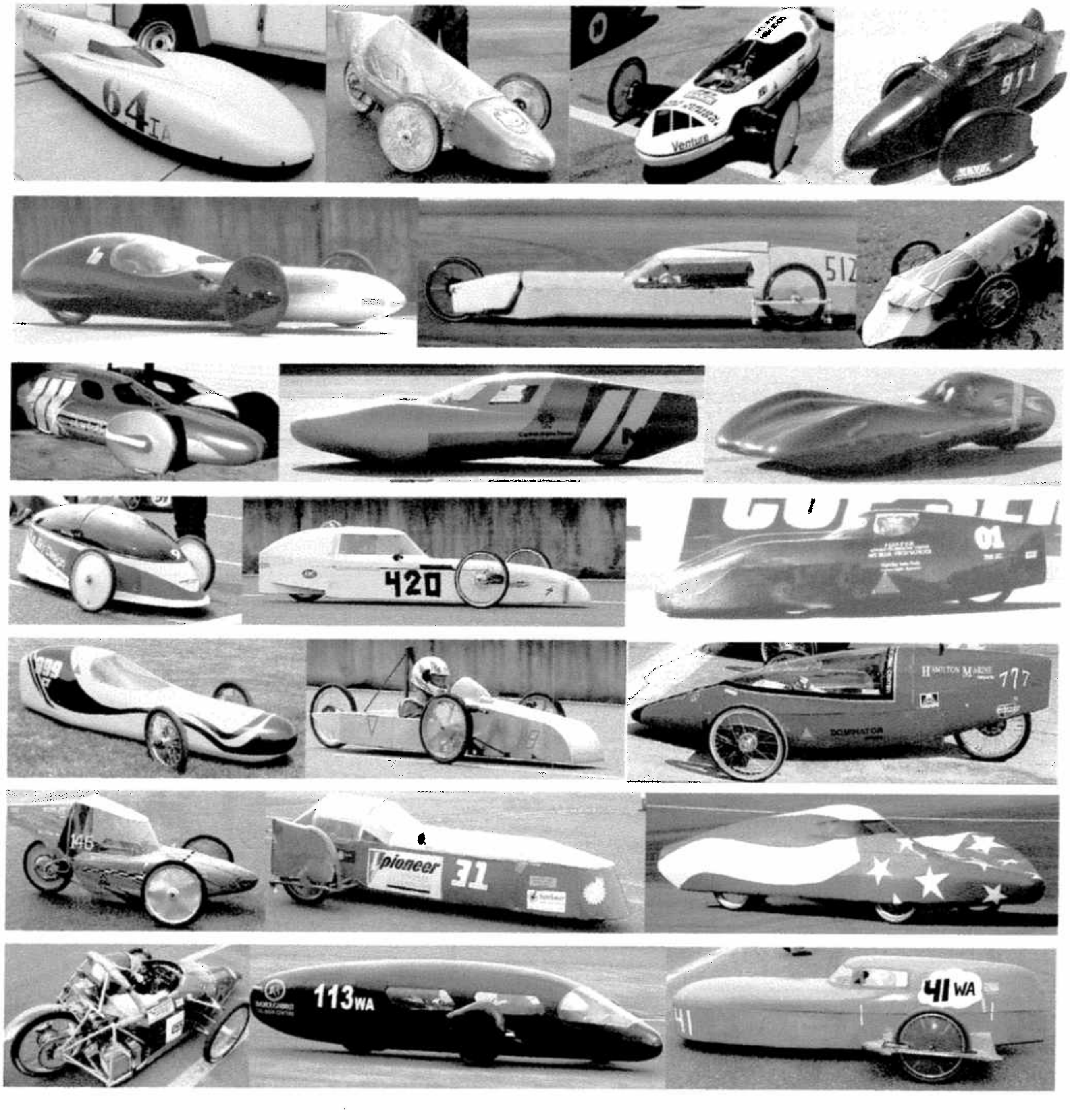
ELECTRATHON AMERICA



DESIGN GUIDELINES

2007/2008

VEHICLE INSPECTION FORM

Car Number	State	INSPECTION COMPLETED (Initialed by Inspector)

Name (car owner or team leader) ______

School or Team Name (if applicable) ______

Address (This is where awards and race information will be sent) ______

City ______ State ______ ZIP ______

Phone Number ______ E-Mail Address ______

Class:

☐ Standard ☐ Experimental

All classes must meet Electrathon America Rules

Division:

☐ High School ☐ College ☐ Open

☐ Entry Fees Paid

☐ Liability Form Signed

☐ Electrathon America Competitor Membership

DRIVER INSPECTION:

Driver Name ______

Driver's License Number ______ State____ Expires______

- ☐ Long-Sleeve Shirt, long pants, and shoes
- ☐ Helmet (DOT approved motorcycle style)
- ☐ Gloves (not required with full canopy)
- ☐ Eye Protection (safety glasses, goggles)

Driver weight ________lbs.

Ballast weight ________lbs.

Total weight ________lbs. (180 lbs. minimum to compete)

List items used for ballast______

VEHICLE INSPECTION:

- ☐ Vehicle number properly displayed and easily visible (min. 6" high)
- ☐ Structure or body shell protects driver from harm
- ☐ Bottom pan protects driver from contact with track
- ☐ No exposed sharp edges or components
- ☐ Axle diameter is ½" or 12mm min. unless supported both ends
- ☐ Safety wire or cotter pins on all cantilevered axle nuts
- ☐ Frame and shell adequately protect driver
- ☐ No for loose fittings and fasteners
- ☐ All tires are pneumatic (inflated)
- ☐ Tire tread is in acceptable condition
- ☐ Roll bar or bulkhead can support driver's weight
- ☐ Roll bar or bulkhead is braced forward or rearward
- ☐ Power kill switch outside the vehicle in a 4" red triangle
- ☐ Correct size fuse or circuit breaker between battery and motor
- ☐ Wiring is safely installed - terminals tight, insulation good, etc.
- ☐ Auto shut-off throttle
- ☐ Batteries are securely mounted to the frame and/or body
- ☐ Batteries are enclosed or covered

VEHICLE INSPECTION WITH DRIVER INSIDE:

- ☐ Guards (if necessary to protect driver from moving parts
- ☐ Ballast (if required) mounted securely
- ☐ Good visibility and field of vision
- ☐ Rear view mirrors, 8 square inches
- ☐ Top of roll bar or bulkhead is above driver's helmet
- ☐ Inside kill switch is driver accessible
- ☐ Brake inspection - car will not roll when pushed
- ☐ Steering inspection- appears tight and stable at speed, will turn 25' radius
- ☐ Vehicle stability test
- ☐ 5-point (minimum) lap and shoulder belt hold driver securely in position
- ☐ Vehicle exit test in 20 seconds (includes canopy and seat belts)

System voltage _____V ☐ AGM ☐ Gel Cell Battery quantity_____ Battery Weight______lbs,

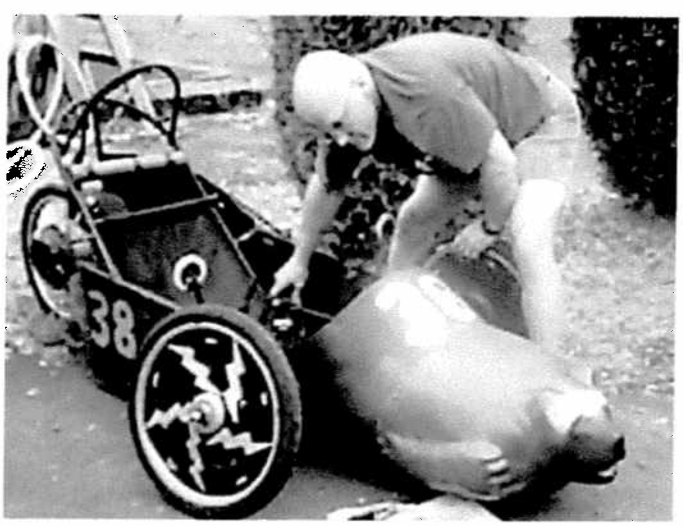
Battery Manufacturer______ Brand______ Group Size______

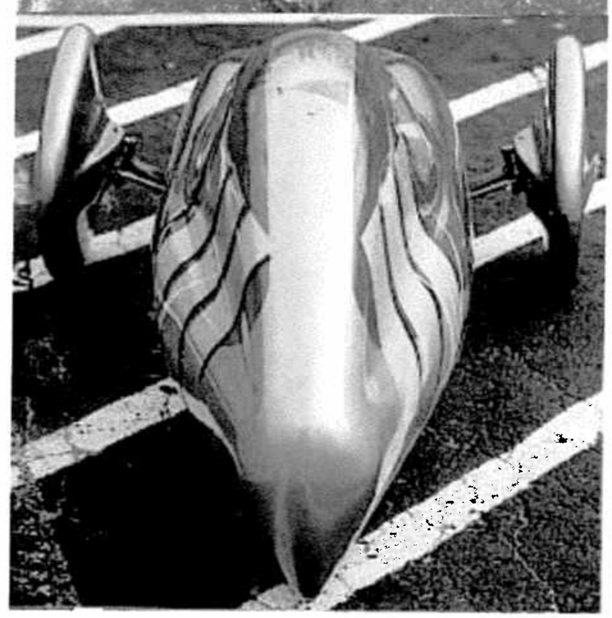
VEHICLE DESIGN GUIDELINES

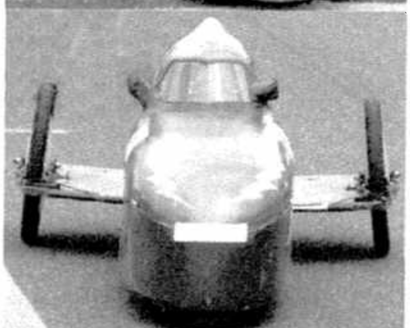
It is not the intent for this section to tell you how to design and build a car, Electrathons vary widely in style and design. One of the most exciting parts of Electrathon is that the car you design is unique to you and your team! You are the engineers, the builders, the mechanics... It is the intent to guide you in a direction. Some experienced builders could easily write this section, while others look at the whole concept and just go blank, most builders are someplace in between.

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.





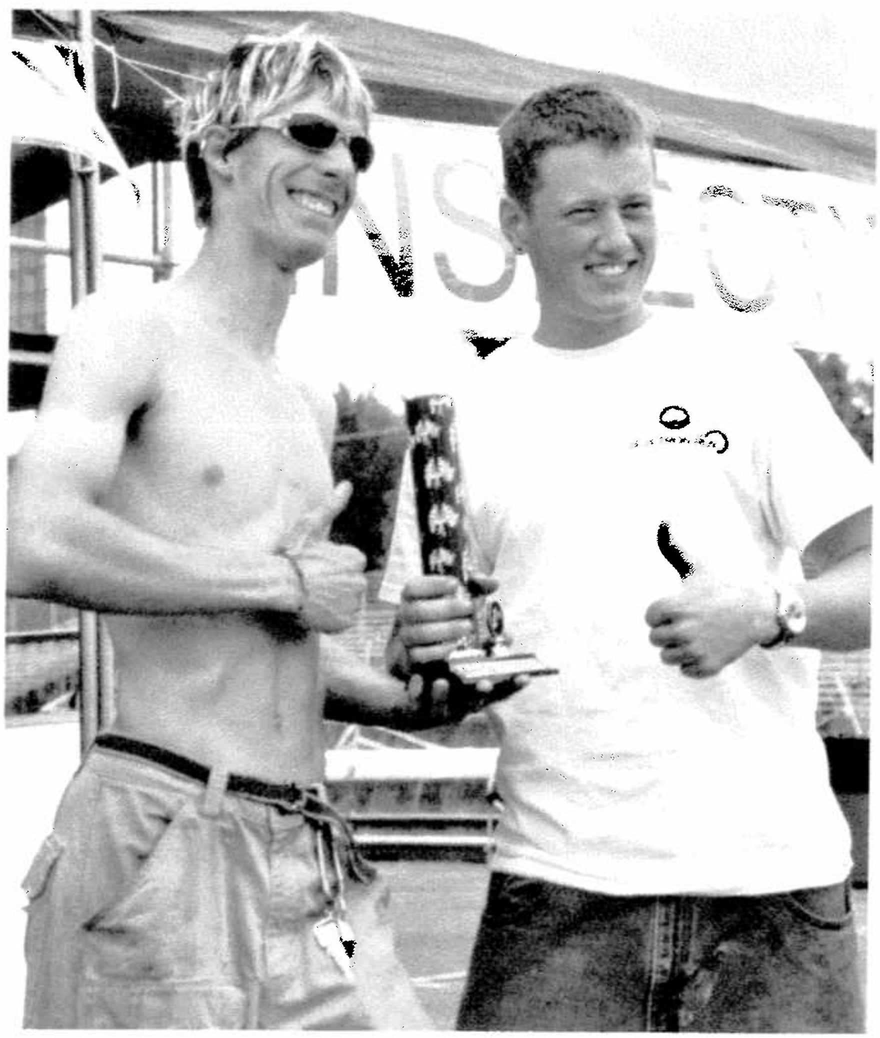


TESTING

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.

ATTITUDE

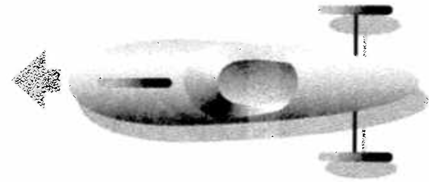
Electrathon is fun. You are not going to get rich and famous doing this, but you will have fun. And you will learn something...about how things work and about yourself. By establishing and refining simple rules, Electrathon is an elegant balance of design and strategy. No single factor is predominant, and the result is an international racing class known for its creative, competitive and efficient vehicles. Building a vehicle is an attainable challenge, and through friendly competition you gain insight and experience that will improve your chances of winning.



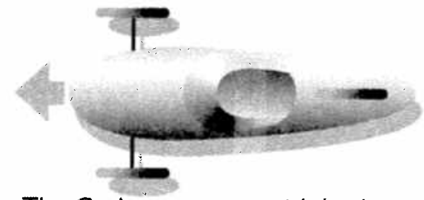
CHASSIS DESIGN

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.

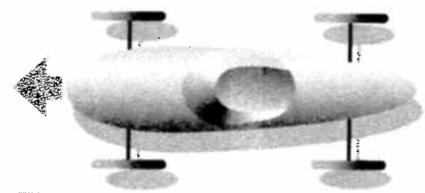
Electrathon vehicles are comprised of three types of layouts: Tricycle: A three wheeled vehicle with one wheel in front. Cycle car: A three wheeled vehicle with two wheels in front. Auto car: A four wheeled vehicle. Each design has disadvantages that you want to minimize, and advantages you want to optimize.



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.



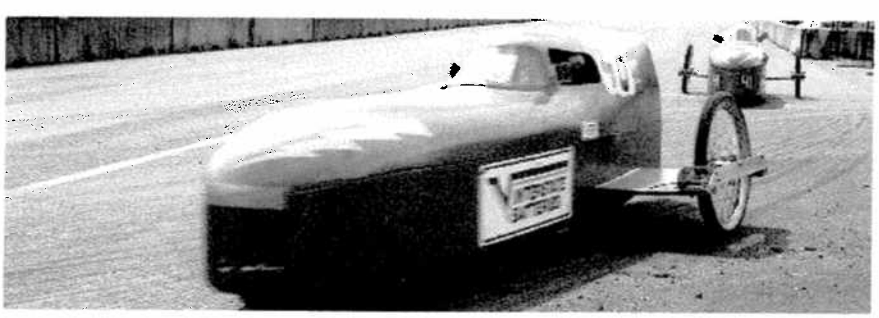
The Auto car layout shares the weight among four wheels, and is less sensitive to placement of weight within the vehicle; but it has the added weight, complexity and rolling resistance of the extra wheel.

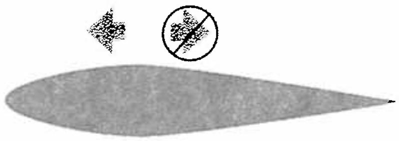
STABILITY

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.

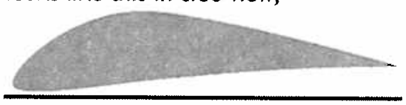
Lift an outboard wheel with driver on board. Your vehicle should not tip over at 33 degrees. (This is not necessarily the minimum angle, even steeper banked courses exist) A vehicle that doesn't tip at 33 degrees when static may do so under dynamic conditions typical during racing. Parking lots have 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.





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,

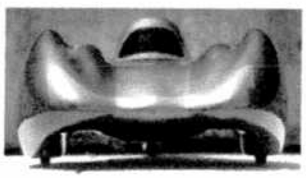


but if it is close enough to the ground, this shape works nearly as well.

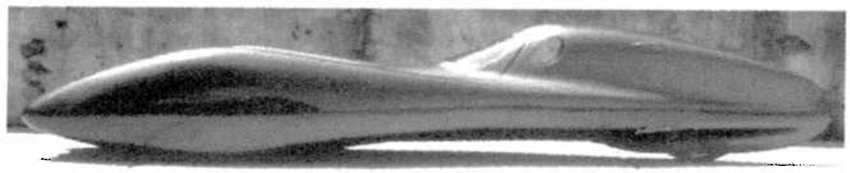
BODIES

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. 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. The body shell is one of the attractive features that make Electrathon distinctive. It can also help attract sponsors for your vehicle.

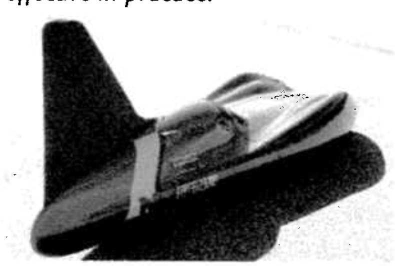


Frontal area, the size of the hole made in the wind, should be reduced as much as possible.



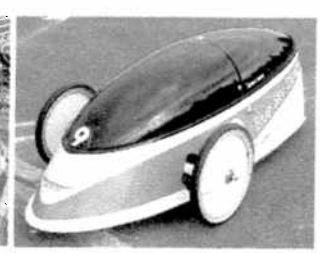
Swept Area, the total amount of body in contact with the wind, should also be minimized..

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.



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.

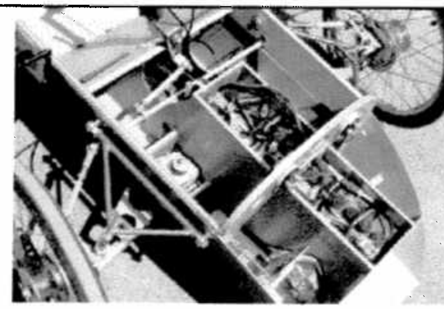
CANOPIES
A windshield is an important part of your body shell. Depending on your design, you can use clear plastic creatively bent to fit (sheets of acrylic and polycarbonate are readily avaiable in various thicknesses), motorcycle fairings, or buy canopies from a variety of suppliers. Most commercial 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.

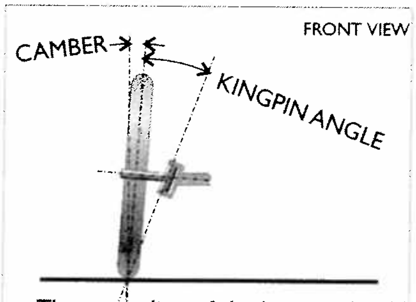


STEERING

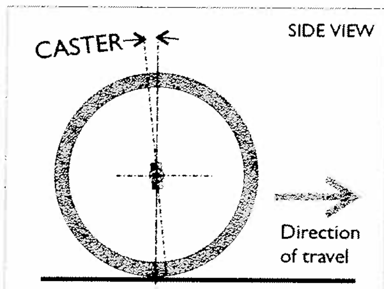
If you decide to build a Cycle car or Auto car, you need a good steering system design. Take a look at Go Karts, ATVs and other Electrathon vehicles. Some vehicles use steering wheels, others have "Joy-sticks" like fighter planes, and other use levers. Spend time on this aspect, and devise a good reliable system. Talk to automotive technicians and look at full sized cars. Good steering geometry is very important for control at speed.

If you build a Tricycle, your steering system is much simpler, however you still need to design the right amount of caster angle to be stable, maneuverable, and minimize tire wear. There are a lot of steering systems out there, going into the choices and terminology would be a book in itself. Take a look around at some of the ones used currently on Electrathon vehicles, but understand what you are doing before you build it.

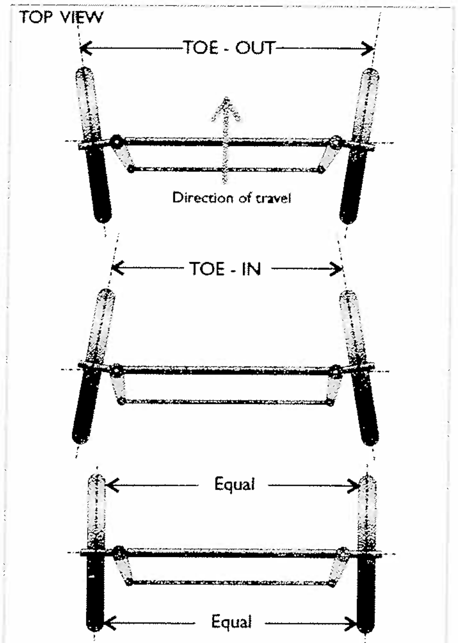




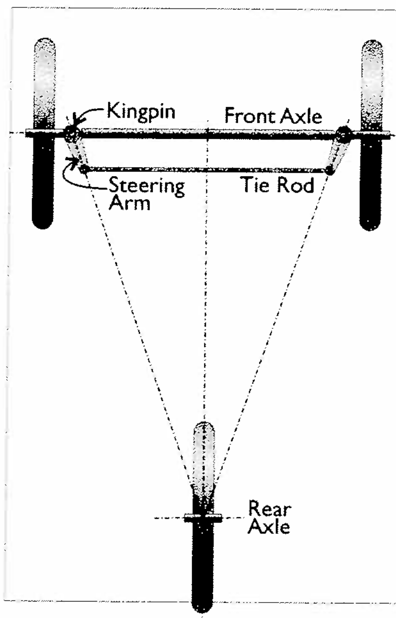
The centerline of the kingpin should intersect the point where the tire contacts the road to minimize tire scrub and insure proper steering action.



Increasing the caster, or rake angle, will increase straight line stability. Reducing it will improve maneuverability.

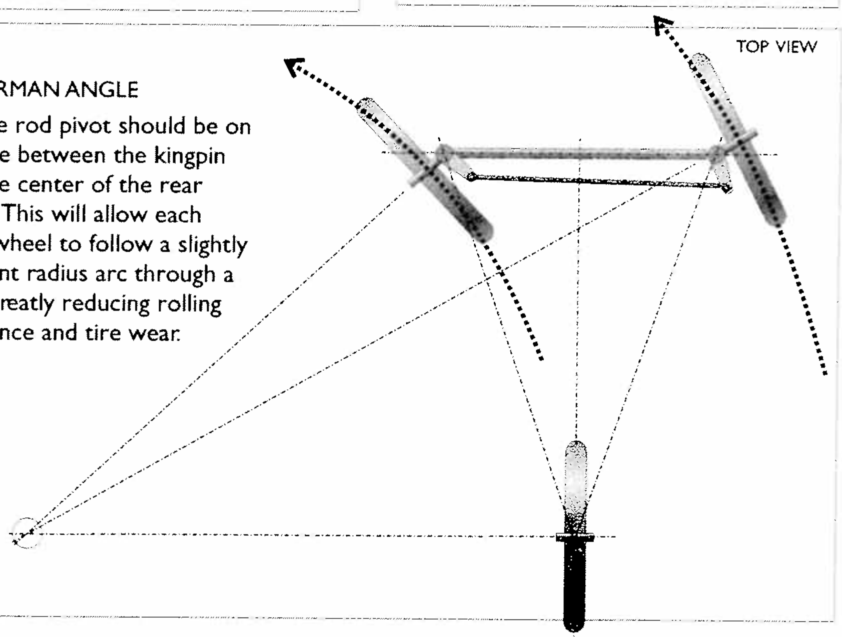


Although some cars may handle better with a little toe-in or out, keeping it as neutral as possible will minimize rolling resistance.



ACKERMAN ANGLE

The tie rod pivot should be on the line between the kingpin and the center of the rear wheel. This will allow each front wheel to follow a slightly different radius arc through a turn, greatly reducing rolling resistance and tire wear.

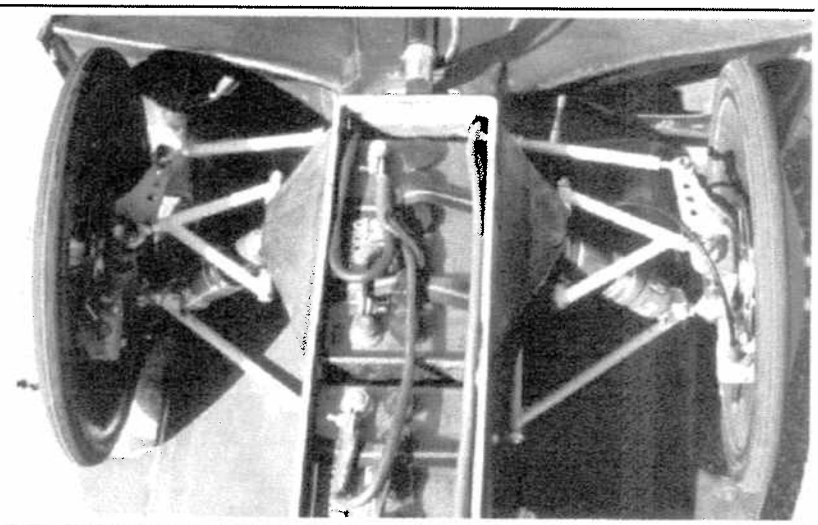


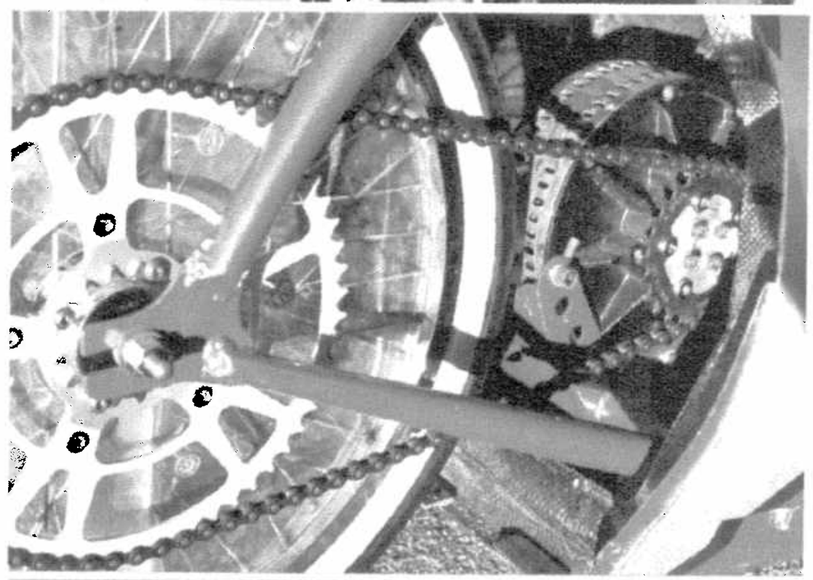
SUSPENSION

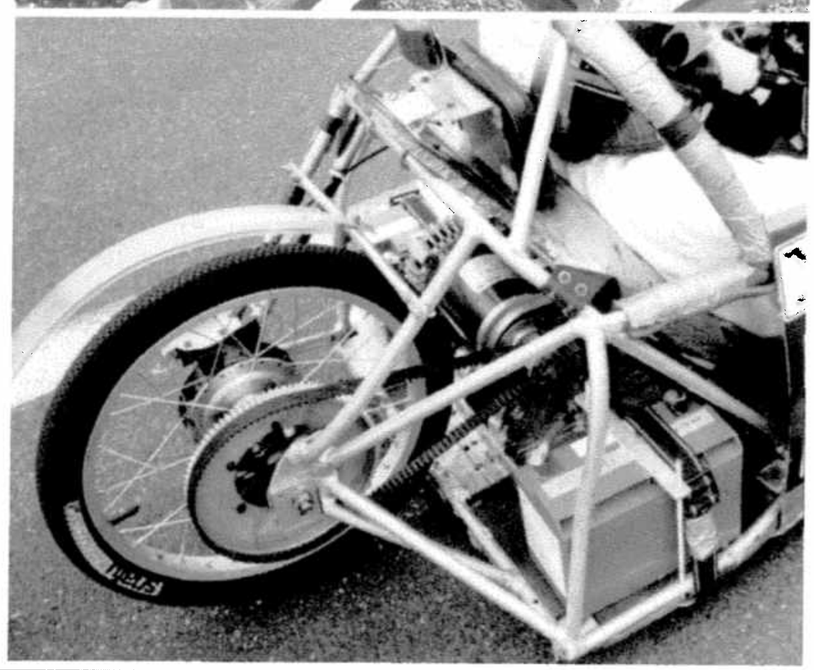
If you enjoy devising the linkages of a steering system, you will love getting into suspension. You don't need suspension in Electrathon, but it makes the ride better. Suspension is an advanced project. One of the unique characteristics of three wheeled vehicles is that the wheels will always be on the ground, no matter how uneven the ground may be. A three wheeled vehicle undergoes no twisting or torque in its chassis due to uneven terrain. A four-wheeled vehicle, on the other hand, needs a suspension in order to keep all its wheels on the ground and reduce stress on the chassis. Remember though, simplicity=reliability! You don't need much suspension travel, even a simple system can reduce vibration and jarring. Just suspending the seat will help.

DRIVE TRAIN

Most vehicles use a direct drive chain (usually bicycle) or belt drive adapted to fit a bicycle threaded rear wheel hub. Unless you are using regenerative breaking, you will want the drive to freewheel when you let off the power. Alignment and tension are critical. Too loose and it will pop off if the drive wheel flexes in turns and bumps; too tight and the friction will cost up to 5% power loss. Gear ratios are critical in tuning your performance and range, well worth the time spent experimenting. Each motor, battery voltage, wheel diameter and course type affects the gearing. A selection of sprockets or pulleys is a necessity. Some vehicles use multiple gear systems, although the added friction may cancel out that advantage.







WHEELS

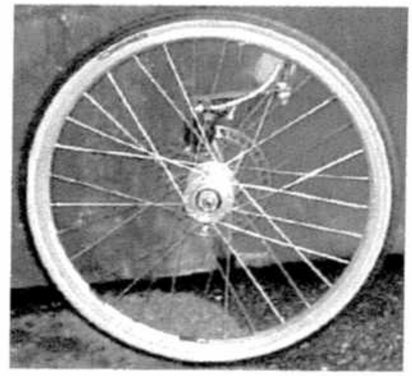
Most competitors use spoked bicycle, BMX or Moped wheels. Keep in mind that these two wheeled vehicles lean into corners so the force is always straight down the wheel. If those wheels are side loaded, they need to be much stronger.

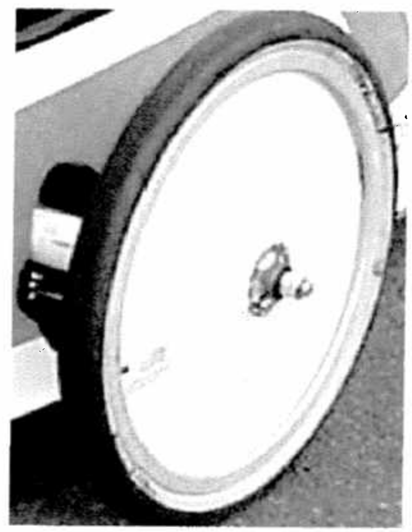
The minimum allowable tire diameter was 12 inches, and 12", 16", 17", 20", 24", 26" and 27" have all been used. The larger diameter wheels have less rolling resistance, while the smaller diameter wheels have less wind resistance, and are typically stronger under cornering loads.

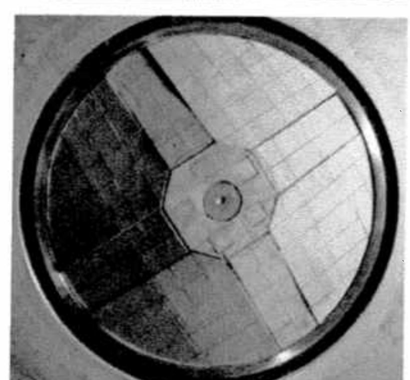
Spoked wheels should use heavy-duty spokes and lots of them. A good bicycle wheel mechanic can set you up with a very strong and light wheel. Remember to check them often for trueness and loose spokes. Wheel collapse is not uncommon, and a wobbly wheel won't go very fast. BMX type plastic wheels are maintenance free and quite strong (except at low temperatures), but heavier than spoked bicycle wheels and limited to lower tire pressure. Moped wheels are rugged and will take high tire pressure but weigh the most. While tire width and tread pattern are important, tire pressure is the biggest factor in rolling resistance. Obviously, the higher the better, but there are safety limits to consider. Choose the tires according to the track as well. Skinny tires work fine on smooth speedways but may not last the hour on a rough parking lot.

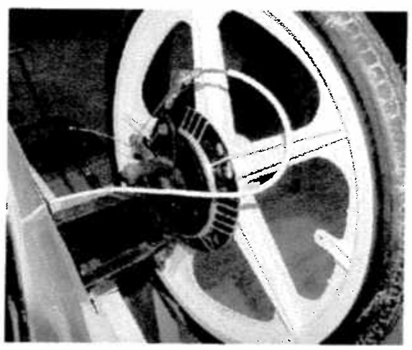
Wheel covers will reduce aerodynamic drag a great deal, as spokes tend to churn the air like egg beaters. There are commercially available models, but they are not difficult to make in fabric or plastic. It is even possible to heat shrink mylar directly to the rim.

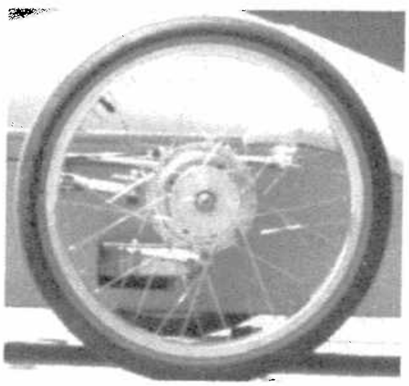
If you are really industrious and have some experience with composites, you can mold your own dish wheels on aluminum bicycle rims. End grain balsa and structural foam have been used as core material. Carbon fiber alone is too brittle and should be reinforced with kevlar. It is also a good idea to cut out a simple flower or spoke pattern so some of the fabric layers can pass from one side to the other, forming an internal web. Remember to use some sort of uncompressable filler material where the bolts go through.

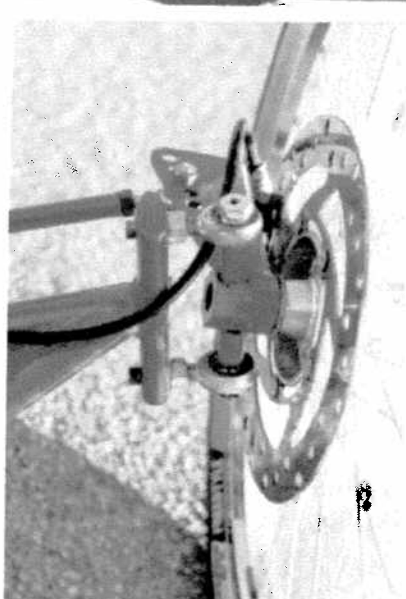












BRAKES

If you can't stop, you can't go. Nowhere are brakes more important than in competition, although most competitors use their brakes as little as possible. From a safety and liability standpoint brakes are vital. In competition, your ability to brake well will help you make that critical pass to win, or avoid a certain collision. In designing your chassis you must resolve how you are going to mount the brakes to your vehicle and what kind of brake assembly will work. Luckily you have a variety of options:

BICYCLE CALIPER RIM BRAKES:
The typical bike brake can be mounted out on arms from your axle to grip the wheel rim. Offset arm style calipers can often be modified to reverse the cable so it pulls back along the wheel to the axle and then into the vehicle. Although this is the least expensive way to go, it is also the least effective, requiring ongoing adjustment and pad replacement to keep them working properly.

BICYCLE DRUM BRAKES:
These are harder to find, but most bike shops can get them for you. They are used on tandem bikes since the pads don't wear out as fast. They must be custom mounted to your bike rims. Their large hubs and internal (automotive type) brake shoes make them a popular solution for Electrathon use. They do require adjustment though, and you must keep your spokes tight. Another variation is to use moped hub drum brakes. If you can, try a used set from an old moped. They are made from an aluminum alloy and can be adapted to fit bicycle wheels, or the entire moped wheel can be used.

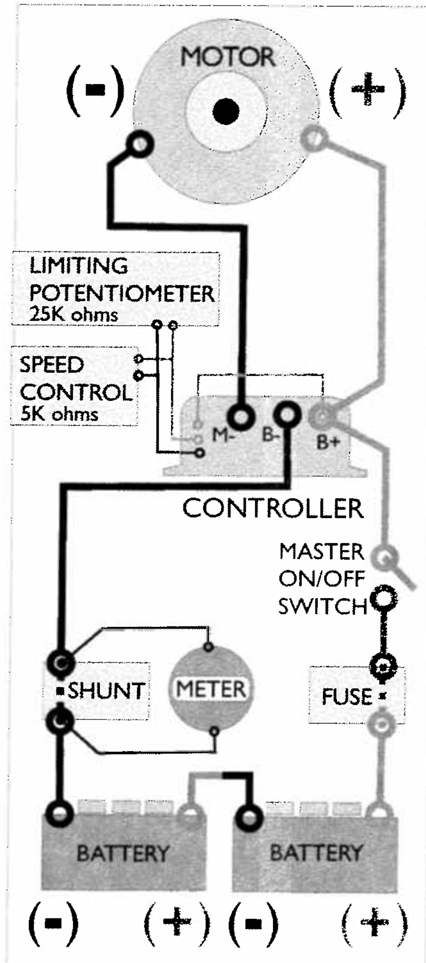
DISC BRAKES
There are many disc brakes available now for mountain bikes and tandems, both cable and hydraulically operated. They are very light and strong' but can be expensive. Go-kart discs are another option, however they are quite large, heavy and difficult to adapt. Small motorcycle disc brakes are also a possibility although large and heavy.
Whatever you use, make sure you can actuate them both evenly. If one side or the other locks up you will spin out or swerve.

AXLES

One important note: DO NOT USE BICYCLE OR MOPED AXLES UNLESS SUPPORTED AT BOTH ENDS. If your axles are cantilevered (attached on one side only like a wheelchair) you MUST replace the stock axle with a 1/2" or 12mm diameter bolt. Axle diameters less than 12mm are illegal. A bicycle or moped axle WILL break. It is easy to pull out the stock axle and replace it with a larger one. You must replace the wheel bearings with cartridge bearing assemblies. These can be found at bearing supply stores. Use an axle bolt and nut that accepts a cotter pin so your wheel doesn't come off. This is a rule requirement.

MOTORS

Most Electrathon vehicles use 12 or 24 volt motors although any voltage (36 volts and up) is allowable provided the total battery weight does not exceed 67 pounds of non-leaking batteries. Most motors are over 2 horsepower permanent magnet types. Series wound motors are lighter, but are not as efficient. Unloaded they can spin up and destroy themselves. Never let them rev free. Choose a continuous duty rated motor if you can, although small or intermittent duty motors can work but may require a cooling fan to prevent overheating. Not only does the fan use power, heat itself is energy - if your motor is hot, you are wasting it. Small motors running near their maximum current tend to get hot. Your batteries will give you about one horsepower averaged over the hour, but you can easily find yourself drawing 3 or more horsepower coming out of a tight turn. Pump, starter, forklift, surplus military aircraft motors and even generators can be found at low prices occasionally. Evaluate your motor carefully, talk to the manufacturer and other vehicle owners. Remember, your power comes from the battery, not the motor. Motors are only another place to lose energy on the way to the wheels.



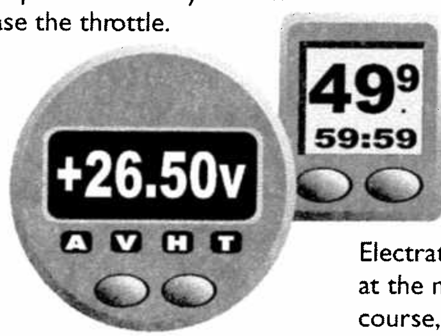
Typical Electrathon 24V Wiring Schematic

MOTOR CONTROLLER

A P.W.M. (Pulse Width Modulated) type electronic speed controller is the best way to go. Although they are expensive, on tight tracks or where you must modulate power in traffic, they are beneficial and very efficient because they very rapidly cut power off and on to the motor. The controller is 'controlled' by a speed control, or potentiometer at the foot pedal, which operates at very low voltage to tell the controller how much power to send to the motor. This is often combined with another limiting potentiometer which sets a top limit on that power. This way you can drive with your foot to the floor and adjust the limit to the desired amperage, rather than trying to hold your foot at a precise point part way down for an hour.

Resistance type Rheostats absorb power from the motor creating heat. They are cheap but not as efficient. The simplest way is an on/off button, and can be fine on a fast track. You must be able to control power manually so that the power shuts off automatically when you release the throttle.

INSTRUMENTS



The goal of Electrathon is to see how far you can go in an hour. To do that effectively, you will need to know what you vehicle is doing, so instrumentation is essential. Amperage and voltage are the most important things to know. Simple analog gauges will work, but its hard to see the needle and small numbers when you and they are bouncing around in a race. Digital units (E-Meters) are more expensive, but they are much more precise, easier to read, and will record the data over time, so at the end of a race you can tell the total number of amp or watt hours you've used. Either way, your meter needs to be connected to a shunt, which is a chunk of metal of known resistance that current flows through.

It is also helpful to know how fast you are going. Bicycle speedometers are inexpensive and offer a reasonably accurate measure of speed and distance, but remember, Electrathon distances are measured at the minimum possible for the course, not how fast or far ***you*** might have gone. Bike speedometers usually have another very helpful feature...a clock! If you do your calculations right, you can also use it as a motor tachometer, unless of course you are spinning your wheel (a definite no-no).

BATTERIES

Electrathon America has tested these batteries to establish a reference point. Your actual results may vary

Optima SC25A AGM (**SC35A** are the same with "reversed posts")
41.8 Amp/hours, 480 Watt/hours

Optima 75/35 AGM (Double Post)
38.9 Amp/hours, 447 Watt/hours

Exide Orbital 75/35 AGM
(Double Posts & built in Handles)
37.4 Amp/hours, 445 Watt/hours

Champion Vortex 75/35 AGM
(Double Posts & built in Handles)
35.8 Amp/hours, 415 Watt/hours

MK 40 amp/hr Gel Cell
21.5 Amp/hours, 233 Watt/hours

Electrathon allows only non-leaking lead-acid batteries, with no more than 67lbs. total weight. Batteries generally offer higher performance when they are warmer, so if you are racing on a cold day, it might make sense to heat them, at least to a level they were designed for, say a hot day in Arizona. Remember, batteries heat naturally when they are being charged or discharged, so keeping them in an insulated box retains more of their energy. Heating can be done with warming blankets, hair dryers, or immersion heaters. Hot tap water is often enough, as there may be diminishing return and permanent damage after 120 degrees (oven thermometers are a handy tool).

Batteries may be labeled as starter or deep cycle, although the distinction has become blurred in recent years and the cost is about the same. Generally, starter batteries have more and thinner plates inside, so they will charge or discharge more quickly, but their useful life is shorter. The heating and deep discharging of racing is hard on any battery, but if you are kind to them (don't go below 21 volts and don't leave them drained for more than a day or two, even starter batteries should last a couple racing seasons.

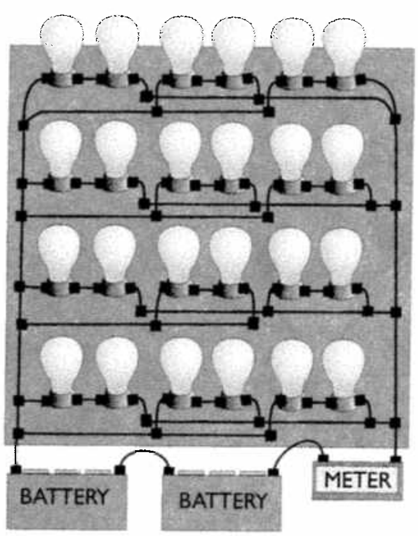
Most batteries are 12 volt, and most vehicles use two of them in series for 24 volts. It's the common compromise. Motors run more efficiently at higher voltages, but fewer batteries mean more of that 67lb. weight is lead and acid, not plastic cases and terminals. But Electrathon is all about creativity and experimentation, so anything is worth a try. Besides...technology evolves. While the basic idea hasn't changed much in a hundred years, manufacturers are trying harder than ever to improve them.

CHARGING

Battery chargers come in many sizes over a broad price range. 10 amp chargers are fine, they just take 6-8 hours to charge, where a 50amp charger can do it in 2-3 hours. 20 amps is a good compromise, and if it has a 24volt option, you can charge pairs together. Its a good idea to keep an evenly matched pair together for life, as a weaker one will get weaker as you cycle them, and a strong one will get stronger.

TESTING

The most important thing to know about your batteries is how much power they have. There is no way to know how fast you can go in an hour until you know how much power you have available. This is the Art (or Science) of Electrathon. To make an intelligent guess you need to draw them down over the course of an hour at a rate you think you can sustain. You can, of course, do that in the car on a track. Since this is not always convenient, or even possible, you can recreate those conditions in the shop. The simplest and most accurate method is to connect a test load directly to your car (and its meter). You will need something that uses power: 12 volt light bulbs (25 or 50 watt) work great, but you should wire them in pairs and test pairs of batteries together if you have a 24 volt system. Screw or unscrew bulbs until you draw the amperage you want. 36 amps is a good number. More than that and you've got a sure winner! To be more precise, you can keep screwing and unscrewing bulbs to maintain a constant draw (or just figure an average draw). Notice that the amps will drop as the voltage drops. This process also gives you a chance to plot the voltage curve. Record the voltage at even increments, say every 10 minutes. Having this data in the car can help you keep track of how much power you are using. A good set of fully charged batteries will show over 26 volts with no load. Under load that will drop to about 24 volts, and continue a slow drop to 21volts. At that point they will drop rapidly, and continuing to drain them will cause lasting damage. While it shows admirable determination to keep a car going at walking speed, it can be expensive if it ruins the batteries.



Typical 24V system test board

RESOURCES

This is just a quick survey, and is not intended to be a promotion or endorsement of products or services. For more listings, go to **www.electrathonamerica.org**. Please contact us about suggestions for future editions.

LOCAL

These are the people you need to establish a relationship with. They have the expertise and the parts you need. They may even sponsor you by donating time and materials.

Bike Shop- wheels, tires, chain, sprockets, brakes, cables, bar ends, grips, speedometers, shocks, old frames, and forks

Hardware Store- nuts, bolts, and other fasteners, tools, metals, plastics, paint, tape, and especially duct tape

Battery Distributor- He sells batteries to all the local stores. Since what you are doing is promoting the wider use of batteries, it is in his interest to at least give you a good discount. Buy batteries locally; this is one item you *do not* want to pay shipping costs on.

Marine Supply Store- composite materials, batteries, switches, fuses and miscellaneous hardware

Motorcycle/Moped/Go Kart Store- Wheels, tires, brakes, helmets, seat belts

Machine Shop- there are critical parts, like motor and sprocket adapters that you can't buy... they have to be made

Welding/Fabrication Shop- If you don't have the expertise or space to work, they do.

Body Shop- ditto

Schools- Even if yours is not a school project, tech high school and colleges often have fabulous shop space, like machine, welding and body shops. If you can involve and inspire students, you may be welcome there.

BOOKS

Bicycling Science
Frank Rowland Whitt and David Gordon Wilson (MIT Press)

The Leading Edge -
Aerodynamic Design of Ultra-Streamlined Land Vehicles
Goro Tamai (Robert Bently, Inc.)

Race Car Vehicle Dynamics
William F. Milliken and Douglas L. Milliken (SAE International)

Successful Composite Techniques
Kieth Noakes (Osprey Automotive)

Race Car **Chassis**- Design and Construction
Forbes Aird (Motorbooks International)

The New Electric Vehicles - A clean and quiet revolution
Michael Hackleman (Home Power Publications)

The Winning Solar Car: A Design Guide for Solar Race Car Teams by Douglas R. Carroll (SAE International)

Electric Dreams
(story of high school kids building and racing an electric car)
Caroline Kettlewell (Carroll & Graf Publishers)

ELECTRATHON KITS and PARTS

Blue Sky Design (541)895-5421 49 North 2nd St. Creswell, OR 97426
wwwblueskydsn.com

Cloud Electric Vehicles DC Electric Vehicles
1(800)648-7716 or (425)251-6380
19428 66th Ave. So. Suite Q-112 Kent, WA98032
www.cloudelectric.com
www.dcelectricsupply.com

Destiny (541)760-1895
585 Canberra Drive, Philomath, OR 97370
www.destinyparts.com

Electric Vehicles of America Inc
(603)569-2100 Box 2037 Wolfeboro, NH 03894
www.ev-america.com

EV Parts Inc (Wilde EVolutions Inc)
(888)387-2787 or (360)385-7966
P.O. Box 221, 107 Louisa St, Port Townsend, WA 98368 www.evparts.com

KTA Services Inc (909)949-7914
944 West 21st St. Upland, CA 91784
www.kta-ev.com

METERS

BS Designs Email:(206)909-3409
www.brucesherrydesigns.com

MOTORS

Enigma Industries www.enigmaindustries.com
P.O. Box 27522 Anaheim CA, 92809

Lynch www.lemcoltd.com

New Generation Motors (703)858-0036
44645 Guilford Drive Suite 201
Ashburn, VA 2014 www.ngmcorp.com

Pentad (805) 492-5858
P.O. Box 1722, Thousand Oaks, CA 91358
http://home.earthlink.net/~glraymond/pentadpg.html

CONTROLLERS

ALLTrax, Inc. (541)-476-3565
Grants Pass Oregon www.alltraxinc.com

Curtis Instruments (914) 666-2791
www.curtisinst.com

COMPOSITES

Composites One www.compositesone.com

FiberGlass Supply, Inc. (509) 493-3464 314 West Depot P. O. Box 345 Bingen, WA 98605
www.fiberglasssupply.com

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