

2003

# PINEWOOD BIBLE

The most up-to-date, informative,  
and extensive pinewood derby car manual ever!

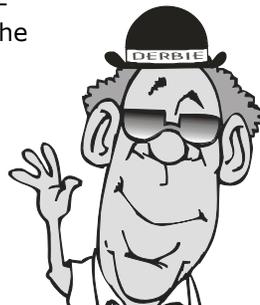
By  
David Whitaker and John Whitaker  
"The Whitaker Bros."

Published and Distributed by FastPine.  
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## ***WHO IS FASTPINE?***

We are the Whitaker Brothers, David and John, who love to work as application programmers during the week, and amateur racecar drivers on the weekends. We both love the analytical nature of our IT field, as well as the challenging sport of racing. Everything in our lives seems to come down to how we can improve the performance. The more simplistic the materials, or the stricter the rules, racing is always a challenge we like to face. Computers offer us a fairly well controlled environment, but the racetrack is full of unknown problems waiting to happen.

We both grew up participating in derbies, which set the gears in our heads spinning early. It is always about the personal challenge, and not necessarily about winning over someone else. This way, the only time you can ever feel you failed, is when you failed your personal best. There will always be someone that can beat you at some point, you just never want to find someone working harder.

It is our sincere hope that you find something personal and impression making in the Pinewood derby that will stay with you for the rest of your life.

**You now have the Whitaker Brother's FastPine Bible to lead you... Good Luck!!**

## ***THE FASTPINE VISION***

FastPine is dedicated to delivering the most up-to-date and the most comprehensive pinewood derby car building commercial site on the Internet. It is our goal to offer all the speed secrets to make your car a high performance pinewood derby car. It is human nature to want the fastest and coolest car at your derby, just as long as we all remember why this derby exists.

In the spirit of competition, someone needs to take home a trophy. If you follow these tips and secrets and pay close attention to the rules, we promise you will have built a fast and very competitive Pinewood racer. Trophies signify who was lucky on that day and had the fewest problems. No one can guarantee a winning pine racer, so have fun, work hard, and enjoy the thrill of watching your car race down that track and the fulfillment you

received at the end of the day. If you didn't place, still make a night to celebrate your accomplishment and never forget what this day really meant to you and your helper.

Most importantly, if you find that there are other kids you can help improve their cars, let them know how FastPine's Pinewood Bible helped you out. Also, be ready to answer questions openly, so everyone can benefit next year.

## ***HOW TO USE THIS BOOK***

The FastPine Bible explains in detail how to build a fast pinewood racer. We suggest you read through the entire book first, before you start on any part of your car's construction. This is so you can see what advanced techniques are available, if you are able to include them in your design.

The High Performance section expands our basic fast derby car to give you a full range of methods to enhance your car's performance. This will require extra time and effort, so plan on focusing most on the basics of the design to ensure you have a good foundation to build on.

As you follow through the Lap 3 chapter, you can look ahead for the advanced preparations for each part of your kit. Make sure you understand the concept completely before you attempt it, so you will fully understand how to fine tune your kit for your needs and the rules of your organization.

We tried to include as many ideas as possible. Challenge yourself to take the knowledge we give you as a base, and possibly develop your own modifications, or better techniques.

Look forward to the diagrams if you need more understanding of what is written. Sometimes it is easier to understand the concept if you see it and not just reading about it. Our diagrams depict as clearly as possible, the idea we are trying to get across. If you feel you still do not understand our tips, please feel free to send us your comments on how we can improve our Pinewood Bible.

**STARTING LINE!****INTRO TO THE PINWOOD DERBY****A Little Derby History – Almost 50 Years Old**

- The Pinewood Derby is one of the most popular events in Cub Scouting. The first Pinewood Derby was held in 1953 by Cub Scout Pack 280C of Manhattan Beach, California.
- The Pinewood Derby was referenced in a Scout publication for the first time in the October, 1954 issue of Boy's Life Magazine. The Cub Scout Program Quarterly gave instructions for running a Pack Meeting Derby.
- The first Pinewood Derby Kits were available from the Supply Division's catalogs - a package of 8 kits sold for \$2.75! Over 15 million kits were sold during the next 20 years.
- Today, over 81 million Pinewood Derby car kits have been sold.
- The races still operate by rolling the freewheeling cars down a sloped track.
- The Pinewood Derby event is also known as the "Shape 'n Race Derby" in the Christian Service Brigade, and the "Kub Kar Rally" in Canada's Scouting organization.

**NOTE:** A more detailed history is available on our web site: [www.FastPine.com](http://www.FastPine.com).

**The Kits**

Each derby participant receives a kit with one pine block, four nails for axles, and four plastic wheels. The kit also includes some basic rules and construction guidelines. We recommend that each entrant purchase at least two kits. This gives you some room for woodworking mistakes, and provides you with more of a wheel selection. This is because the supplied wheels are made from at least a couple different molds. You can choose the best spinning wheels for your final racer. This is explained in more detail later.

**Clubs That Race**

This traditional kit car races spans several organizations. We have provided a simple chart for event naming comparisons for the different groups.

<b>Organization</b>	<b>Name of Car Race</b>
Boy Scouts of America (BSA) & Cub Scouts	Pinewood Derby
Royal Rangers	Pinewood Derby
Royal Ambassadors	Royal Ambassador Racer Derby
Indian Princesses and Indian Guides	Pine Block Derby
Pioneer Clubs	Pine Car Derby
Christian Service Brigade (CSB)	Shape 'N Race Derby
Awana Clubs International	Awana Grand Prix
Girl Scouts (GSUSA)	Girl Scout Grand Prix
Scouts Canada	Kub Kar Rally

**Following Rules and Philosophy**

***Let FastPine show you the simple techniques to make your car a Fast Pine!***

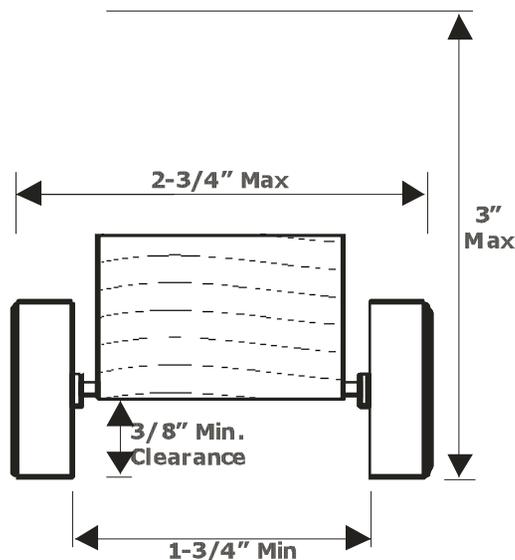
How do I build the fastest car? This is the challenge every young derby participant faces each new year as they try to start over with the same simple kit. Those who have raced before will have experience over the newcomers, but I believe the newcomers could be as knowledgeable as the veterans about the existing speed techniques. We want everyone's pine block to go fast.

The force of gravity powers all these small pine cars, which roll freely down a 32 foot track. The starting positions on the track are elevated about 4-5 feet. The track then slopes downward where there is a small flat straightaway before the finish line. The cars are released from the starting pins simultaneously. It seems to be very straight forward and simple.

Of utmost priority, one should follow the rules in the Pinewood Derby car kit and any rules established by your local pinewood derby committee. The basic rules in the kit are provided.

### Follow the Rules

1. The overall width of the car shall not exceed 2-3/4 inches.
2. The width between the wheels shall not exceed 1-3/4 inches.
3. The overall length of the car shall not exceed 7 inches.
4. There shall be a 3/8-inch clearance between the bottom of the car and the track.
5. The weight of the car shall not exceed 5 ounces.
6. Wheel bearings, washers, and bushings are prohibited.
7. The car shall not ride on springs.
8. Only official wheels and axles are permitted.
9. Dry graphite is the only lubricant allowed.
10. The car must be freewheeling with no starting devices.
11. The car must pass inspection by the committee at registration.



### Sample of Unwritten Rules

1. Cars from previous years are not allowed, since the point of the derby isn't the race, but the process of building a car.
2. Cars cannot be modified (except for critical repairs) once they've been impounded for the race.
3. Good sportsmanlike conduct is expected from everyone involved.
4. Powder graphite, or other potentially messy lubrications, should be used in a way so to minimize the mess created.
5. Participants must be registered members of that specific organization, and may enter only one car each.

Any tips or secrets you incorporate into your car to make it faster, especially techniques you feel might be in violation of the rules, need to be approved well in advance of race day by your leadership. Please, do not wait until the morning of to find out that your design is controversial and expect to fight it just because it is not in the rules.

The rules need to be simply unambiguous and perfectly clear in the limitations. Our opinion is that if the written rules do not explicitly say you cannot use a specific technique, then it should be allowed. This is why we say that if you are pushing the envelope, it is your responsibility to check with the leadership way in advance of the race day, to give them time to resolve the issue. Otherwise, we feel you are conducting very un-sportsmanlike behavior and you are only interested in causing trouble and degrading a great time for all the other children and their families.

The local organizations should not greatly expand on the basic rules set forth by the derby kits. This is a very heated topic for some indefinable reason, just because it is "unfair" in the competition. If children and their helpers are not allowed some leeway to use their ingenuity, the sport loses the thrill behind challenging everyone to learn. We strongly believe that every kid who wants to build a car should be allowed the same access to the tools and all the tips that others are more fortunate to have available. The event overall will improve and there will be more competitive cars. There is more worth in winning, if there are more to compete against.

Our hope is that with every book sold, by FastPine or any other commercially available PWD booklet that the playing field is not

only more leveled, thus more fair, but also raised to a level where the secrets diminish and the imagination is encouraged. Everyone should be welcoming the new innovations, because it only serves to add to the spirit of competition, which is still a real world phenomenon that the children will have to learn about someday. The children are served if they are able to learn about all the lessons in life, and how to maintain an attitude of sportsmanship. Even losing can be transformed into a positive in a child's life. I think it is some of the parents' egos that cannot let their Johnny fail. It should be taught, if you don't achieve your goal, you might have just gone about it the wrong way. Just try again.

So, all participants should be allowed access and use of the most updated pinewood derby "tips and secrets", and as result, it will ease many of the tensions between entrants that would like to extend more effort to the races and the rule enforcers. Everyone should maintain the highest level of sportsmanship, and stay focused on the simplicity of the event centered on the betterment of the children.

### **Alternatives for Adult Racing Participation**

We understand the competitive spirit that some parents feel when they become involved in the project for their children. Some just can't help wanting to be more clever than the other. To help channel this enthusiasm, and prevent the scouts' races to be clouded with more controversy, it is a great idea to create car classes that allow basically anything, while following some very miniscule rules. We have some suggestions of such rules.

The classes could even be designated as "Adults", "Outlaw", or "Renegade". Your classes could even allow kids that wanted to test their own boundaries to also enter in these classes with additional cars. One of the favorite alternative classes focuses on the opposite of speed. It is the "Slowest Car" Contest. This is where whoever crosses the line last, wins! You must cross the line though. This one is probably more challenging than any high performance holy grail. These options should create an outlet for the ones in the group that just want to spread their creative engineering wings, without further tainting the scout's traditional races.

The Rules for the "**Adult**", "**Outlaw**", or "**Renegade**" Derby could be as follows:

1. **NO Rules** except the width between wheels must be 1 3/4" to fit over the guide strips on the track and fit under the finish gate.
2. The participating Cub Scout in the family **MUST** race in the Official Derby Race to make his immediate family eligible for this special class. The Cub Scout may make another car of his own to race in this category.
3. You must purchase your own kits, and may have to pay an additional entry fee.
4. Prizes will be awarded for how the organization deems suitable.

The Rules for the "**Slowest Car**" Derby class could be as follows:

1. To win (or actually finish last) you must be the last car to cross the finish line.
2. If your car does not finish the race, you cannot be considered for the placing.
3. The participating Cub Scout in the family **MUST** race in the Official Derby Race to make his immediate family eligible for this special class. The Cub Scout may make another car of his own to race in this category.
4. You must purchase your own kits, and may have to pay an additional entry fee.
5. Prizes will be awarded for how the organization deems suitable for the slow, slower, and the slowest car of that year.

## LAP 1: PROFESSOR DERBIE'S BASICS

### Most Important Factors

The simple "official kits" and the included rules, limits the amount of factors that one can play with in order to achieve a fast car. There are slight differences in the wheels each year that are possible, but the main factors that you have to focus on remains fairly consistent through the years. Once you have made it through your first year in the derby, your mastery of the construction processes will become more highly tuned. You will understand the main factors of the wheels, the axles, weight, lubrication, balance and trueness, are not as easily mastered as you thought, your first year.



All your preconceived notions that assumed this project couldn't be very involved, should have vanished. In the following sections, some of the more fundamental concepts that this project entails will be presented to help you better grasp exactly why the methods we suggest work. It will also give the racer a good foundation of knowledge, so he can better fine-tune his car as his experience grows. The design process will use all of these scientific properties to make your car the fastest.

### Energy

Even though rockets or rubber bands do not power your car, your car has stored energy when it is placed on the starting line behind the holding pin. This energy is called potential energy. Gravity is pulling down on the car, trying to make it roll through the slope of the track. Once the car reaches the flat of the track, kinetic energy takes over. Kinetic energy is the energy possessed by the car because of its motion. So, the more your car weighs (max 5oz.) and the faster it is moving, the more kinetic energy it has.

Since the car is not allowed any powering devices, the potential energy is the only energy it has to get it moving. You have to consider, even though the car will not gain any energy traveling down the track, it sure can lose it. This is where knowledge of other forces is necessary to understand how to maximize your car's energy supply.

### Acceleration

The force that powers the car is gravity, which is applied to everything on the Earth. Any object that is dropped from an elevation will gain speed or accelerate during its fall. The car on the racetrack is falling, but it is not falling directly downward. Because of this, there are different parts of the force of gravity that affects the motion. There is a part that pushes the car down the slope of the track, and then there is a part that holds the car on the track. These two parts are acting at right angles, or perpendicular, to each other as the car travels. Gravity is pulling the car faster and faster down the slope of the track, only until the car reaches the flat straight away. Then it is the momentum, or kinetic energy, that continues to propel the car.

### Friction

This is your main competitor. It has the most effect on your cars performance. The force of friction occurs when an object is in contact with another object. The surfaces of these two objects directly affect the amount of friction present. This is a resistant force that slows the object's movement. Your challenge is to minimize the rubbing between the parts of the car and the track. Here is a list of the rubbing interactions the car faces: wheel and axle, axle head and wheel, wheel and track, and wheel and body. How well your wheels are aligned can have a dramatic positive effect on those interactions.

## **Aerodynamics**

Aerodynamics is the interaction of moving objects with the atmosphere. The object moves the air around the shape of the object. The less air you have to move, the faster the object travels. It is another resistant force that uses some of the car's energy and slows it down. You want to make your car is somewhat air resistant to cut down on some of this force. It has been proven, though, this force is very miniscule on these cars, because the cars never go faster than 30 miles an hour. The difference in a very aerodynamic design and the original block shape are only a few hundredths of a second. Most races are never that close. Some will say every little bit helps. You certainly don't want to add anything that catches the air, like flags or sails, to your car. A good, safe design is the wedge, because it has a small front, and with a large rear, allows plenty of space for your weights. Overall, this force should not be one of your primary concerns in your construction of a fast car. This is stated to encourage creativity in the shape, and not limit the child to creating a toothpick with tires. We had a "Hot Dog" shaped car in our Pack win the championships one year as proof. The sleeker cars are just more numerous, so they appear to be the way to go. I like it when someone has fun with the originality of the car's shape, and screams by all the "stealthy" cars to add to the fun of it all.

## **Momentum**

Momentum is the measure of the motion of an object equal to the product of its mass and velocity. It is also referred to as linear motion. This takes into account all the properties of the car, like it's mass (weight), shape, velocity, and gravity. You want to keep up your momentum and minimize the resistance. Keep this in mind when weight placement is discussed later in the book. If your car is constructed properly, it should actually sustain more momentum than the other cars. This is why when scouts have followed our tips; their cars actually seem to accelerate on the flat of the track. It appears this way because the other cars are actually slowing down, because they are losing their momentum.

## ***LAP 2: THE CHECKLIST***

### **Safety**

Safety should be your first priority when constructing your racer. Adults, that means the kids should never operate power tools without your supervision. Some of the techniques involve razor sharp Exacto knives, which should also be under the same supervision-required category. It would be advisable to wear gloves, to avoid splinters or accidental slips with sharpened tools. Goggles are especially recommended when metal grinding or polishing is required. Sometimes a Dremel tool is used for sanding or shaping. Goggles and a simple particle breathing mask are suggested when hand sanding, even more so for high speed sanding and shaping. You need to avoid inhaling the fine sawdust particles to protect your lungs. Also use your goggles to protect your eyes from getting irritated.

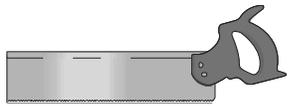
No lead will be melted. Do not attempt this. Heating lead to its melting point is very poisonous and very easily splashed on skin, causing very serious burns. This technique is never recommended and does not serve any advantage to your car.

### **Tools:**

- Carpenter Square or a Try Square
- Level
- Ruler and Straight edge
- Pinewood Derby Wheel Turning Mandrel – see p.23 for larger picture.
- Electric Drill or Dremel Tool
- Dremel Tool - also recommended for 3-Dimensional shaping and hollowing out
- Wood Rasp - can be used to hand shape the car
- Drill Bits – we don't use this technique, but if you want to drill your axle holes use a bit about 1/16", No. 43 or No. 44, or something that is about 0.089".
- 12" Mitre Back Handsaw (\$6) – great for cutting axle slots and simple dimensional cutting
- Coping Saw (Even better is a Scroll Saw or a Band Saw) for shaping
- Metal Files – fine teeth are important for modifying the axles
- Electric Sander (optional)
- Hammer
- Pliers
- Hot Glue Gun – small ones can be found just about anywhere.
- Flat Surface
- Scale (optional – can use the scales at your local Post Office)

**Supplies:**

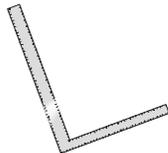
- Gloves
- Particle mask
- Eye Protection
- Lead Weights
- Sandpaper - One sheet of 600 Grit Wet/Dry & One sheet each of 100, 200, 400 Dry
- Polishing Compound
- Duct Tape – to cover cavity on bottom of the car for aerodynamics.
- Hot Glue
- Wood Filler – if you intend to relocate the axle slots.
- Primer
- Paint and Clear Coat
- Quick Setting Epoxy (5-minute is best)



12" Mitre Back Saw



Coping Saw



Carpenter's Square



Goggles



Exacto Knife



Fine Metal File



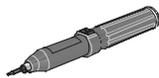
Drill Bits



Wheel Mandrel



Electric Drill



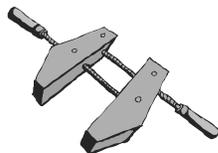
Dremel Tool



Hot Glue Gun



Pliers



(



Types of Clamps



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**Organization of Steps**

Here is an overview of the construction process and organization that the next chapter explains in more detail:

1. Decide on or Create You Own Design
2. Wheel Prep
3. Axle Prep
4. Follow the process to build the basic fast car that will win some of the time.
5. References will be made that point to the High Performance chapter – These tips are advanced to achieve the fastest car and should be checked for compliance with your local rules.
6. Squaring the pine block for ultimate alignment
7. Mark axle locations
8. Saw new slot for FRONT axles
9. Transfer your drawn profile of your car to the block
10. Rough cut car's profile
11. Transfer drawn top view to block
12. Rough cut car's top view and any needed openings
13. Shape, hollow out spaces, and sand
14. Weigh body, axles, wheels and any accessories that you want.
15. Add weight to bring the car's weight to 5 ounces
16. Shape lead if needed to fir your design and glue in
17. Weight positioning
18. Final Sanding
19. Prime, Paint and Clear Coat
20. Detail It
21. Install wheels and check for alignment
22. Add Graphite lubrication

## LAP 3: FROM BLOCK TO RACING MACHINE

### Planning Time

Avoid the last minute rush, so this project will be an enjoyable learning experience for everyone. To help with the planning, we have suggested some time guidelines. We cannot account for all the situations, but we will attempt to give you a sense of the time required to complete this car properly. Our advice is to plan on 4 weeks to complete. This depends on how many of the additional secrets you use on your design, and how much experience you may have in the different areas. It is very possible to produce a fast car with our basic speed techniques and a plain paint job, in about a week. We have had to do this a couple times ourselves, due to unforeseen circumstances, but this is not the best way to go. Here is a non-rushed timeline, but it can be cut in half:

### Basic Fast Car

Design	1-2 hours
Squaring and Slotting	1-2 hours
Shaping and Sanding (depends on style)	1-8 hours
Add Weight	2 hours
Final Sanding and Painting	2 hours
Paint Coat Dry Time (depends on type)	2-48 hours
Wheel Prep	2-3 hours
Axle Prep	2-3 hours
Attaching Wheels and Alignment Testing	1 hour
Gluing Axles to Body (depends on type)	½ hour

### High Performance Modifications (additional time)

Block Baking	2 hours
Design Shape	1 hour
Wheel Modifications	1-5 hours
Axle Modifications	2-3 hours
Advanced Wheel Alignment and Testing	2 hours

### Body Shape and Design

Fundamental Design Points:

- Car as long as rules allow.
- New Front slot for axles as far forward, leaving about ¼" of nose past the edge of the wheels. Rear axle slot could be moved back slightly, if rules permit.
- No pointed noses. This will not trip sensors and could break more easily.
- Keep enough of car's rear shape to hide weight.
- Car's weight centered as far back as car stability allows.
- Wheel alignment dead on.
- Weight as close to max as possible.
- Wheels in round, balanced and all rub points polished.
- Axles rub points polished.
- Hub contact area close to wheel's axis.

### Squaring and Slotting

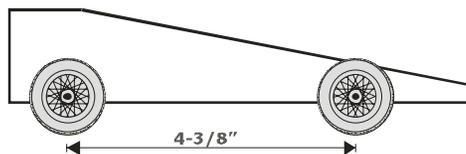
The pine block in the kit is pre-cut for you. The blocks may not be square, which means that the sides of the block need to be at right angles to the bottom surface of the car. This is vital, because the sides will be your reference for your new axle holes, especially if you want to drill new axle holes. Even if you cannot extend the wheelbase, you need to still true the block for the best wheel alignment later. To check your block, lay it on a flat and clean tabletop or any other surface that is perfectly flat as possible. Now place your Try Square, or Carpenter Square, up against the block, and rest it on the table. If you see a space between the Try Square and the block, then your block is not square. Most adjustments here will be minor. Mark on the back of either end of the block whether the LEAST space was at the top or at the bottom of that one side. Repeat this for the other side. Then you can lay a sheet of 100-grit sandpaper flat on that same tabletop surface. Place the block down on the sandpaper with the side that needs to be sanded down. Now look at your mark and apply more pressure on that edge. Do a few strokes, then stop and recheck your block's square with the above method. Do this until there are no spaces on either side.

**Note:** This next step is only if your rules allow you to extend your wheelbase, or if you found that your block was dramatically out of square and you wanted to redrill new axle slots.

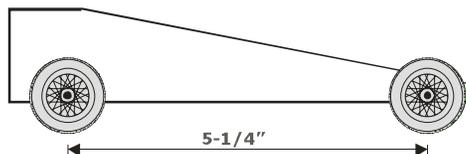
Now that your sides are at right angles to the bottom of your car, you can now drill or cut new axle slots. We suggest that it is much safer and easier just to use a 12" Mitre Back Saw to create the new slot for the front wheels. It has a wide stiff 3" blade that keeps your cuts very straight. This is much easier to control the precision and depth of the cut, as opposed to having to get access to a drill press and attempting to drill at perfect right angles to the block. Here too, if you use a drill press, your block MUST be squared. Also, cutting slots allow you to have some adjustability for your wheels and their alignment. We will assume that most of you will use the slotting method as we proceed with this process.

Preferably use the Mitre Back Saw here, but you can use the coping saw if you are extremely careful that the saw blade does not bend inadvertently causing a crooked cut. Also, if you use the Mitre handsaw, you can use your Try Square to guide and steady the saw as you make your cutting strokes. Just slide the blade against your square and keep it aligned with your markings. Two slots are pre-cut for you already. The one that already exists and is closest to the end will be the BACK of your car. The new slot you want to cut will be your FRONT wheel slot. The new front slot should be located closer to the edge of the block. We recommend that you leave about  $\frac{1}{4}$ " of wood on the nose to the outer edge of the wheels. This will protect the wheels from being damaged at the finish line. So, you should measure about  $\frac{3}{4}$ " back from the edge of the block. This is where your new slot will be located. The slots are about  $\frac{1}{16}$ " wide and about  $\frac{1}{8}$ " deep. Make these markings where your new slot needs to go using your Try Square, or Carpenter Square, to ensure perfect right angles. Stay within these measurements, so your axles will fit tight. The old slot can be filled in with epoxy or wood filler.

Out of Box



Front Extended



### Shaping and Sanding

With your new slot for front axles finished, you can proceed to cutting the rough shape of your car. Many cars only have a profile cut, which is much simpler construction wise. If you are feeling ambitious, the top view cut can add much more style to your car's shape. You should also wear at least a simple particle mask when you are sanding for the part. Here are the steps for shaping:

1. Transfer your Side-View of your design to the block.
2. Rough cut Car's Side-View.
3. Transfer the Top-View of your drawn design to the top, or bottom if easier, of the block.
4. Rough cut out the Top-View.
5. Shape the body with hand sanding with 100-grit sandpaper, or use a wood rasp, or even better is to use a Dremel Tool to make quick work of shaping your car.
6. Hollow Out from bottom inward – This step involves removing most of the unneeded wood while still leaving your car structurally strong. It is easier to add lead weight to where you need it than to make adjustments later by removing wood. You want the most weight in the back of the car, while still maintaining your car's control on the racetrack. If enough wood is not removed in front  $\frac{3}{4}$  of the car, you will not be able to effectively be able to shift your center of weight as far back as you could, if you had removed more wood in the front portion.

### Weight and Location

First point to make here is that a rear-weighted car is faster. Also, the heavier car goes faster, so you need to get to as close to that 5-ounce limit as possible. Balancing your car's weight so the car's center of mass is around  $1\frac{1}{4}$ " to  $1\frac{1}{2}$ " from the rear, is ideal. You also should center the weight along the centerline of the car that runs from the rear to the front. If you have removed enough wood from the car, you can easily create this balancing point.



If you are racing on a familiar track that is in great condition, especially the aluminum type with no seams, you can actually move this point back a little further. Doing this will create more speed, but you have to carefully approach this threshold, because your car's nose will have more opportunity to pop off the track more easily and could possibly ruin your future racing chances. We suggest for piece of mind that most should aim for just longer than 1 1/8" from the rear of the car.

To achieve this optimum location, you will have to have spaces for weights either inside your car, or additional weight on top to arrive at the correct balance and total weight. Before we go further with this, we must discuss the type of weight you need. There is no other option than using LEAD weight. Yes, real lead in some form. There are weights that are being sold for these derbies that are made of a zinc compound of some kind, and contain no lead. The problem with this "environmentally safer" weight is that it is around 60-65% less dense than lead. This means to you that it becomes almost impossible to achieve the best weight location. We suggest you use lead to take up less space, to keep the center of weight as low as possible and as far back as possible, and it is much easier to shape.

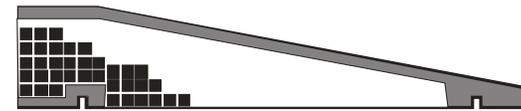
Types: Lead weight comes in many forms. Here are some useable forms for your car: lead pellets, lead shot, lead tape, lead putty, lead fishing weights, lead wire, lead golfer's tape, and segmented hobby lead weights.

Once you have decided on what type, or combination, of lead weight you will use, you need to find a scale to find out how much you need. You will weigh all your parts together, the wheels, axles, car's body, lead, and any other accessories that you think might add to the total weight. If you do not have a scale at home that accurately measures to 5 ounces, your local post office would be more than happy to weigh your parts for you. This approach insures that you are close.

Now that you know how much weight you need, you can start adding it to your car. Either by drilling holes, or cutting / sanding out spaces, below or in back of the car, for your weights, you have created your starting points for the installation of your weight. It is very handy to use a hot glue gun here to apply the weights, because if you need to move them around, you just heat up the glue with the tip of the glue gun and move the weights with some tweezers. If you find that you are running out of spaces to hide your weight, you will have to add them to the top of the car toward the rear. You might be able to hide them in a redesign.

The weight can be painted over later. Also, some of the lead needs to be accessible for the race day weigh-in. This is so you can make adjustments by drilling out or removing small amounts of the weight, as needed to maintain the max allowable mass of 5 ounces. Instead of gluing, you can also create a removable hatch, made of duct tape or a screw on cover, to hold loose type weights. Applying some small strips of lead tape on the bottom or top is a simple and fast technique to add small amounts of weight on race day. Decide what works for you, but plan ahead, because 99% of the time you will need to make fine adjustments.

Weight Placement



(Balance Point- about 1 1/4" to 1 1/2" from Rear)

Remember to keep the car's balance point in mind as you add the weights. Check and recheck the changing point as you add weights. A simple way to do this is to sit your car on a pencil laying flat on a tabletop. You can move the pencil around to see exactly where the car is currently balanced from front to rear, and make adjustments as you continue to add more weight. Use this same technique to balance the car from side to side. For real fine-tuning, you can temporarily tape on your wheels and axles to the sides of your car. This will allow you to more perfectly balance your total weight.

### **Final Sanding**

Once your final shape has been roughly sanded down to your satisfaction, and all your weight is able to fit in the spaces you've created, you can begin on your final sanding. This process involves sanding your car with finer and finer sandpaper grits, until you have a fairly smooth car without any major blemishes. You can progress from 150 - 220 - 400 grit of sandpaper. Then use a tacky cloth, or cheesecloth, to remove all the excess saw dust. This will prepare the car for painting.

### **Prime, Paint and Clear Coat Finishing**

Apply a couple of thin coats of primer to your car. Thin coats will control the dripping and will result in a better paint job. Once each dries, sand lightly with about 600 grit sandpaper, then clean with

the tacky cloth again. You are then ready for painting and clear coating. Just remember more light coats are better than one heavy coat. The paint won't adhere properly and may not dry completely.

### Detailing

Now that your paint is dried, you can add decals, numbers, or more fine finishing touches to the look of your car. You could also glue on additional effects as your design allows. This is usually where names are applied and flames are painted. It is up to your imagination. Have fun with your idea, and take pride in the paint job you worked hard to finish.

### Wheels - Prep and Conditioning

There are some basic, but very important steps to preparing your wheels. The care you put into your wheels and axles will make the difference in 1<sup>st</sup> place and no place. Another key point is that the wheels in these kits are not identical. There are even made from a few different molds. For those that bought a couple of kits have a prime opportunity to be able to test and choose the best spinning wheels, instead of being stuck with the four the kit randomly supplied. If you have more than the four wheels, perform a simple spinning test to find out which four will spin the longest. NOTE: Do not let the wheels touch the head of the axle, because the axle still has some burrs that need to be ground down. It would be a good idea to repeat this test on each of the wheels several times to double check your results. You can also test your axles this way by selecting a good wheel from your supply and record the spin time of that one wheel. The differences may seem minute at some point, but it is to your advantage to handpick wisely.

You have a good set of four wheels that you will now clean up and make as perfect as you have sanity remaining. Seriously, the prep of these wheels should be approached with patience and care to produce wheels that will lose the least amount of energy on race day. The next steps will show you how to remove molding defects, smooth the running surface, and ensure that the wheels you use are as close to being in round as possible.

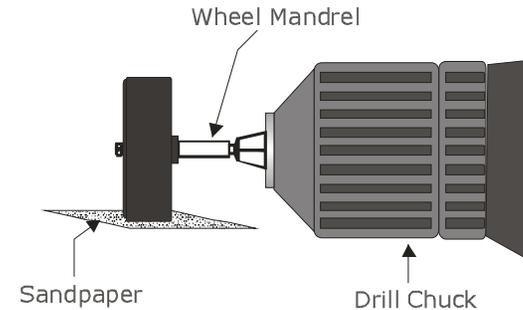
Speaking of energy, your goal is to reduce the starting energy of the wheels as much as the rules allow. Another way to put it is that the lighter your wheels are, within the guidelines, the faster your wheels will start turning. The lighter wheels will also be

rotating much faster at any point on the track, when compared to heavier wheels. Minimally, the light sanding for removing defects and smoothing the wheel's surface will lighten your wheels slightly. More advanced approaches are addressed in the High Performance section.

First you need to remove all the imperfections and smooth the tread on all wheels. You can wet sand them by hand using 600 grit sandpaper. Most prefer the more precise and quicker method of using the Pinewood Derby wheel mandrel and an electric drill.



Use a vise, or clamp the drill down on top of a table surface. Wrap some wet 600 grit sandpaper around a wood block with a hard smooth surface.



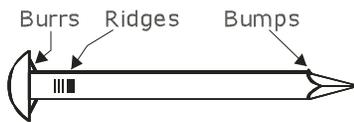
As the wheel is turning at slow to medium speed, slowly move the wood block closer until it makes gentle contact with the sandpaper. Sand until the imperfections are gone. Also, all four wheels need to be about the same size, so make sure one wheel is not sanded more than the others, or sand more on the other wheels to equalize the set.

You can also polish your wheels with this same method of using the clamped drill. To polish, we recommend using a soft compound like jeweler's rouge, which may come in the form of a stick or a powder. Apply it to a soft cloth. With the wheel mounted on the mandrel, and then chucked in the drill, turn the drill on again on slow to medium. You don't need to melt your wheels by having your drill on high. Let the cloth with the polishing compound gently touch the wheels tread. This won't

take long, and will start to look shiny when it might be done, just stop the drill to feel how smooth it is and continue, if necessary. Remove all polishing compound when finished.

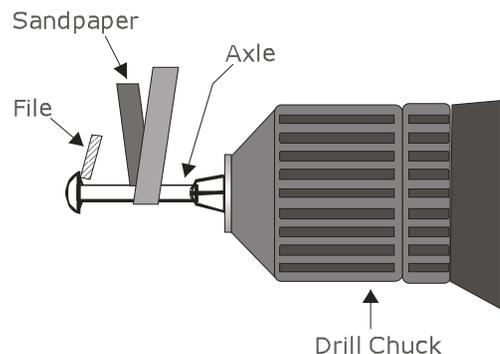
### **Axles - Prep and Conditioning**

You have four axles that need preparing now, before they are race ready. First, before anything else, use a metal file and file down the bumps that might have been made around the point of the axle.



The point does not need to be pretty or polished, because this end will be glued into your car later. Don't scratch the rest of the shaft while doing this though. This step is important because the bumps would enlarge your axles channel, and would cause a loose fit. This may cause more headaches later.

Now use your drill setup, but without the wheel mandrel. You can directly insert your axles point first into your chuck. **\*\*Make sure that you only chuck about 1/3 of the axle.** This will ensure that you will not add scratches to the surface where your wheel will rub later. If you look closely at the axles you will see small ridges on the shaft as well as burrs by the head. It is absolutely necessary to remove these features so your wheel can rotate smoothly. A small fine metal file is needed for these areas, one that has a pointed edge or use a triangular shaped file. This is essential to reach into the tight space under the head and reach the burrs.



With the drill spinning the axle, apply increasing pressure to the areas with ridges and burrs to remove and smooth these surfaces as much as possible. Once the areas are free of the obstructions, polish the axle with a wet strip of 600 grit sandpaper. Then apply some of that same polishing compound on the sandpaper, and continue to polish. You could finish by polishing with the soft cloth. The axles should be shiny and absolutely smooth to your eye. Another tip is to apply some graphite to the cloth to polish the lubricant into the metal surface. Definitely remove the polishing compound when you have completed the polishing.

### **Matching**

This next step will help you maximize all your hard work preparing your wheels and axles. First, match up a specific wheel to an axle and then keep them as a set. To match, you just need to do spend some time doing the same spin test you did before to choose the best axles and wheels. Now, though, you start with an axle and spin all the wheels on that same axle. Once you find the fastest wheel, set that axle and wheel aside as a matched set. Continue the process until all axles are matched with a wheel.

### **Lubricant Essentials**

Lubrication is one of the greatest ways to minimize friction. Many types of lubrications have been used and tested. There are a variety of solutions available in the marketplace today. The most favored and most proven successful over time has been a compound combination of graphite and molybdenum. This type is also widely available at hobby stores. A couple of known brands that we have used are Hob-E-Lube and G-M Lube.

Advice for Lube Application:

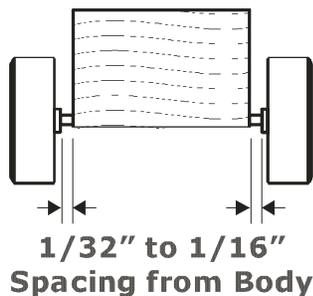
1. In most unwritten rules, you are not to over apply the graphite to your car parts. This is for the simple reason that graphite easily creates a mess, and this could dirty the track, and ultimately degrade the performance of the track. Once on your hands or car's body, it can easily spread.
2. Each set of matched axles and wheels need to be "broken-in". You can apply some lubricant to the axle and insert into the wheel. Now just spin the wheel for a minute or two. Some people like to do this step while the wheel and axles are mounted in the drill setup, as mentioned

previously. Apply small puffs at a time. This will provide an adequate graphite layer to your parts.

3. All the contact points we mentioned in the Friction section need to be lubricated, except for the wheel-to-track contact. You don't want graphite on the track. Don't forget about where the hub rubs against the car's body and the area where the axle head rubs against the outside hub. Make sure to remove any excess graphite.
4. When the rub points have been lubricated properly and you have broken in the parts, with your finger, your wheels should spin smoothly for at least 15-20 seconds. With some of the more advanced modifications in later sections, the wheels should spin longer than 25 seconds.

### Attaching Wheels

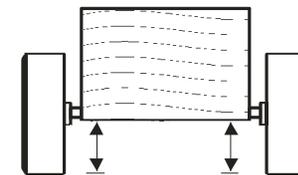
There are several approaches about how to attach the wheels. There is one method that we suggest that proves to be the easiest and most trouble free. First you insert an axle into its matched wheel. Lay the wheel down on a hard surface with the axle tip pointed up. Then take your car and line up the axle slot with the axle tip. Press the body down onto the axle until the hub barely touches the body. **\*\***(Try to leave a little space above the axle, so the axle can be tapped deeper if needed later. This will come in handy when you are trying to align your wheels.) You should leave about 1/16" of clearance between the hub and the body. This is optimal spacing to begin alignment. More spacing than this will cause the car to swerve back and forth as it travels down the track. The tight spacing keeps the "play" amount down.



### Wheel Alignment

This is the last performance critical step. The car **MUST** roll in a straight line. Any pulling to a side will cause enormous speed loss against the track's guide rail. You need to have a long, flat, smooth and level surface for accurate results. We have taken ours to the local school's indoor wooden basketball court. Once the floor is cleaned of all minute particles, it makes a great test track. You will need at least 10 feet of runway for your new bullet car. A large tabletop is minimally sufficient, but we recommend a longer test path.

First, place your car with all four wheels attached on a tabletop. Carefully measure the distance from the table surface to the bottom of your car, near each wheel. It is easier to tap the axles deeper than have to back them out of the slots. This is why we advised to leave a space when the axles were first installed, so you could adjust deeper. At this level, it is best to have all four wheels touching the ground with the same clearance.



**Equal Clearance  
On All Corners**

Also, check that all wheels are installed straight up and down. The total flat of the tread should touch. In the High Performance section, we will suggest some more alternatives, if you want more speed.

Find or create a long straight line on your car's runway. Make sure there is no debris or small particles in the way, because this could disturb the alignment. Concentrate on the overall movement and direction the car travels for the first few rolls. Then concentrate on one wheel at a time noticing whether it moves inward toward the body, stays pretty evenly spaced between the body and the axle head, or pushes outward toward the axle head. Now, gently give your car a push noticing how it travels relative to that straight line you are referencing.

Adjustments that need to be made will depend on the average of your results. The adjustments needed for:

1. Wheel moves inward toward body:  
This results from the axle angling down.  
Adjust the axle angle UP.
2. Wheel moves outward toward axle head:  
This results from the axle angling up.  
Adjust the axle angle DOWN.

**Note:** Sometime the axle might actually be bent slightly. A turn of the axle with some pliers might help here.

The goal should be to have a car that runs straight where the wheels don't move inward or outward on the shaft of the axle.

### **Gluing Axles to Body**

Gluing the axles, once the alignment has been finalized, is a highly recommended final insurance step. This gives you the opportunity to fill in spaces that will help support the axles and help them from working themselves loose, or becoming misaligned at a minimum. There are many things that can go wrong on race day, and a wheel popping off is one of the more preventable ones. Hot glue works great; once again there is that flexibility and rework ability that makes it easy to use. If you are allowed to reuse the wheels for next year, the hot glue route still enables easy removal and reusability. A quick setting epoxy also does the job nicely to secure your axles, but this is permanent. You can apply the glues inside the axle channels from the middle of the car where the axles do not reach. This will allow the glue to seep under the axles. Also, apply glue to the top of the axles. Remember not to have excess glue hanging too low to interfere with your ground clearance under the car.

**\*\*CAUTION** – do not allow the glue to run down the axles and glue the wheels to the axles.

## ***LAP 4: HIGH PERFORMANCE MODIFICATIONS!***

This is the section that will take your fast car and turn it into a lightening bolt. These methods need to be closely checked against your local rules to make sure they comply. Remember, if the rules do not explicitly say, "No, you can't ...", then you need to raise the question with someone in charge of your derby, hopefully weeks before the derby event. This will ensure everyone will have a better race experience.

We will divulge these stealthy tips for you with some basic explanations and diagrams because they are all additional steps to the fundamentals you have looked at in the previous section, and use the same setup techniques. You can apply all these modifications to your car, or a combination of a few you feel comfortable with, but allow enough time and be patient so these secrets will work correctly for you. Don't attempt these additional steps if you are short on time. Your basic fast car we showed you how to construct needs to be your strong foundation. If you have not constructed your basic car properly, these tips won't have as big an impact on your overall performance.

*These speed tips have produced many winners, so be prepared to be in the spotlight!!*

### **Block Drying**

This is a neat step that most would not think of off hand. Not everyone can benefit from this technique. For this step to be needed, you would have to live in a climate that has a high content of moisture. It is more often wet than dry most of the time. Here, a piece of wood actually soaks up some of that moisture in the air, which in turn adds weight to your car where you may not want it. If you live in a dry location, this step does not need to be performed. It is not difficult, and needs to be done either at the very beginning, or no later than before you go to weigh the sum of all your parts, so you will have the max amount of lead. To dry your block, you just need to place it in an oven around 300 degrees for about two hours. That should be plenty of time.

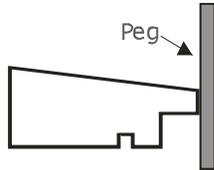
### **Body Shape**

- **Raised Nose**

Both of these nose techniques are used to gain the advantage immediately off the starting line. Since aerodynamics is not the most important factor, we can raise

the nose so when the holding pin swing down and forward, your car will be released slightly ahead of the other noses that are lower and take longer to be released by the bottom of the pin. If you can incorporate a channel in your nose, the next technique works much better.

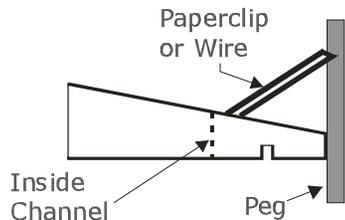
### Side View Nose Notch



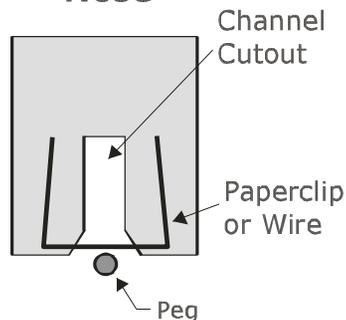
- **\*Channel Nose**

This is our favorite that we use every year. We have not heard of any group yet that has banned this awesome speed tip that we developed six years ago. This method even allows the aerodynamic followers to be happy, by maintaining a low front profile. The idea is still to be released as early as possible off the starting pin, but now we cut away a channel in the front of the nose and use a wire, like a large opened paperclip, to straddle the channel higher up the pin. Whatever you use for this, make it light and sturdy. The large variety of paperclips has never failed us. About a  $\frac{3}{4}$ " to 1" long channel is needed. The width of the channel should be about  $\frac{1}{2}$ " to make sure it clears the  $\frac{3}{8}$ " dowel pin. A smart approach, so not to make it so obvious, is to make this a part of your design, an accessory of some sort. File down ends of the nails if they extend into the channel.

### Side View Nose



### Top View Nose



### Beyond 5-ounces

When you weigh all your unassembled parts to find out how much lead you need to add, add enough lead to make your car about 5.1 ounces. The reasoning behind this is that some scales work off of rounding, which means if the car weighs 5.04 ounces, the scale will read 5.0 ounces. If your car weighs 5.05 ounces, the reading changes to 5.1 ounces. Remember, the heavier the car, the faster it goes, so every little hundredth of an ounce will translate into faster speed. Just anticipate having to shave off a minute amount of weight on race day.

### Wheel Modifications (Reference Wheel Diagram Page)

- **Balancing**

This step will not be as necessary if you rounded your wheels properly. Balancing your wheels is especially important when you have drilled holes in the sidewalls or tread to lighten the wheels. Then your wheels will definitely need to be checked to keep in balance.

Unbalanced wheels can cause the car to shake slightly as it picks up speed down the track. Balancing each wheel so the weight is evenly distributed can minimize the oscillation, which causes this shake. Insert a dowel that fits tightly through the hub of the wheels. Whatever you use here must be cylindrical and tight fitting so the wheel rotates around the center of the hub. It cannot just spin like it does as it sits on one of the axles. You can construct a simple setup using two razor blades, or thin sturdy pieces of material, and the dowel that can span the space. You should be able to mark which side is heaviest, by allowing the wheel to come to a stop after you gave it a slight spin. The part of the tread that stops at the bottom is the heaviest.

- **Tread Variations**

Remember that lighter wheels go faster. It takes less energy to get them rolling. Also, less contact with the track surface, the less friction your wheels will create. We have a diagram of the many variations that you can choose from, depending on your circumstances.

Use the same drill setup that is clamped to a sturdy surface. Place the wheel on the wheel mandrel as before. You can reverse the wheel, to where the inside hub points outward, if this makes access easier for the different cuts.

**Shaping:** You can see in the diagram that there are several ways just to shape the tread. You just use different sanding surface angles or even shapes as the wheel is spinning. Say you are using a sanding block. If you apply it to the wheel at a slight angle off of flat, you achieve simple slanted wheels, and less contact with the track's surface. You can slowly rock the block back and forth, to create the rounded wheels.

**Grooving:** A simple Exacto knife is used here to cut grooves in the tread or cut the tread down. With the wheels spinning on the drill, lightly touch the Exacto blade to the wheel tread to make the initial groove or grooves. To remove material between grooves, depending on design, just turn your blade slightly and cut away the excess.

**Cutting Down:** If you want to cut the tread down, apply the Exacto blade straight on, as you would to make a groove, but you cut all the way through. More smoothing and polishing is needed after you are finished with the changes.

- **Holy Wheels!**

This is a real awesome way to lighten your wheels further, when you can't cut them down more. Be careful though, you will need to check the balance of your wheels. If you carefully space your drilled holes, you should be ok. If you kept the original wheel width, you can go one step further. The treads can actually have holes drilled as well, only if you cant, or tilt your wheels outward. This is so your car will ride on the outermost part of your wheel, and not where the holes are, which would be a pretty bumpy ride.

- **Letter Removal**

For the people that don't have enough speed tips, you can sand off the small raised letters on the sidewalls of the wheels. Some do this cut down on wind resistance, but we suggest it more to further lighten the wheels. Lighter wheels are always better, unless the structural integrity has been reduced.

- **Hub Trimming**

Cutting down the length of the hub, will reduce the amount of contact surface with the axle. This tip needs to be considered when other wheel tips are used.



Sanded Smooth



Speed Wheel



+ Coning and Cut Down Hub



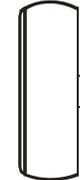
Two-Ribs Left



Single-Rib Left



Rounded Channel



Rounded Wheel



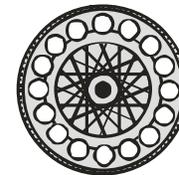
V-Point Wheel



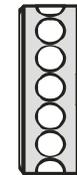
Slanted Outward



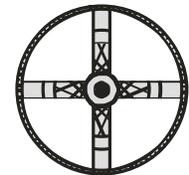
Slanted Inward



Drilled Holes In Sidewall



Drilled Holes In Tread



Cut Out Sidewall

Some combinations do not work well with each other. For example, we don't recommend carving grooves into the axles and cutting the hub down, because this may be counterproductive if not done with utmost precision.

- **Hub Coning**

Reducing the diameter of the end of the hub that will rub against your car's body is another modification that will reduce friction. This tip for coning the hub involves the use of a Dremel tool or an Exacto knife to remove excess plastic. Once finished coning, it is also suggested that you polish this surface.

- **Sticker Caps**

This tip is similar to the idea of hubcaps on real cars, but for a different purpose. You can use simple sticker type labels for this, either cut to circles, or buy pre-cut circle shapes that will fit inside the wheel diameter. The concept here is that these caps will act as a lubricant holding system, which will keep more graphite around the needed axle.

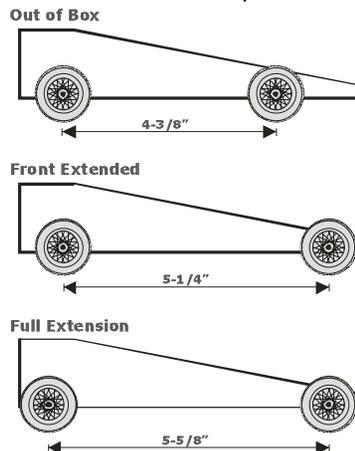
- **Bore Polishing**

The inside hub surface that rides on the axle, is not polished and could have been marked up if you were not careful when inserting the axles for the first time. An easy way to polish or burnish this hard to get at surface is to use a real pipe cleaner found at a hardware store. You could also use anything else semi-soft that would fit and polish the inside of the bore, (may need to get creative here). Lock the pipe cleaner into your drill and put some of your graphite onto the cleaner. This will help work a layer of graphite onto the interior surface, as well as smooth it. Thread a wheel onto the pipe cleaner, and then turn the drill on. You want to move the wheel back and forth along the pipe cleaner, so no uneven grooves are left.

### **Axle Modifications**

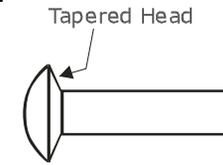
- **Location**

We have mentioned that the front axle location needs to be moved forward. It is also recommended that you move the rear axle back, until the edge of the wheel is even with the end of the block. This will achieve the maximum car length, and a faster car, because you are in essence giving yourself more track to build speed.



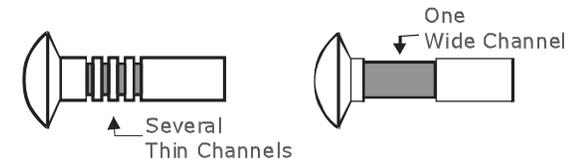
- **Tapering**

We are referring to tapering the head of the axle. This alteration will reduce the contact between the head and the wheel. It is similar in purpose to coning the hub. You use you same metal file. It might be a good idea to use a coarser file, if you are not making any progress with your fine metal file. Sand and polish this surface extremely well, because you caused a lot of coarse cuts in one of the main surfaces.



- **Grooving or Channeling**

Here is another approach to cut down on the friction between the wheel bore and the axle. It also functions to hold more graphite. We are suggesting that you grind several thin grooves, as opposed to one larger one. This is because the larger one may interfere more with the wheel travel.



- **Diameter Reduction**

Another way to reduce the contact is to reduce the diameter of the axle. This is almost like creating a large channel, but one that goes from the head to where the axle is inserted into the car's body. We do not highly recommend this step, because it is very easy to bend the axle in the process. The grooves mentioned earlier achieve the same effect.

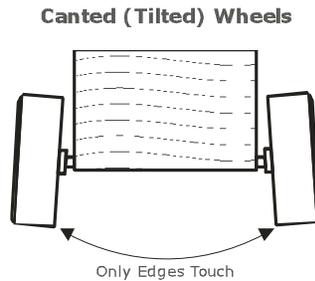
- **Hardening**

The axle itself can actually be hardened. Why? The graphite you use as lubrication can scratch the polished surfaces. If you harden the axle, less scratching occurs, resulting in the polished surfaces remaining smoother longer. To harden an axle, hold it in a flame of a propane torch until the axle become red-hot. Then remove, and cool in a cup of cold water. You will then need to polish and condition the axle, as mentioned earlier.

## Wheel Alignment

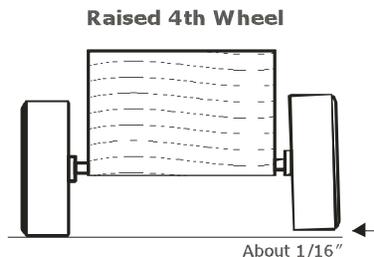
- **“Canting” or Angling**

This is a term to describe the angle of your wheels to the body of your car. We are suggesting an alternative to straight installation, to tilt your wheels outward. This will allow the entrants that cannot modify their wheels, to still ride on a small part of the tread. The car will actually be riding on the inside edge of the tread. This will greatly cut down on the wheel to track friction. Just make sure the wheels do not rub against the body where the top edge of the wheels are slanted inward.



- **Three Wheelin’**

Here is one of our favorites. It is simple and sometimes very stealthy. This method is introducing the idea of having your car ride on three wheels instead of four. All you need to do is raise one of your front wheels about 1/16”. Make sure your car is balanced in back, then this will work properly. We have even seen entries where the cars were riding only on two wheels. That is a little more of a challenge.



## **LAP 5: BAD ADVICE OUT THERE**

Be **CAREFUL** of what you read! Be critical and try to test the technique or tip first, if you are worried that it doesn't work. The commercial booklets out there have been doing a good job with trying to modernize their information. Some tips are actually hazardous or could at least cause your car to roll slower.

Be confident in our hard work to present to you only tips that we have proven, or we will tell you that you may need to test it first. We have listed below some of the “tips” or advice still out there that we strongly suggest you avoid.

### Melting Lead

This should never be necessary and it is never recommended. Hot melted lead is caustic and poisonous. When it is in its molten state, it can cause serious burns, as well. There is a variety of lead shapes and forms, so you do not need to worry about custom forming. Lead is mostly a soft material that can be easily reshaped, especially the lead putty that is available.

### Self- Adjusting Weight System

There is a tip out there that suggests you use a sealed test tube with an amount of mercury inside. You then are supposed to conceal this tube inside your car. The mercury is in a liquid state that allows it to move freely. The idea here is that when the car rolls down the track, the weight will move to where the gravity needs it most, instead of being static. This goes against all ideal principles of keeping the weight as far back as possible. The shifting of the weight could also cause the car to shake more as the car shifts, then the weight shifts. Also, the shifting weight would not allow you to balance your car on three wheels. There are many more problems with this theory, so stay away from this one. This would require a lot more testing before we could be sure of what may come of this idea.

**White Powder Teflon**

White Teflon lubricant is another option out there for racers. It sounds so cutting edge, but the truth is that for some reason it is worse than graphite. It lubricates so badly, that some say you would go faster without any lubrication at all. Time and many tests have verified that this is not a good option, if you want to be fast. Stay with the graphite derivatives.

**Sticky Noses**

We have seen this used before, where the nose of the car has a sticky substance on the nose where it touches the starting pin. The idea here is to have the pin actually pull the car when it is released. We have seen where the cars are actually misaligned because the pins are pulled so quickly. This happens when the cars are not exactly lined straight on with the pin. It can jerk the car to one side, causing all sorts of problems. An approach such as this should be avoided. It is just too prone to problems.

**Bathing Wheels and Axles in Lubricant**

Some people think that it is necessary to bathe their wheels in the graphite. Bathing the parts will only cause a big mess on the track. It will not give you an advantage on race day. Follow our steps to applying your lubricant on the rubbing points specifically, and work it in. The graphite sticks very well, and if you have worked it in, the graphite will perform for you all day long, without you worrying about it.

**Wheels Angled Inward**

We have canted our wheels outward many times, and it works great. Another approach to this is to angle the wheels inward, or at least on of them. This technique tries to angle the wheels inward to ride against the rail, so the car will bump into it less. This one's obvious. More contact with the track, the more friction, and the less speed. Keep your wheels straight or canted outward, and you'll be safe.

***FINISH LINE: RACE DAY***

We always like to be prepared for the worst. Even when someone doesn't intend to damage your car, uncontrollable things do happen. This could end your day and kill your spirit for the event. Sometime the organizations will be prepared with all the needed supplies, but you should not depend on that, especially if you want to have spare prepared wheels. Those wheels are very durable, but just as soon as you assume you will be fine, the worst happens. If a car does get damaged, you will usually be given until the next heat to get it fixed. A Hot glue gun performs quickie miracles in a crunch.

**Supplies to bring:**

- Hot glue gun
- Extra weights
- Dremel Tool or Drill
- Try Square/Carpenter's Square
- Duct Tape
- Super Glue
- Pliers
- Lubrication
- Your FastPine Book for Record Keeping
- Spare wheels and axles are a plus

**Cars Final Prep and Care:**

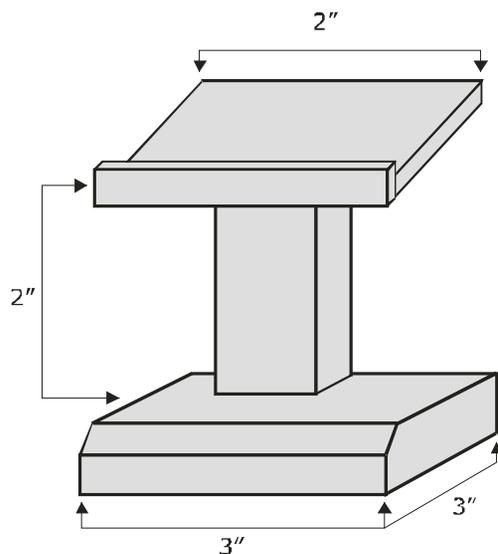
- Before check in, lubricate your car's rub points one last time.
- Spins the wheels for a couple of minutes.
- Remove or Add weight as needed during weigh-in.
- Transport your car in a container that has padding and a way to keep the car from rolling around.
- Keep car in box if allowed. This will prevent onlookers at the table from picking up your car.
- Keep an eye on your car to make sure that there is no one rough housing around the cars.
- Place car back in protective box in between heats.
- Be an attentive and supportive scout that will demonstrate what good sportsmanship is all about.

**WINNER'S PODIUM****CONGRATULATIONS!!**

You've made it through an intense competition, and have come away with more experience and knowledge of the Pinewood Derby.

Your race day is over, and you are probably relieved. We hope your efforts made you proud of how your car performed on Race Day. Most importantly is, whether you placed in the standings or your day was cut short by a mishap, you did your best. We know that if you followed our instructions in our FastPine Bible, you probably had to control your look of disbelief of how fast your car zipped down the track.

Well, now what do you do with your car? This piece of your history you will want to keep forever. Believe us when we say you will wish you had kept your car, because we have three generations of derby cars on display. That carved piece of pine block will represent many great things to you. We have seen people put the cars in acrylic display boxes from the hobby shops. We like to incorporate our cars into a homemade trophy. You can either make a stand for it, or you can mount the car on a plaque-type display that you can hang on your wall.



Pinewood Derby Car Stand

**KID QUIZ**

Here is a list of fun and simple fill in the blank questions to test what you have learned.

- The first Pinewood Derby was held in \_\_\_\_\_ (year).
- \_\_\_\_\_ is the force that slows your car down if your wheels rub against your car's body.
- What type of lubricant works best?
  - Oil
  - Glue
  - Teflon Powder
  - Graphite Powder
- It is a good idea to melt lead. (True) (False)
- The balance point of the car should be near the \_\_\_\_\_.
- What is the device called that holds the wheel in the drill?  
\_\_\_\_\_
- Does a heavy or light derby wheel roll faster?
- Which is **NOT** a speed technique for your axles?
  - Sand any ridges smooth.
  - File off the burrs under the axle heads.
  - Paint the axles "Speedy Red".
  - Taper the heads with a metal file.
- What are some other names for the Pinewood Derby?
- How much fun have you had learning about the Pinewood derby?

