RACER MANUAL
&
BUILDING PLANS
2012
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Amendments

• Cars must be updated to the latest rules. If not specifically stated in the plans or Rulebook, YOU CANNOT DO IT!
• Each soap box car may only have a maximum of three drivers assigned to it.
• All drivers, ages 17 and under, must have a responsible adult in the pit crew
• All drivers are guaranteed a minimum of 3 races.
• Brake pedals or handles to be bolted through the floor.
• All soap box cars/ racers must be inspected on September 7th, 2012 by 8PM. The soap box cars/ racers must be left at the facility to ensure no major changes are made prior to race day. The soap box cars/ racers will be in a secured facility provided by the Valley-Wide Recreation.
• 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 Valley-Wide Soapbox Derby is a fun filled family event, designed to encourage participation through a parent-child program. 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 Valley-Wide Soapbox Derby 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. The age cutoff date is September 8th, 2012 for all boys and girls to participate in the race. Depending on age, each child will be placed in their respective age group. There are three divisions to compete in:

- Training Wheels: Ages 8 to 12
- Big Wheels: Ages 13 to 17
- Super Wheels: 18+ years of age
- Limo Wheels: Businesses/ Organizations*

Different building schematics for the Limo Wheels Division
Official Rules and Regulations for the Training, Big, and Super Wheels

1. Wheels: No shaving of tires, covering of wheel hubs, or any major alterations whatsoever is permitted; except lubrication and painting of the 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 and Hand brakes only. 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 bar. Steering must be a secured design to prevent of cords tangling or other unsafe mishaps. If cable is used, it must be of the marine/aircraft type. Clothesline is not acceptable.
11. Wrist straps are recommended 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 recommended.
13. A roll bar is optional. 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" solid or threaded rod or equivalent.
15. Ages 17 and under: The weight of the car including driver must not exceed 250 lbs (113.4 kg).
   Ages 18 and over: The weight of the car including driver must not exceed 375 lbs (170.1 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. This rule does not apply to the Limo Service Division.
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.
Mandatory Official Dimensions

A. Axle length (front & rear):
   Minimum 34” (86.5 cm)
   Maximum 36” (91.5 cm)

B. Protrusion of axles beyond wheel hub:
   Maximum 1” (2.5 cm)

C. Overall Length:
   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.

G. Wheels:
   Maximum Diameter 12 ¼”
   Maximum Width 4 ½”
   Solid rubber or urethane tread. Any type of wheel bearing may be used.

Limo Wheels Division has a different set of rules and requirements. If you have entered your business/organization in this division, please make sure that you have the modified rules.

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 3/4” (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 how he/she is going to be sitting up in a driving 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 driver's back up. Remember that the knees may stick up quite a distance from the floor, and that the eyes of the driver should be at least a few inches above the knees so the driver 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. If a roll bar is used, it 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:

![Diagram of floorboard layout]

**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 "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 2x6 piece of wood or equivalent to support the axle may be required (see diagrams).

- The axle rod is supported by a 2" x 6" piece of wood.
- The axle pivot or King pin is a loose fitting bolt bolting the axle to the bottom of the frame (again "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 or equivalent can be used to attach the steering cable to the axle support.
- The rear axle can be bolted directly to 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 or Hand brakes only. NO caliper brakes what so ever are allowed.*

**Wrist Straps**
Loose fitting wrist straps are recommended 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.

**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 a straight line 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; 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 all your safety equipment (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 and Prizes

Every car entrant will be given a Valley-Wide Soapbox Derby Driver's License. There will be prizes and trophies given out on race day. Trophies will be awarded to 1st, 2nd and 3rd in each age division.

Limo Wheels Division will have a trophy for “Best In Its Class” which is voted on by designated local celebrities/ dignitaries. Limo Wheels Division will also allow the community to vote which will award the winner with the trophy for “People’s Champion”

Safety and Specification Checklist

The following conditions are to be adhered to. The Safety Inspection committee is the only group that is permitted to allow non-compliant cars to still race. 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 extreme movements
- 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 extreme movements
• 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 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
  → 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!

Material List
**Lumber:**
1 – ¾”x(13” to 24”)x(78” to 90”) Floorboard
2 – 2”x6”x28” Wood Axles
2 – 2”x3”x(4’ to 5’) Side Supports
2 – 2”x3”x(11” to 15”) Front Steering Column
2 – 2”x3”x(13” to 17”) Back Steering Column
2 – 2”x3”x(Width(Modify to Floorboard)) Steering Rows
1 – (3/4” to 1”) Plywood or Hardwood Designed Steering Wheel
2 – 2”x2”x3 ½” Axle Stops
1 – 1”x3”x8” Brake Line Guide
1 – 1”x8”x10” Brake Pedal
1 – 2”x4”x17” Brake Arm
2 – 2”x3”x(13” to 17”) Body Columns
1 – 2”x3”x(Width(Modify to Floorboard)) Body Rows
2 – 1”x2”x(3” to 5”) End Supports
Multiple Boards – 1”x5” Front and Rear Ends
2 or 3 – ¼”x2”x8’ Body Support Strips
1 – Inside Width x Inside Height x 1” Back Rest

**Metal:**
2 – 5/8”x3’ Threaded Rod Axles
8 – 5/8” Washers
8 – 5/8” Nuts
4 – 10” Pull Cart Wheels (10”x4”)
1 – ½”x3’ Metal Pipe (For King Pin Bushing and Braking Levers)
1 – ½”x(5” to 6”) Hex Bolt (Full Thread) King Pin
2 – ½” Washers
1 – ½” Nut
2 – ¼”x1 ½”x18” Rear Struts
1 – ¼”x1 ½”x12” Front Strut
2 – 3/8”x3/4”x6” Axle Steering Connectors
1 – 1”x18” Steel/Iron Pipe (Threaded at one end)
1 – 1” Steel/Iron Floor Flange
8 – ¼” Hole Angle Brackets (at least two holes per side)
8 – ¼” Hole Square Attach Strips (at least 4 holes)
3 – 3/16” Turnbuckles
1 – ¼” Eye Bolt
1 – ¼” Eye Screw
1 Box – #8x2” Screws
1 Box – ¼”x2” Hex Bolts
1 Box – ¼”x3 ½” Hex Bolts
2 Boxes – ¼” Wide Washers
1 Bag – ¼” Small Washers
1 Box – ¼” Nuts
1 – 50’x1/8” cable
3 – Wire Ring Anchor Points
2 – 3” Hinges
1 – 3” Strap Hinge
1 – ¼”x1”x1”x1’ Angle Steel/Iron
1 – Bolt/ Nut Epoxy (Locktite)

**Finishing:**
The body shell can be whatever you like. Just keep it sturdy and safe!

**Building Plans**
The following building plan is a basic and sound design to start from. We encourage the use of your imagination (within the regulations we have set) so please feel free to modify the plans that suit you. Please keep in mind drag, balance and weight limit when you modify your racer.

Drag = slower speed  
Unbalanced = Irregular steering  
Exceeded Weight Limit = Unable to race

Floorboard

1. Start off your floorboard by getting the right piece of plywood for the width and the length you prefer. Keep in mind the driver’s height and width. Get the width to be as close to the driver as possible. This will ensure less drag. The length should be determined based on the driver’s sitting position.
   a. Ideal dimensions for 12 and under: 78” x 14”
   b. Ideal dimensions for 17 and under: 84” x 16”
   c. Ideal dimensions for 18 and over: 90” x 24”
2. There are several ways of cutting the floorboard to the proper shape. The easiest way is to drill holes through the plank all along the outline, just outside the line. Using a jigsaw, cut through the inner edges of these holes. This gives the floor its rough shape.
3. After the floor is cut to the general shape, the next step is to finish to its exact size. This may be done using wood plane.
4. Now is the time to finish the bottom of the floorboard, if you have used a thick piece of wood. It should be streamlined by rounding it slightly toward both sides and ends, or by making it slightly V-shaped. This may be done by the use of a wood plane. The sketch above shows a cross section view with the ends properly shaped.

Axle Trees

Axle trees are the wood coverings which reinforce the axle rods. They keep the axle rods from bending under the weight of car and driver. If the rods were not reinforced they might bend, which would let the wheels slant. This would sacrifice speed, due to additional friction on the bearings and road drag on the tires. The trees should be built to create as little wind resistance as possible. This means that they should be made as thin as is consistent with their purpose of keeping the rods from bending. To endure the pressure, it is advisable to use hard wood even though it is somewhat difficult to work with. When made with soft wood they have a tendency to break or split.

1. You’ll need two axle trees; work two boards to size 1½” x 5½” x 28”. Locate grooves for the trees by drawing a line parallel to the front edge, 2 ’½” from it; another line 5/8” back of this line.
2. Next the grooves for the rods are to be cut. They are to be 5/8” deep and 5/8” wide. You can cut them out by using a router.
3. Now work the trees down to their streamlined shape. To do this, use a planer or a wood plane. Finish the job by sandpapering them to give them a smooth, even surface.

4. Now, with the trees shaped and grooved, bolt the rods into the trees. Use #8 x 1 ½" flat Phillips wood screws, one to each end of the rod drilled 3" from the square ends of the rod. Your rods may have holes already drilled in them; if they do use them.

5. The bushing for the King pin may be made from a 3" length of ½" pipe. Using a hacksaw split the pipe for a distance of 1 ½" holding the pipe in a vise while working on it. So that you don't crush it, put an old 5/8" bolt in the part of the pipe between the jaws of the vise.

6. Now flatten out the two halves into which you have split the pipe. Be sure that during this operation you do not squeeze the remainder of the pipe out of round. If this happened the King pin would not go through it nor would it work freely if you could get it in.

7. Next, drill a 3/16" hole in each flat piece. The King pin will be installed in the front axle tree; a carriage bolt or a hex bolt 1/2" in diameter and as long as necessary, makes a good King pin bolt.

8. Drill a hole with a 5/8" drill in the exact center of the axle "tree lengthwise, in front of, but close to, the axle rod. Insert the bushing, with the flat pieces on top of the tree, and screw it into place, using wood screws. It is very important that the King pin be the same distance from each end of the axle rod, so that the wheels line up.

9. If the King pin does not work freely inside the bushing smooth the inside with a round file. However, very little of this is likely to be necessary, if the pipe has not been pinched out of round in the vise.

**Brake Hole**

The Brake Hole section and Brake Section is for a Drag Brake construction. If you are planning to use a Hockey Stick or Plunger brake system, a different construction process is necessary. At this point in your construction you should cut the hole in the floorboard through which the drag will operate. Take great care in seeing that your measurements for this purpose are exact. If you have made your floor thicker than two inches it will be necessary for you to cut out places in the floor in which to set the trees, so when you are in your care, it will have the necessary clearance of three inches, as provided in the rules.

1. Draw an outline of the brake hole on the rear end of the floorboard as shown in Figure 1. Make certain that it is located exactly between the sides of the floorboard. Otherwise your car would swing to one side or the other when you applied the brake. The size of the hole is 18" x 3 ½".
2. Next, drill holes on the inside corner or the outline you drew. You may drill more holes to make the sawing process easier.
3. Using a jigsaw, cut out the outline of the brake holes.
4. Sand or file to smooth all edges.
5. Before you do any more work on the floor you are reminded that the front wheels of the car must be behind the nose of the car. The front axle tree must not be placed so near the front that the rims of the front wheels are as far forward as the nose of the car.
6. If you are using a floor more than 2" thick it is necessary to cut out channels in the floorboard in which to set the trees, so that your car, when loaded, will have a minimum clearance of 3" provided by the rules.
7. If you decide that you should provide cutouts for the trees on your car, draw the outline of them on the floorboard as shown here. The channel for the front tree should be a little wider, you notice, to allow the front wheels to turn for steering.
8. Saw across the floorboard along the lines you have drawn. Make the cuts only as deep as you have decided necessary to give the bottom of the car the 3" clearance.
9. Use a hammer and chisel to clear out the waste wood between the cuts you have made with the saw. When about done finish with a wood plane and sandpaper.

**Suspension**

**IT IS NOT NECESSARY** to equip your car with a strut system, but results of special tests made on Derby Downs, as well as lessons learned from past years' races, prove that well-suspended cars handle better, ride better and have more speed than cars without struts. Derby rules allow the use of almost any kind of strut/spring suspension as long as the action of the suspension does not interfere with proper control of the car. Flat struts are the safest and the easiest to obtain and to install. Soapbox Derby rules permit you to have a workshop cut, shape, temper, taper, trim, punch or drill the suspension to suit your needs.

1. You will need three pieces of metal: two which measure 1/4" x 1 ½" x 18" for the rear, and one 1/4" x 1 ½" x 12" for the front. You can drill and shape them base on the sketches in Figure 2.
2. Drill a 5/8" hole in the floorboard in the exact spot which will bring the front axle rod about 8" to 12" from the front point of the floorboard. Be extremely careful to determine this hole depending on the size of your floorboard.

3. Now insert the King pin up through the floorboard, through the bushing in the front tree, and through the 1/2" hole in the front end of the front spring. Taking great care that this hole in the spring is DIRECTLY over and in line with the King pin hole in the floor, carefully bolt the leaf on the floor.

4. With a steel tape, or something else that won't stretch, check the distance from the King pin to the cotter pin holes in each end of the front axle rod. The distance to each hole, from the King pin, should be exactly the same.

5. Now it's time to attach the rear axle tree. Clamp the tree with the rod in its place onto the car floor. Distance from each end in the rear axle to the center of the King pin must be the same for proper alignment.

6. Fasten the two struts to the rear axle tree by drilling holes through and securing by using bolts. Then bolt the other ends of the springs to the floorboard. Recheck to see that the tree did not slip out of alignment during this operation.

7. Put all four wheels on the car and make another check on alignment. To ensure proper alignment, the front part of the front and rear wheels should be the same distance on both sides of the racer.

8. Two pieces of wood worked to 2" x 2" x 3 ½" are used as stop blocks to limit movement of the front axle so that the front wheels cannot over turn. To install, align axle in straight forward steering position: put a mark on the floorboard edge approximately 1 ½" from rear edge of axle tree. Turn axle so that edge of tree meets this mark. Install block by attaching to the floorboard with bolts. Do same with other block.

**Steering**

NO PART of a Soap Box Derby Racer is more important than the steering assembly, just as no part of the race you drive is more important than the steering you do. Between close to equal cars, the car which runs in the straightest line will win the race. Mechanical steering, of any type, is not allowed. You may use either the vertical or the horizontal type of steering.
assembly. Either type may suit the smaller drivers, but the larger drivers are inclined to favor the horizontal, because it gives them more leg room. The type shown here is the horizontal. It is designed for safe, sure control of the car.

1. Next construct two body bulkheads. Each one is made of three 2"x3" pieces of wood, held together by flat steel or corner braces. The basic structure of the bulkheads are:
   - $h = $ Front steering columns are 11" to 15" (label front columns)
   - $h + 2" = $ Back steering columns are 13" to 17" (label rear columns)
   - $w - ½" = $ Steering rows are the width of floorboard

2. Drill a hole in each steering row using a wood drill bit approximately 1 ¼" through which the steering shaft will go. The hole should be exactly in the middle of the steering rows. This should be done by taking half of the width of the steering row and marking it with a midline. Label each steering row front and rear. On the front steering row, using the midline, place the drill spot 7/8" from the top. On the rear steering row, using the midline, place the drill spot 7/8" from the bottom. Now you have your spots to drill through.

3. Now you can shape the top of the steering rows to the desired shape of your racer. Take care not to modify over the hole to keep the structural stability. Try to make the steering row symmetrical. Shown in Figure 3.

4. Attach the appropriate steering columns to the steering rows using the flat brackets on both sides. Attach by using through bolts and nuts. Shown in Figure 3.

5. Attach the angle brackets at the bottom of each column, again on both sides using through bolts.

6. Attach the steering columns to the floorboard or side supports if you installed them. The distance between both steering bulkheads should be approximately 16".

7. For a steering shaft, use a piece of 1" plumbing pipe 18" long. Drill a ¼" hole 9 inches from one end. Have a 1" floor flange WELDED to the end of the pipe nearest to the hole you have drilled. Don't use a drum on the steering shaft, the steering is more accurate without.

8. You may use any kind of steering wheel allowed by the rules. If you want to use one like the one shown here you may cut it out of 3/4" plywood. Cut out slots for your
fingers. Bolt the wheel firmly to the floor flange, which has been welded to the steering shaft.

9. Next run the steering shaft through the holes in the two bulkheads; running it from the large bulkhead to the smaller one. Washers should be placed on each side of the large bulkhead and you should fasten them by putting cotter pins through holes drilled in the shaft for that purpose. This will prevent end play.

10. Get two pieces of ¾”x3/8”x6” strap iron and shape and drill them according to the directions in this sketch. Fasten them to the front axle tree at the locations also shown here. Use bolts to fasten them securely to the tree. Fasten 3/16” turnbuckles to each of these pieces of strap iron. Shown in Figure 4.

11. In fastening all cables throughout the steering and the braking assemblies use a secure hitch. Bring the cable through the eye at least two times. Then make one or two knots around the cable and then clamp or wire the end of the cable to the cable proper. This will ensure the cable will hold.

12. Bolt two strap hinges to the floorboard under the steering shaft, one about 1 ½” in front of the other. Start rigging by fastening one end of a length of 1/8” cable to the eye of the turnbuckle on the right hand end of the front axle tree. Thread the cable through the back pulley, then up and over the left side of the shaft.

13. Make four complete turns around the shaft and then thread the cable through the hole in the shaft. Continue with another four turns, in the same direction. Then bring the cable down to, and through, the other pulley and then anchor it to the turnbuckle on the left end of the axle tree adjust the turnbuckles to take the slack out of the cable.

Brake

THE SINGLE DRAG BRAKE, operated by a pedal is the only type of brake allowed. Don’t slight any feature of your brake construction; check and then recheck to make sure that every bolt, screw and cable connection will withstand the strain of quick stopping which may be required. Remember that the inspectors who will go over your car before the races will give close attention to the soundness of your brake assembly. Be prepared to make adjustments.
1. Make a brake pedal of hard wood, size \(3/4\" x 8\" x 10\"\). Fasten, as shown in the Figure 5, an eyebolt into the pedal. The brake cable will be attached to this.

   **Figure 5**

   ![Figure 5 Diagram]

2. Now cut a piece of hardwood to this size: \(7/8\" X 3\" x 8\"\). Bolt it to the floor in the area of the brake hole. Make sure that you leave at least 6 \(\frac{1}{2}\"\) of brake hole area from the rear. Bolt a strap hinge onto the center of this board. The brake cable will run through this.

3. Cut a hardwood board to these dimensions: \(2\" x 4\"(3 \frac{1}{2}\") x 17 \frac{1}{2}\"\). Next make a diagonal cut across one end of it, as shown in Figure 6. Obtain a piece of old auto tire tread and cut it to fit the surface of this diagonal cut; bolt it in place. There must be, according to the rules, at least 9 square inches of tire tread to touch the road.

   **Figure 6**

   ![Figure 6 Diagram]

4. Using a 3\" strap hinge, attach the brake to the underside of the floorboard by bolts.

5. Four brackets are necessary; you can make them out of 1\" x 1\" angle iron. Directions are given in Figure 7.
6. Put an 8½” length of ½” pipe in the vise. Use a hack saw to split one end for a distance of two inches. Widen the fork created by the split so that it will go around another piece of ½” pipe. Flatten the other end with a hammer and drill a hole for a ¼” bolt. Drill ¼” holes in the split top end. Check your measurements with the Figure 8.

7. Now flatten both ends of a 12 ½” length of ½” pipe and drill ¼” holes in them. Drill another ¼” hole in the pipe about 5 ½” from one of the holes in the ends. Check your measurements with Figure 9.
8. Bolt the brackets to the pieces of pipe as you see in Figure 10. Then bolt the bracket on the short pipe to the drag bar in position shown. Bolt the other bracket to the floorboard in the position shown in the next sketch. Fasten a length of screen door spring to the top of the long piece of pipe; fastened later to the end-piece, it'll keep the drag up.

*Figure 10*

9. Using two 3" hinges, bolt the brake pedal to the floor. Anchor a length of 1/8" cable through the hole in the top of the 12" pipe. Then thread the cable through the pulley, through a 20" length of ¼" copper tubing which you should fasten to the floor by staples or narrow strips of metal. Anchor end of cable to eyebolt in brake pedal. Use Figure 11 for basic setup structure.

*Figure 11*

**Finishing**

THE SHAPE OF THE RACER BODY is somewhat determined by the shape of the floor. Pointed front and rear ends of the floor quite naturally call for pointed front and rear ends of the car body. No matter what the general design, or of what materials you construct it, it is very important that the car body be as long and as narrow as the rules allow. This provides a minimum of skin surface to create air friction or drag. A simple body, and a very efficient one; is covered by just four pieces of material. It is easy to make out of any of the approved coverings. Be sure that you leave no exposed rough or sharp edges.
1. You have already installed two of the bulkheads necessary. Now make the third one like the rear steering bulkhead. Do not drill a hole in the row.

2. Install the new bulkhead by the same method used in attaching the others. This one is placed where the driver's back would be able to rest against it.

3. Make front and rear end pieces by nailing together a number of pieces of wood. Shown in Figure 12. The notch in the bottom of the rear one allows axle to move up and down. The ½" x ¾" blocks come to ¼" of the tops and the sides of the end pieces. Now screw both end pieces to the floorboard.

4. Nail, or screw strips of wood ¼" thick by about 1 ½" wide to the block on the rear of the front end piece and to the sides of the first two bulkheads. Do the same from the rear block to the third bulkhead. Fasten still other strips between the second and third bulkheads. Basic design is shown in Figure 13.

5. Before you cut the material for the sides and the top you should make paper patterns of these sections. Cut them to the proper dimensions and then fit them to the body. If they fit perfectly cut the cover material to the same figures. If they don't fit trim them to size or make whatever adjustments are called for.

6. The side covering should be nailed or screwed to the side rails and to the floor board for the full length on both sides, except for the cutouts over the axle tree.(These cutouts allow the axles to spring up and down). The sides should be attached before the top is put on.

7. If the top paper patterns fir, cut the top material and attach it to your car with nails.

8. You will want aerodynamic ends, front and rear, on your racer. To make them, use two pieces of hard material 3" x 11", bent to fit the front and rear ends. Nail or screw them around the front and the rear pieces. These will shield the ends from damage.

9. A seatback will give something to push against when you apply the brakes. It must be either hinged or removable so inspectors can see into the back of the car.
Figure 13