$2.00


SOAPBOX
DERBY
GRAVITY HAS NO SPEED LIMIT


OPTIMIST
INTERNATIONAL


GRAVITY HAS NO SPEED LIMIT
Abbotsford Optimist Club Soap Box Derby


OPTIMISTS–
BRINGING
OUT THE BEST
IN KIDS


OPTIMIST
INTERNATIONAL
Friend of Youth

Builder's Manual

It is our intention to make our derby as safe as possible. In doing so, we are continually improving and adding to the information provided in our BUILDERS MANUAL.

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Introduction

The South Windsor Optimist Soapbox Derby is a fun filled family event designed to encourage participation through a parent-child program. For the big and little it is an occasion to spend many happy hours designing and constructing racing machines or some very special looking cars. The adult will help in the building of the car for the child, but share closely the ideas that the child has to offer. This Derby is meant to be enjoyable learning experience for both parent/guardian and child, and provide them with the opportunity to develop mutual respect and trust, and demonstrate the importance of individual prides and sportsmanship.

The Soap Box Derby is designed to permit as many races for each contestant as possible to determine a winner. The overall winner is not necessarily the fastest racer but that driver who has won all the races in which he or she has competed. The fun and experience for the children is of primary importance.

In the following pages, you will find the specifications for the racers, safety specifications, and some suggested design details. Apart from the safety and specifications, do not feel unduly restricted by the information given. Use your own imagination and design with the materials and skills that you and your child have.

It is important that you get started early on your racer. Plan to spend at least fifty hours on the task, including design, searching for parts and materials, building, and testing. The child should be working on the many small jobs involved. Arrange to have access to a work area large enough to accommodate the completed car and one that has a door large enough to get through.

We would like to take time to mention that this is a non profit event and that volunteers and helpers are needed and always welcome for the committee and other associated tasks, before and during race day!

Waiver

EVERYONE MUST HAVE HIS OR HER WAIVER SIGNED AND SUBMITTED IN ORDER TO RACE.

Registration is on a first come basis and space is limited so don’t delay. Boys and Girls ages 6 thru 16 are eligible as per entry form.

Official Building Rules and Regulations
for the South Windsor Optimist Club Soapbox Derby

1 Wheels, 6”x 1.75” thru 12” x 1.75”, approved by the committee, must be used so as to assure equal chance by all racers to compete. Wheels must not be altered or exchanged. There is to be no changing of bearings, shaving of tires, covering of wheel hubs, or any alterations whatsoever to the wheels except lubrication and painting of hubs.

2 Mandatory Car Dimensions must be followed. See the “MANDATORY CAR DIMENSIONS” section for specific details.

3 Gravity is the only form of motive power allowed.

4 Cars must run on four wheels – two front and two rear. All four wheels must touch the ground at all times when racing.

5 The floorboard of the racer must be made of minimum ¾” (19mm) plywood or of a material that provides equivalent structural support. Particleboard is NOT acceptable.

6 Feet must be foremost when driver is in racing position. -

7 A properly fitting helmet must be worn. Bicycle, motorcycle, football, or hockey helmets are acceptable. Full-face protection is preferred.

8 Drivers and pit crew must wear the official derby uniform / t-shirt provided.

9 Foot-operated brakes are recommended. Brakes must be capable of stopping the car in a short straight line, with no damage to the road surface.

10 Steering must be by wheel or t-bar fastened to a steel shaft or cable. Cable must be of the “marine/aircraft” type. Clothesline cable is NOT acceptable.-

1 Axles must be minimum ½” solid or threaded rod or equivalent.

2 The weight of the car including driver must not exceed 250 lbs (113.4kg).

3 All major components must be attached with through bolts, not screws. See the check sheet at the end of this manual for the list of major components.

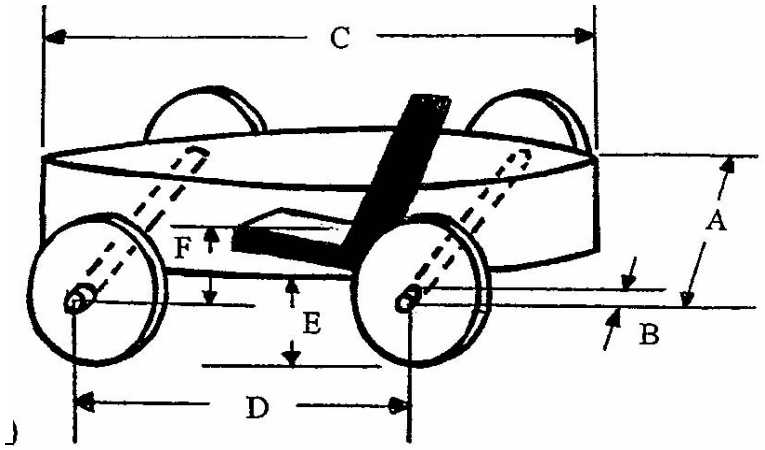
4 Turnbuckles are to be safety wired or equivalent, to prevent them from vibrating loose.

5 Each car must display its assigned number clearly on car body.

Mandatory Official Dimensions

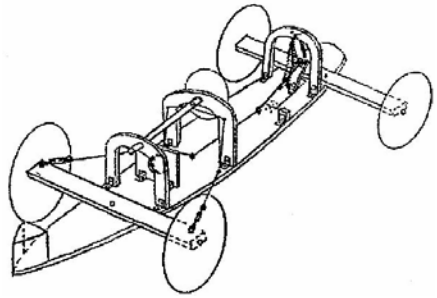
1. Axle width (front & rear) Minimum 30" (86.5 cm) Maximum 36" (91.5 cm)
2. Protrusion of axle beyond wheel hub. Maximum 1” (2.5cm)
3. Length overall Maximum 84” (213.4 cm)
4. Wheel Base front to back axle measurement minimum 40" (101.6 cm)
5. Wheel Size minimum 6” diameter Maximum 12” diameter.
6. Ground clearance Minimum 3” (7.6 cm).
7. Body Overhang (front and rear) Maximum 12” (30.5 cm.) or Provide a minimum 3:12 slope for ramp clearance
8. Seat or seat pad must be no higher than 5” (12.6 cm) above the center of the axles. Care must be taken to keep the center of gravity as low as possible.

All cars must meet the mandatory official dimensions or they will not be allowed to race.



Safety Considerations

The overriding requirement in any soapbox race is safety. Mishaps do occur, of course; but it’s your obligation to design and build a car that is safe to ride, and presents minimal danger to the driver and spectators if an accident should occur. Keep in mind that safety of others is important and the design of the front of the racer should be kept from being too dangerous in a collision. The body of the car should obviously be very sturdy. There should be some form of bulkhead at the front and back end, securely fastened to the floorboard, protecting the driver. The speeds attained by soapbox may exceed 40km/h.



How To Get Started

It is important that you get properly started. However, this is a fairly simple step, for you will not have to make all the decisions right at the beginning.

In almost all cases, you will start with a solid wooden floorboard. The best is a 3/4" (19 mm) thick piece of plywood. Decide roughly how long and wide the car is going to be. Points to consider regarding size are:

Size of driver (now and next year).
Transporting it to and from the race
Moving it in and out of the work area
Storage after the race

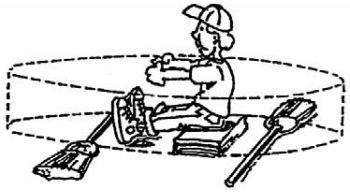
The body width should be at least 12" (30 cm), and should not exceed the axle width of 36" (86.5) specified in the manual earlier. The length is primarily dictated by the height of the driver, and whether he/she is going to be sitting up in a driving position or lying back (layback position).

If you sit the driver on the floor, and use a couple of broomsticks to indicate the positions of the axles, it is possible to get the principal dimensions established. Also mark the locations of the brake pedal and steering wheel. On the stock you are going to use for the floorboard, carefully draw a clear centerline. You will need this centerline many times during the construction. Mark the position of axles, brake, brake pedal, seat, tip of the nose, and rear end. With consideration being given to the type of body you are going to build, the design of the car, and safety, you can outline, perfectly symmetrically around the centerline, the shape of the floorboard, and cut it.

Allow room (at least 6" or 15 cm) in front of the feet for a brake pedal. Also have in mind the way you wish to finish the front end of the racer. Solid "bulkheads" are mandatory at the very front to protect the driver in case on a head-on collision with a solid object, and to support the car against the starting pad on the starting ramp. This "bulkhead" must, of course, be solidly attached to the floorboard, which is the main structural element in the racer. Thus, an additional few inches in front of the feet may be required.

At this point, it is also a good idea to determine the shape of the racer as seen from above. Is it going to be an elongated oval, a teardrop shape, or a rectangular box, which gets its aerodynamics from sort of wedge shape in the vertical plane? Again, you don't have to make the final decision about the detailed shape, just a general one.

Have the driver sit on the floorboard roughly in the driving position. Prop the child's back up. Remember that the feet stick up quite a distance from the floor, and that the eyes of the driver should be a few inches above the toes so the child can see the road (it is not necessary that they be able to see the first 10 or 20 feet of roadway in front of the car, but the child should be able to see the road clearly beyond that.)



Next is to determine the position of the axles for the wheels. Keeping in mind the official specifications for wheelbase (min. 40"), you should try to distribute the weight of the driver evenly over the four wheels. Now turn to the decision of which type of brake to use. Some brake designs include a vertical plunger, horizontal hockey stick, or drop arm brake.

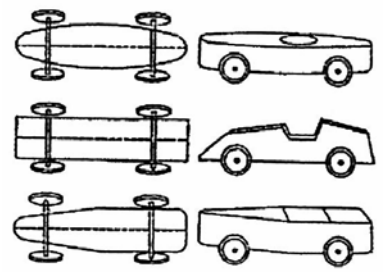
Finally you're ready to build the body itself. It can be done with plywood, sheet metal, fiberglass, papier-mâché, cardboard, or any other material. This is where you let your imagination roam, and you can come up with new aerodynamic designs!

Details of the Different Components

This section talks about some of the specific components in the design.
They can, of course, be combined in many different ways.

➢ Layout of the Floorboard

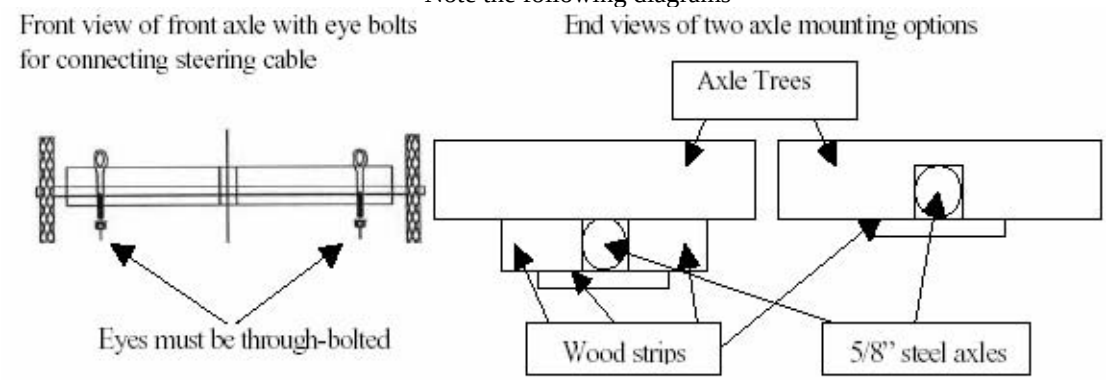
The basic body shapes shown here may help you to get your design under way:



Axles

The wheels must attach to a 5/8” diameter axle rod or equivalent. This can be a threaded “ready rod”, which is simple because lock nuts can be used to position the wheel as opposed to cotter pins. A lock nut does not require a hole drilled in the rod for the cotter pin; but the nut should be held in place by “Lock-Tite” or similar method. Since the rod isn’t strong enough by itself, a 2x4 piece of wood or equivalent to support the axle is mandatory.

Note the following diagrams



- The axle rod is supported by a 2"x 4" piece of wood or equivalent.
- 1”x 2” wood strips hold the rod in place on the main 2" x 4" support.
- A routed channel can eliminate two strips.
- The axle pivot is a loose fitting bolt bolting the axle to the bottom of the frame (lock tite is required to avoid the bolt from loosening off). The pivot should be in front of the axle for stability.
- Sturdy through bolt eyes can be used to attach the steering cable to the axle support.
- The rear axle can be bolted directly to the bottom of the frame.
- Mount the axles no more than 12" from the front and rear of the car.

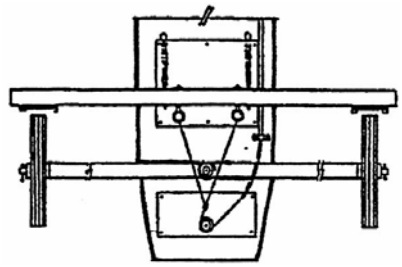
➢ Suspension

Although a suspension system is not really necessary, some increased performance may be achieved by building one.

- Brakes

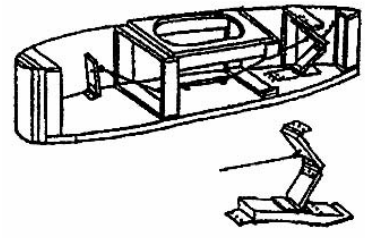
There are several kinds of safe and reliable brakes.

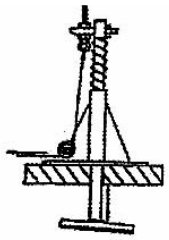
The hockey stick brake is a piece of strong stiff hardwood parallel to the rear axle that is pulled up against both rear wheels by a cable. A spring pulls the bar off the wheels when the cable is released.



The drop arm brake is a popular design among true racers because it can be designed to remain flush with the body until the finishing line, and thus minimize wind drag (see examples). You can construct it relatively easily.

The plunger brake is a brake that may be mounted in the back or the middle of the car. It moves vertically down on the road surface when braking. Both "plunger" and "drop arm. Brakes" are very much dependent on their position on the car with respect to the center of gravity. The further forward they are the more road friction there is available. The hockey stick types apply road friction well behind the center of gravity, which limits available stopping power.





Brakes (cont'd)

For any type of brake make sure the brake lining (a piece of old tire, for instance) is very well attached to the brake shoe.

The braking must be symmetrical with respect to the car. More specifically, if you have a hockey stick brake make sure they pull evenly. If you have a rear-mounted drop brake, the car itself must be perfectly balanced side to side and the brake perfectly on the midline of the car. If this is not the case, the rear end will tend to swerve to one side or the other. The harder one brakes, the more this tendency manifests itself.

Somewhat surprisingly, the best place for a plunger brake is slightly in front of the center of gravity of the car. The vertical force from the brake tends to take force evenly from all four wheels, and stability is less of a problem

Foot-operated brakes only. Hand brakes will not be allowed to race.

General Brake Requirements

Over the years we have seen numerous types of brake systems, materials and fastening methods. Some have worked extremely well, some have failed miserably and some have worked for a few races and then suddenly failed. It is important that this information be passed on to the builders.

The brake pad is typically the material that rubs against the road surface or the car's tires to make it stop. The resulting friction causes heat. The more friction, the better the stopping power and the more heat that is produced. It therefore stands to reason that the better the stopping power, the more heat your system will produce. The point of all this is that no matter how good your brake system is, it is imperative that you have brake pads that can handle the heat and stress.

Unfortunately, brakes most often fail when they are being used, which is when you need them most. We have seen many types of materials used for brake pads, and lots of them have failed. Here are some pros and cons of some of them.

Automobile Tire Tread (Recommended):
This is by far the best and only material recommended for ground contact brake pads.

The tread needs to be deep so that bolt heads can be tightened down deep between the tread. Most tire shops will let you pick though their discarded tires for free. Very often you will find rejects or damaged tires that have almost new tread on them. Nylon or Kevlar belted tires are harder to find than steel belted ones but are easier to cut and do not leave prickly edges when cut. A hack saw or scroll (jig) saw with a metal cutting blade works on the tread. Mount the tire solidly and keep the saw kerf open. Tin snips or a sharp knife will work on the sidewalls. Again, keep the kerf open. Advantages:

Very wear resistant.
The belting holds the washers and bolt heads from pulling through.
Easy to find

- Inexpensive Disadvantages:
- Some what difficult to cut

Hockey Puck (NOT recommended):

Hockey pucks are made of materials suited for cold temperatures. They are similar to snow tires in that they work well initially but also wear down much faster, especially when heated. Heads of bolts used to attach the puck, must be countersunk substantially so that, as the puck wears down, the bolt heads are not exposed. In one brake application, the puck can go from working fine to not working at all. Countersinking so far into the puck also weakens it. This means that flat washers are needed to prevent the bolts from pulling thought the puck. This also in turn reduces the amount of surface area available for friction. In short, you have a fast wearing, weak mounted, quick to fail brake pad.

Advantages:

Does not require cutting to shape
Easy to find

• Inexpensive Disadvantages:

Wears out very quickly.
Bolt heads can pull through material.
Bolts must be countersunk into puck.

Bicycle and ATV (All Terrain Vehicle) tires (NOT recommended): Bicycle tires typically have a very shallow tread and ATV tires typically have a somewhat deeper tread that is spaced quite a ways apart. Since the treads are not deep enough to countersink a bolt head into properly, the pad is often wrapped up around and attached on top of the backing plate. Now comes the downfall. The tread usually does its job well at first but because of the small amount of tread, it wears down extremely quickly. Check out your kid's rear bike tire after a good skid. The belting that becomes exposed only provides the tires strength and is absolutely useless for providing traction. It is actually a very slippery material when dragged on pavement. On ATV tires, there is only a thin film of rubber over the belts. Advantages: Easy to find Disadvantages: Wears out very quickly. Compound is NOT made for contact with pavement. Must be attached above backing plate. Somewhat difficult to cut .

Other Materials (NOT recommended): Various other materials have been tried with limited success. We do NOT recommend any of these: Truck bed liner – Most have no inner reinforcement fabric. Conveyor belting – Too slippery and rubber layer is too thin. Tire Retread material – The retread material alone has no belting beneath the tread so bolt pull through is a problem.

Brake pads must be attached to a backing material with through bolts and flat washers. The bolt heads must be sunk well below the contact surface so there is no chance of them ever coming in contact with the road.

Design your brake for the worst-case scenario keeping in mind that the road may be wet or slippery making braking much more difficult.

The braking must be symmetrical with respect to the car. The car must be balanced from side to side and in the case of a hockey stick brake make sure pressure is applied evenly to both wheels. Brake pads that drag on the ground must be able to extend 1" below the road surface to compensate for any road surface irregularities such as ruts etc.

Remember: Foot-operated brakes only.

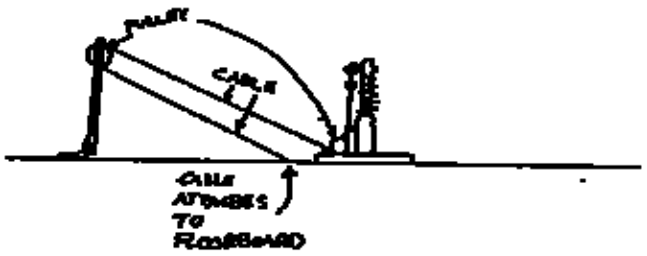


FIG. 1

FIG. 2

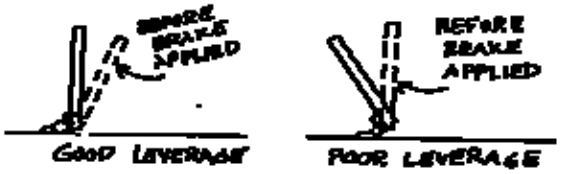


FIG. 3

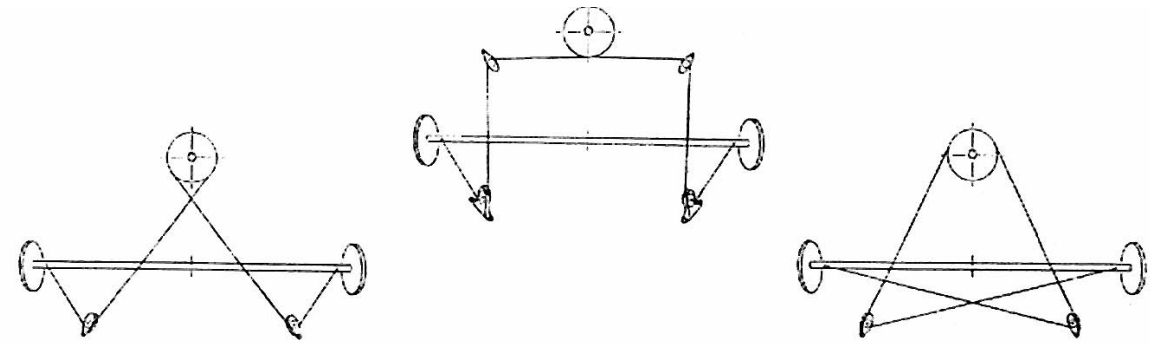
FIG. 4

FIG. 5

- Steering

The steering mechanism is one of the most interesting aspects of the car to design and build.

The simplest steering system consists of a cable that is wrapped around a steering column. The cable passes through pulleys and is attached near the ends of the front axle. The steering column may be vertical, horizontal, or for that matter at any angle. The cable is securely attached to the steering column or drum to prevent slippage and is tightened with turnbuckles. Make sure the cable is wrapped around the steering column in the proper direction to prevent backward steering. (See diagrams for some examples)



The steering wheel should be large enough to allow a secure grip, and have no sharp points or edges in any position. The sensitivity of the steering should be neither "too quick" nor "too slow". There should be minimal "play". The turning radius of the car can be relatively large since the racecourse will have very smooth curves if any. Should the car get off course, however, it is important that corrections can be made. A turning radius of 30ft (10m) is adequate. Stop blocks are mandatory and must be secured extremely well. They must prevent the axle from turning the steering wheel excessively if one wheel hits an object.

The cable used for the steering mechanism must not stretch. Clothesline is NOT acceptable. Use only marine/aircraft cable. TWO good quality crimps or clamps must be used at EACH END of all cables. Yes, there are good and bad ways to install cable ‘crimps’ and there is also a right and wrong way to install ‘saddle’ type cable clamps. These methods are often NOT indicated in the product’s instructions so we have included some.

Cable Crimps/Clamps:

A proper crimping tool is obviously the best method for attaching cable crimps. It is also the only method recommended by the derby. Many alternate methods have been tried in the past, with varying success. Here are a few that we have rated in comparison to crimping with a proper crimping tool.

Pound the crimp with a hammer on a solid object such as a block of steel or another hammer.

Squeeze the crimp in a LARGE vice. Most small bench vices cannot produce the pressure that can be obtained by a number of light impacts from a hammer. Chances are you will break the vice first.)

Pinch the crimp with ‘Side Cutters’. Depth of the pinch is difficult to determine and you will likely cut into it and damaging the crimp or even the cable inside.

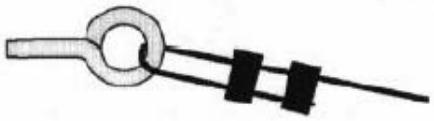
Squeezing with vice grips or pliers. You may think you are getting lots of pressure on the crimp with these but it is not enough for a proper connection.

‘Saddle’ type clamps are the ones with a ‘U’ shaped bolt that fits into two holes in a base piece called a ‘saddle’. The ‘U’ bolt is tightened with two nuts clamping the cable between the ‘U’ bolt and the ‘saddle’. These clamps are convenient in that they can be reused without cutting the cable, however the drawbacks are that the correct size (3/32”) is hard to find, the 1/8” ones are only 45% as strong as crimps and the nuts tend to loosen off as the cable settles over time.

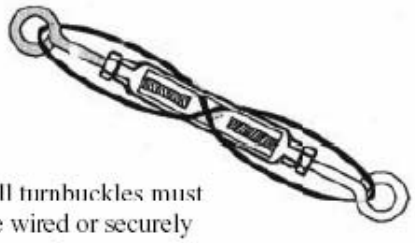
The tricky part with the ‘saddle’ clamp is, knowing the correct way to put it on. The reminder is, ”NEVER SADDLE A DEAD HORSE”. The ‘DEAD’ end of the cable is the end that is exposed (and pokes you) if you don’t tape over it when you’re done. The ‘SADDLE’ is the part of the clamp with the holes in it. When you put the first clamp on (about an inch from the ‘DEAD’ end), make sure that the ‘DEAD’ end of the cable is in the ‘U’ bolt side of the clamp and not the ‘SADDLE’. Tighten the nuts evenly. The second clamp must go between the first clamp and the object you are attaching the cable to. The space between the two clamps should be 6 times the diameter of the cable. Remember, the nuts on the clamp must be locked and checked regularly.

When turnbuckles are used for tightening the cables, they must be wired or otherwise restrict from loosening themselves off.

For the mechanically inclined, direct linkage steering is another option that can be used



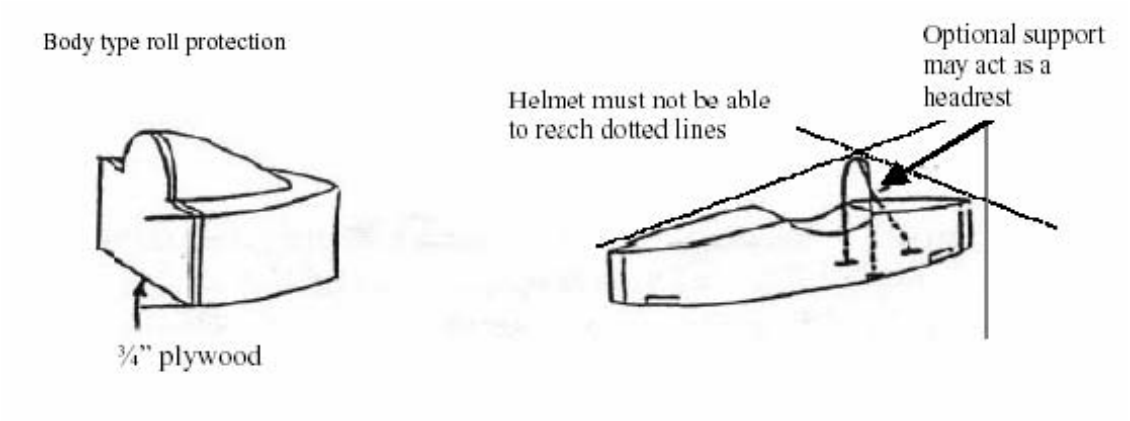
Two cable crimps or clamps must be used on each cable end. Cover the free ends of the cable with a crimp or tape to prevent pokes from the sharp wires.



All turnbuckles must be wired or securely fastened to prevent them from loosening off.

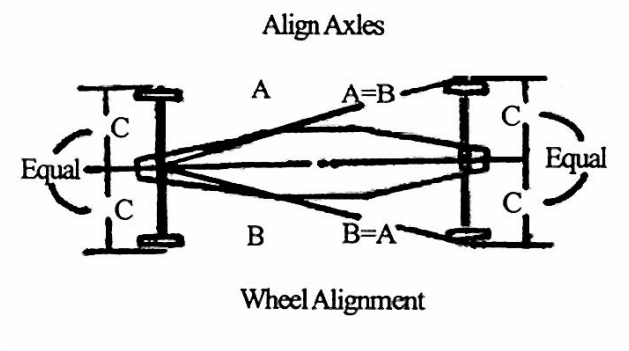
- Roll Bar

The Safety requirement here doesn't necessarily call for a metal tube shaped in an arch, but essentially a super-structure extending some inches above and to the sides of the driver's head and back. It should be made from solid materials and fastened securely to the floorboard and/or frame so that it won't come loose if the car should roll over. It should be easy to integrate into your design. It is very important to provide protection against potential whiplash. Provide an adequate head rest for the driver.



- Alignment of Rear Axle

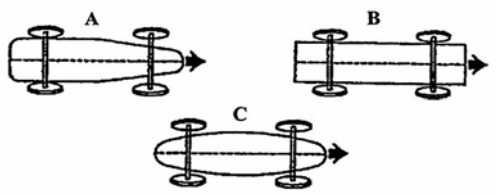
First, check that the center of the rear axle is located exactly over the centerline on the floorboard. Next, measure the distance from the front axle center point to each tip of the rear axle. The distances must be exactly the same. Secure the rear axle to the floor. This



- Balancing

An important factor in soapbox racer design is the weight distribution. A well-balanced car will roll cleaner downhill and will be more stable in handling and braking. The more weight over a wheel, the more resistance it presents. For reason alone, you will want to have even weight distribution over all four wheels. An unbalanced car tends to wander. In a car in which the weight is located towards the rear, the light front end will react to the steering too quickly. This leads to erratic motion. Also, a light front end tends to bounce more when hitting bumps. If the front end is too heavy, the steering will be "heavy" and the driver may over-steer.

- Body



Aerodynamics is the study of the interaction between air and solid moving bodies. In racecar design there are many factors to be considered. We will only discuss drag here, which is the most important to us. Drag is the force from the air on a moving object. The most obvious factor is frontal area. This is the maximum cross-section of the racer as seen from the front. All things equal, the car with the smallest frontal area is faster.

Shape is important to "air management". The three cars shown have the same frontal area. Car A will be faster than Car B because the air pressure in front of it will be lower, but Car C is faster than Cars A and B because the air flows around it in a "cleaner" way. The airflow behind Car A is turbulent and creates a negative pressure that tends to pull the car back.

Imagination is the only limit when it comes to body shape. Design and color will give the Optimist Soapbox Derby a memorable and unique flavor. Racers don't have to be super streamlined to be fast. Wheels, suspension and alignment are at least as important.

- Testing the Racer

An important and often ignored part of the building of a soapbox racer is carefully executed testing before the race. You can start testing well before the racer is completed by running the car on flat or slightly inclined surfaces. When the racer is completed, test it at higher speeds. Make brake tests where there is no danger if they fail or if the car starts to skid. Let the driver get used to the car and learn to control it so that it runs in a straight line or on a smooth curve.
The ideal place for a test run is a quiet paved footpath at least 6' wide, with no solid objects nearby and a very long horizontal continuation at the foot of the hill. There should be at least two adults present; one at the top and at the bottom of the test course within shouting distance. All parts of the course should be visible to a least one of the observers. It is essential to keep people and animals out of the way for the few seconds that the test takes place.

Carefully reread all sections and use the checklist at the end of this manual. Make copies of the checklist and have it with you when you plan to do the test.

DERBY DAY

The big day has arrived. Your racer is ready and tested, and the paint job is almost dry. Some form of platform for the racer is very useful; plastic boxes or a collapsible workmate to get the car off the ground. Tools, spare parts, oil lubricant, soft cloth, helmet; nuts and bolts, extra cotter pins, etc. should be packed the night before. A chair, water, snacks and sunscreen are always a good idea.

It is essential that you test the car carefully before the race. Start on a flat driveway or quiet street by giving the car a healthy push, testing all systems. Ask your driver to push hard on the brake and execute steering maneuvers. Next try a small hill, and work up to higher speeds. If there are problems, they will appear, and you will have a chance to correct them.

SAFETY AND SPECIFICATION CHECKLIST

The following conditions are to be adhered to. The Safety Inspection Committee is the only body permitted to concession non-compliances. Their decision is final.

The term "Major Component" refers to the following
Steering system (Steering wheel, cable, pulleys, connectors etc.)
Braking system (Foot pedal, cable, pulleys, connectors, pads etc.)
Suspension system (wheels, axles, axle supports etc. including moving and nonmoving systems such as the rear axle bolted directly to the floor etc.)

STRUCTURAL SAFETY

- All steering and brake system turnbuckles must be wired or otherwise prevented from turning due to vibration.
- All "Major Components" must be mounted securely with through bolts
- backed with suitable flat washers.
- All steering and brake system cables must remain snug throughout movement extremes.
- All steering and brake system cables must be terminated with double crimps or double clamps.
- No open pulleys are to be used (where cable may come off pulley wheel).
- Brake pad must be able to extend below road surface to compensate for road surface irregularities.
- Wheels must be secured via Locking Nuts, double nuts, cotter pins, or other suitable method.
- Wheels must not bind or rub anywhere throughout movement extremes.
- Axles must be securely fastened.
- No -sharp objects are to be in the vicinity of the driver when seated.
- All parts of the "Major Components" must be accessible for visual inspection.
- Car must be reasonably solid in construction and free of loose parts.
- Braking system design must be mechanically sound.
- Steering system design must be mechanically sound.
- Steering wheel design does not present a potential hazard.
- Steering stops must be adequately positioned

DRIVER PROFICIENCY

- Brakes must operate satisfactorily by driver
- Steering must operate satisfactorily by driver
- Driver must understand the structure of the race regarding:
- When to brake
- Staying in own lane
- Driver must have proper helmet with recommended mouth guard or face mask

Only after the racer passes all of the above requirements will be allowed on the race hill. Should your car not pass you must make the necessary adjustments and have it re inspected
Reasonable effort will be made to have your car qualify; but as you know safety is the utmost priority!

The Optimist Creed

Promise Yourself-
To be so strong that nothing can disturb your peace of mind.
To talk health, happiness and prosperity to every person you meet.
To make all your friends feel that there is something in them.
To look at the sunny side of everything and make your optimism come true.
To think only of the best, to work only for the best, and to expect only the best.
To be just as enthusiastic about the success of others as you are about your own.
To forget the mistakes of the past and press on to the greater achievements of the future.
To wear a cheerful countenance at all times and give every living creature you meet a smile.
To give so much time to the improvement of yourself that you have no time to criticize others.
To be too large for worry, too noble for anger, too strong for fear, and too happy to permit the presence of trouble.

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