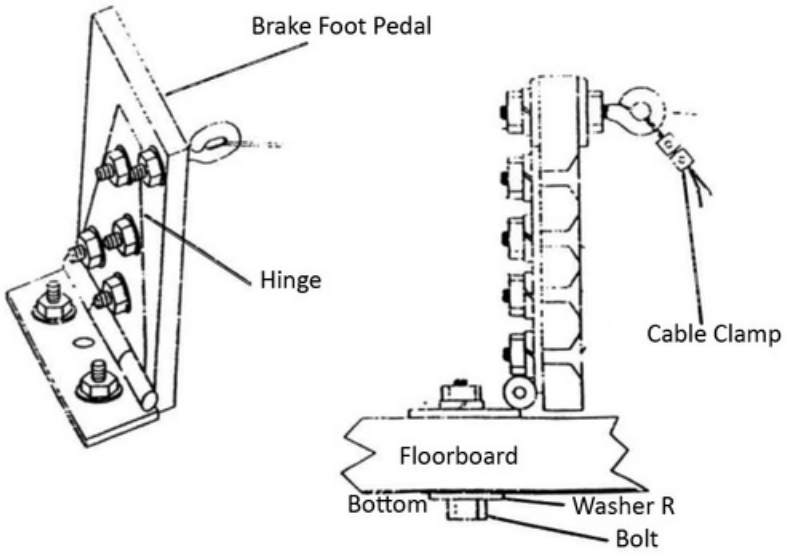
Mission Soapbox Derby

Amendments

- • Cars must be updated to the latest rules. If not specifically stated in the plans or Rulebook, YOU
- CANNOT DO IT!
- Wheels: dimensions 10" x 1.5" with solid rubber tred. Any type of wheel bearing may be used .
  Brake pedals to be bolted through the floor (see diagram).
- The driver is responsible for and may be disciplined for personal conduct as well as the personal
- conduct of people in the driver's party including but not limited to pit crew and family members.
- Race officials have the right to eject any persons from the pits or racecourse.
  Disqualification Committee:
  An authorized committee of not fewer than two people may disqualify, exclude or eject a driver, or any member of his/her party for any of the following violations:

1. Vulgarity, verbal or physical abuse and/or unsportsmanlike actions directed towards officials, spectators or other participants.
2. Pit crew or members of driver's party failure or refusal to comply with regulations.
3. Unwillingness to abide by an official's decision.
4. Car or driver, in official's opinion, that endangers the driver, other drivers or spectators. Including if the driving of the racer interferes with other drivers.
5. Any attempt to gain unfair advantage or concealment of any illegal material or parts in the racer.
6. Violation of any other rule or guideline contained within the rulebook or plans.



Introduction

The Mission 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 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 an enjoyable learning experience for all, the parent/guardian - child team, and the sponsors. It provides them with the opportunity to develop mutual respect, trust, and understanding; and will demonstrate the importance of individual prides and sportsmanship.

The Mission Soapbox is for **"home built"** cars only and 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 50 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, with a door wide enough to get it through.

Waiver

Everyone must have their waiver signed and submitted in order to race!

Registration

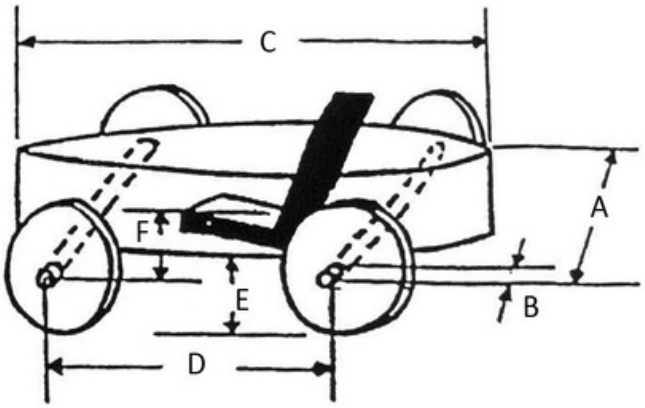
Registration is on a first come basis. Space is limited, so don't delay. Boys and girls age eight on May 30th in the year of the Race Day to age fourteen on Race Day are eligible. Depending on age, each child will be placed in their respective age group. There are three categories to compete in: 8 to 9; 10 to 11; and 12 to 14 years of age.

Official Rules and Regulations for the Mission Soapbox Derby

1. Wheels provided with the material must be used to assure equal chance by all racers competing. Wheels must not be altered or exchanged. No changing of bearings, shaving of tires, covering of wheel hubs, or any alterations whatsoever is permitted; except lubrication and painting of the metal hubs only.
2. Gravity is the only form of motive power allowed.
3. Cars must run on four wheels; two fronts and two rears. All wheels must have contact with and touch the ground at all times when racing.
4. The floorboard of the racer must be made of 3/4" (19 mm) plywood. Particle Board is not acceptable
5. Feet must be in forward position when driver is in racing position.
6. Seat belts are required. They must be safely attached to the floorboard or frame member. Two belts from shoulder to crotch attachment or a combination shoulder and lap attachment are acceptable.
7. A properly fitting helmet must be worn. Bicycle, motorcycle, football or hockey helmets are acceptable. Full face protection is preferred.
8. Drivers must wear shoes and goggles during competition and may also be required to wear elbow and/or knee pads.
9. Foot operated brakes only. No hand brakes. 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; circular or similar design, but not a T-bar and must be fastened to a steel shaft. If cable is used, it must be of the marine/aircraft type. **Clothesline is not acceptable.**
11. Wrist straps are required to prevent hands from extending out, in case of a roll-over.
12. A headrest capable of restraining any sudden backward movement of the head is mandatory.
13. A roll bar is mandatory. It must be firmly attached to the floorboard. It must be high enough to protect the drivers head while seated in the car in the unlikely event of a roll-over.
14. Axles must be 5/8" or 1/2" soli d or threaded ro d or equivalent (cars b uilt prior to 1999 may use existing 1/2" axles and bearings if desired).
15. The weight of the car including driver must not exceed 250 *lbs* (113.4 *kg*).
16. There will be no "Kit Cars" (Derby racers purchased in kit form from Akron Ohio, etc.) permitted to race. This Derby is for home-built racers only.

17. All *major components* must be attached with through bolts, not screws; See the SAFETY AND SPECIFICATION CHECKLIST referred to later in this manual for the list of *major components.*
18. Turn buckles are to be safety wired or equivalent, to prevent them from vibrating loose.
19. Each car must display its assigned number and driver's name clearly on the side of the car body.
20. No car shall display advertising or sponsorship not authorized by the association.

Mandatory Official Dimensions



Axle length (front & rear)
A. Minimum 34” (86.5 cm)
Maximum 36” (91.5 cm)
B. Protrusion of axles beyond wheel hub:
Maximum 1” (2.5 cm)
C. Length overall – maximum 84” (213.4 cm)
D. Front to back axle measurement (wheelbase) minimum 40" (101.6 cm)
E. Ground clearance - minimum 3" (7.6 cm).
F. 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 soap box race is safety. Mishaps do occur, of course; but it's your obligation to design and build a car which is safe to ride, and presents minimal danger to the driver and spectator; 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 soap box racers may exceed 30 mph (50 km/h). It is therefore mandatory that goggles be worn during the race. Watch out for condensation inside the goggles.

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 ¾" (19mm) 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

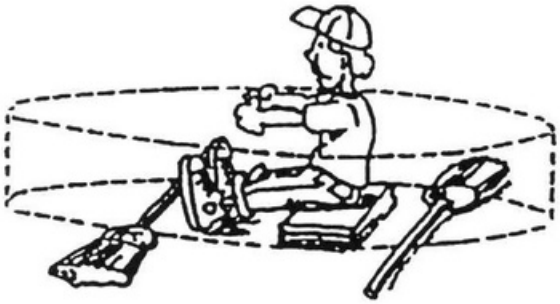
The body width should be at least 12" (30 cm), and should not exceed the axle width of 36" (91.5 cm) specified in the manual earlier. The length is primarily dictated by the height of the driver, and whether he/she is going to be sitting up in a driving position of lying back (layback position).

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 15cm) in front of the feet for a foot 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 of a head-on collision with a solid object. 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.

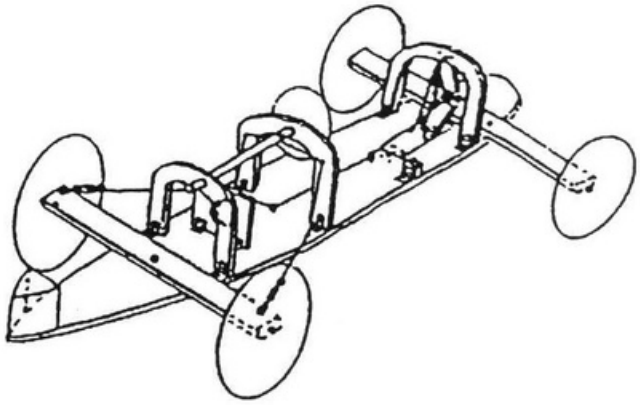
At this point, it is also a good idea to determine the shape of the racer as seen from above. Is it going to be an elongated oval, a teardrop shape, or a rectangular box which gets its aerodynamics from some sort of wedge shape in the vertical plane? Again, you don't have to make the final decision about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



Have the driver sit on the floor-board 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, drop arm brake. Then decide where and how to anchor the roll bar so that it is an integral part of the main structure of the racer. For example the floor board and possibly also the main structures above the floorboard. The roll bar must extend above and on both sides of the driver's head.

Finally you're ready to build the body itself. It can be done with plywood, sheet metal, fiberglass or any other material. This is where you let yours and your driver's imaginations roam and you can come up with new aerodynamic designs.

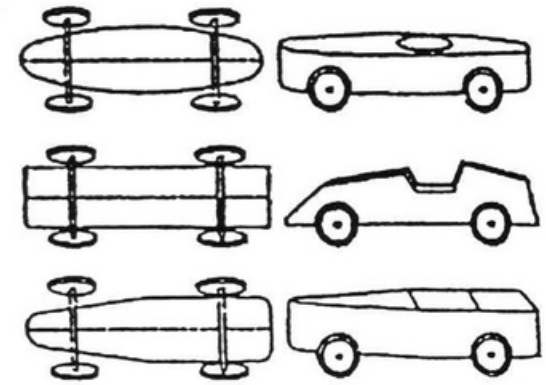


Details of the different components

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

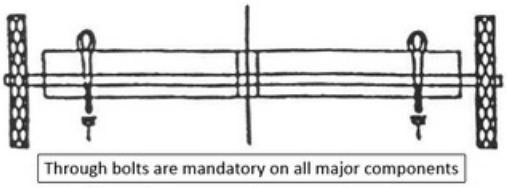
Layout of the floorboard

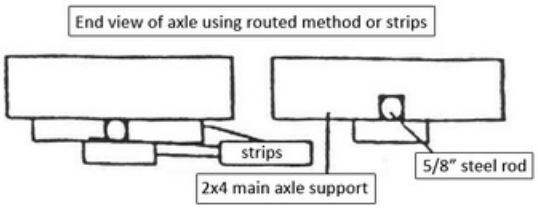
The basic body shapes shown here may help you to get your design underway:



Axles

The wheels must attach to a 5/8" or 1/2" (1/2" prior to 1999) 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 "lock-Tite" or similar method should be used to hold the nut in place. Since the rod may not be strong enough by itself, a 2x4 piece of wood or equivalent to support the axle may be required (see diagrams).





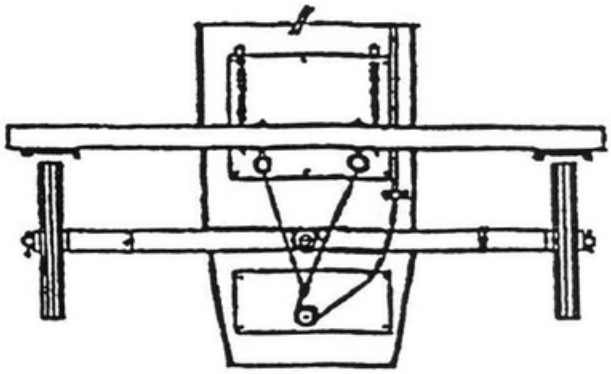
- The axle rod is supported by a 2" x 4" piece of wood.
- Wood strips hold the rod in place on the main 2" x 4" support. A routed channel can eliminate two strips.
- The axle pivot is a loose fitting bolt bolting the axle to the bottom of the frame (again "Lock-Tite" is required to avoid the bolt from loosing 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.

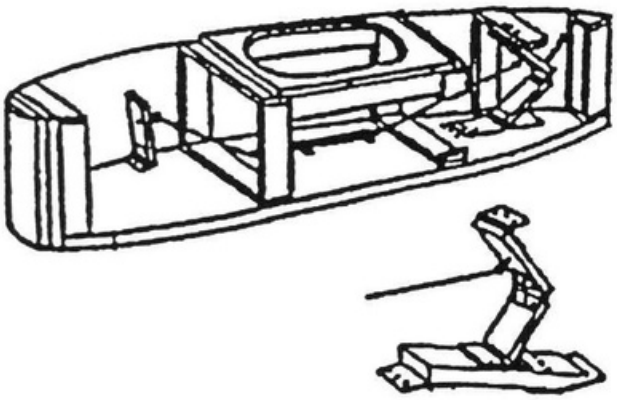
Suspension

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

Brakes

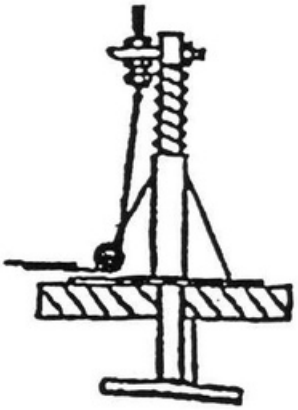
There are several kinds of safe and reliable brakes. The hockey stick brake is a piece of strong stiff hardwood parallel to the rear axle which is pulled up against both rear wheels by a cable. A spring pulls the bar off the wheels when the cable is released.





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). It can be constructed relatively easily by you.

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 dependant 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 type applies road friction well behind the center of gravity, which limits available stopping power.

> *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*.

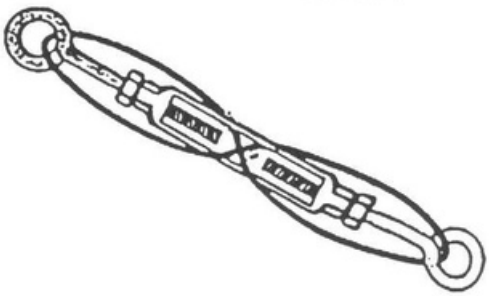
The braking must be symmetrical *with* respect to the car. More specifically, if you have a hockey stick brake make sure they pull evenly. If you have a rear-mounted drop brake, the car itself must be perfectly balanced side to side and the brake perfectly on the mid-line of the car. If this is not the 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.

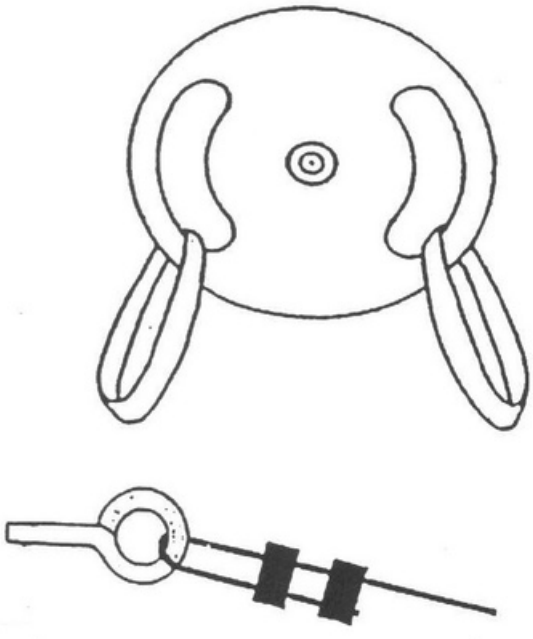
> *Foot -operated brakes only. Hand brakes will not be allowed to race.*
> *NO caliper brakes what so ever are allowed.*

Wrist straps

Loose fitting wrist straps must be provided where body styles increase the chance of injury; this restricts the drivers' natural reaction of extending their arms out of the car in the event of a roll over.



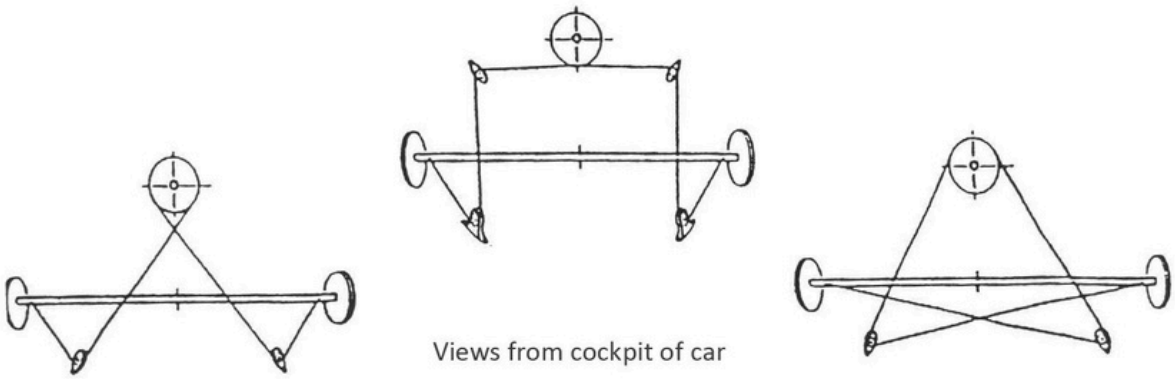
All turnbuckles must be wired or securely fastened in the event that the turnbuckle loosens up



Note: 2 cable ties are to be used
*Try to put the second tie covering the dead end of the wire for safety

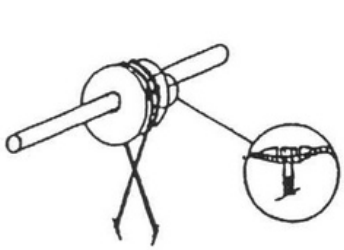
Steering

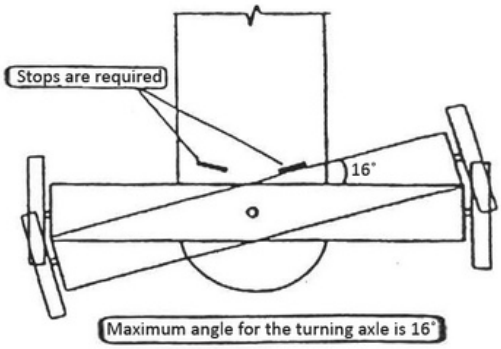
The steering mechanism is one of the most interesting aspects of the car to design and build. Most soap box racers have a rigid front axle which is rotated around a kingpin by means of a cable attached to the axle close to the wheels (see diagrams).



The steering wheel can be mounted on a shaft that is nearly horizontal. Many cars have vertical steering column and horizontal steering wheel. 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. Use stop blocks to prevent over-steering. The cable used for the steering mechanism must not stretch. Clothesline is NOT acceptable. Use *only* marine/aircraft cable. Attach the cable with two good quality damps at each end, and tighten with a turnbuckle. Wire or otherwise restrict movement of the turn buckles for added safety. They have a nasty habit of unscrewing themselves when the car vibrates.

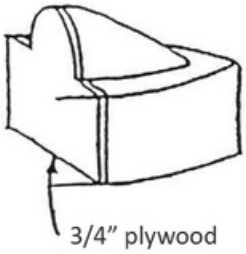
The simplest steering system consists of a cable running between the outer parts of the front axle via a couple of turns around the steering column. The steering column may be vertical, horizontal or for that matter at any angle. The cable is tightened with turnbuckles. The cable must be securely attached to the steering shaft or drum to prevent slippage. Make sure cable is wrapped in the proper direction to prevent backward steering.

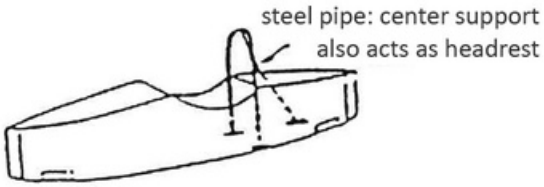




Roll Bar

The Safety requirement here doesn't necessarily call for a metal tube shaped in an arch, but essentially a superstructure 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 rolls over.



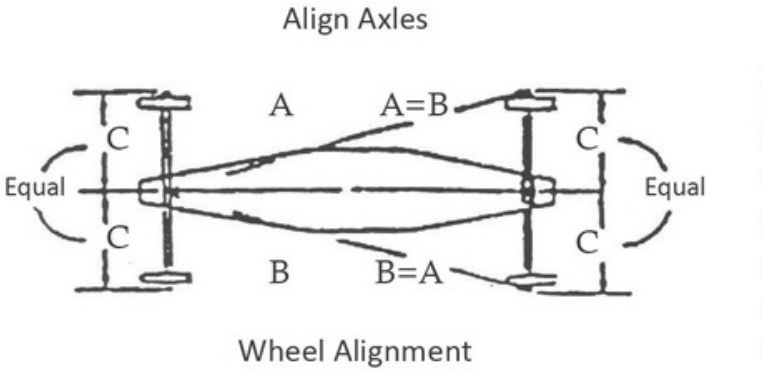


Preferably use a sturdy metal roll bar. It should be easy to integrate into your design. The best place for the roll bar is slightly ahead of the driver's face. This position allows it to deflect on-coming objects more safely.

It is very important to provide protection against potential whiplash. Provide an adequate head rest for the driver.

Alignment of the 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 alignment ensures that the centerline of the racer is parallel to the direction of travel.



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 this reason alone, you will want to have even weight distribution over all four wheels.

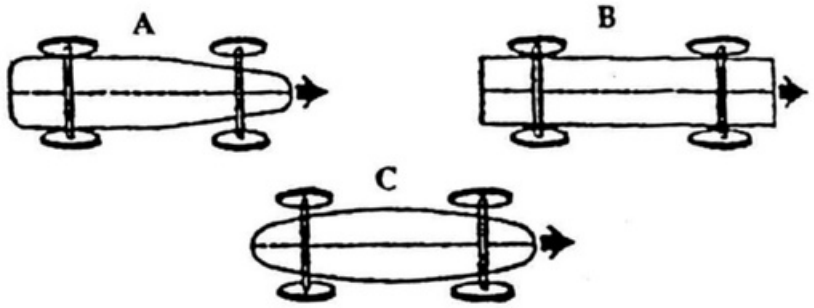
An unbalanced car tends to wander. In a car in which the weight is located towards the rear, the light front end will react to the steering too quickly. This leads to erratic motion. Also, a light front end tends to bounce more when hitting bumps. If the front end is too heavy, the steering will be 'heavy' and the driver may over-steer.

Body

Aerodynamics is the study of the interaction between air and solid moving bodies. In race car 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 air behind Car 'A' is turbulent and creates a negative pressure which tends to pull the car back.

Imagination is the only limit when it comes to body shape. Design and color will give the 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. Please refrain from designs that may pose a hazard when involved in a collision such as sharp points, ornaments or trim that may come loose.



Testing the racer

The most important and often ignored part of the building of a soap box racer is carefully executed testing before the race. You can start testing well before the racer is completed by running the racer on flat or slightly inclined surfaces. When the racer is completed, test it at higher speeds; perform brake tests where there is no danger if they fail of 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 surface.

The most 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 run out at the foot of the hill. There should be at least two adults present; one at the top and one 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. When you test the car at moderate to high speeds, remember the full regalia (helmet, elbow pads, safety belts, goggles, shoes, etc.).

Carefully re-read 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. Wooden crates will do fine but probably the best for the job is a collapsible workbench (Black & Decker's Workmate for instance). Tools, spare parts, helmet, goggles, nuts and bolts, extra cotter pins, oil etc. should be packed the night before. Don't forget a camera!

Trophies ÁÎÄ 0ÒÉÚÅÓ

Every car entrant will be given a participant shield. There will be numerous prizes and trophies to be won on race day.

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 peddle, cable, pulleys, connectors, pads etc.)
- Seat belts (webbing, buckles, mounting hardware etc.)
- Roll Bar (Bar and mounting hardware etc.)
- Suspension system (Wheels, Axles, Axle Supports etc. including moving and non-moving systems such as the rear axle bolted directly to the floor etc.)

Structural Safety

- All steering and brake system turn buckles 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 1" 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
-

Safety Equipment

- Helmet, Goggles, Elbow Pads must be available
- Seatbelt must be installed and properly adjusted
- Wrist straps must be installed

Driver Pro[illegible]iciency

- 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
  - Proper use and reasons for wrist straps

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