WINNING PINEWOOD DERBY SECRETS™

PINEWOOD PRO™

Everything you need to build a winning car!

Winning Pinewood Derby Secrets

by
Joe Gargiulo

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Winning Pinewood Derby Secrets™
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WINNING PINEWOOD DERBY® SECRETS

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Dad, I'll never forget this night.
Steven Gargiulo, 1st place, District Race

ABOUT THE AUTHOR AND PINEWOOD PRO

Thank you for choosing Pinewood Pro and *Winning Pinewood Derby Secrets*, the #1 best seller for over 15 years! This book will help you and your child have fun building a cool, hot, and fast car.

Winning Pinewood Derby Secrets covers the entire project with new and critical ways to design and build your car. It also adds important finishing touches -- with special emphasis on how to make your car go even faster. While building the fastest car is the ultimate reward, you should keep in mind that Pinewood Derby is not just about winning (there can only be one 1st place winner!). It's also about having fun and spending **quality time** together with your son, daughter, or grandchild. Knowing that, is it possible for you to build a winning car? Yes indeed! Even a first-time car builder can win their race! Just read our many testimonials and product reviews on www.pinewoodpro.com.

Pinewood Derby builds memories that can last a lifetime. The experience is especially fulfilling for both parent and child if they build their Pinewood Derby car **together**. When parents take the time to teach their children how to use tools and how to do many simple things often taken for granted, the experience is especially enriching for the child – as well as the parent.

Children will always have fun, but what they will remember the most is being close to their parent and sharing valuable, quality time together. To make it fun for them, take a little extra time and let your children do as many "age appropriate" things as they can. The more they participate, the more they will remember building it years later. And the more they will feel the car is theirs. I still remember building my car with my Dad as a young, enthusiastic (and impatient) Cub Scout. My car didn't win a single race. It didn't win for best design or best paint job. It didn't win anything at all, but still, it is one of my most prized possessions. Why? **Because it's the Pinewood Derby car that I built with my Dad.**

As a Dad with my own enthusiastic (and impatient) Cub Scout, Pinewood Derby was doubly rewarding. I got to repeat the fun with my son. But unlike my Dad, I had a degree in engineering (some would say I got an engineering degree so I could figure out how to make a fast Pinewood Derby car, but that's not true!). I applied my engineering knowledge to help my son build

fast cars, while teaching him the physics principles and speed secrets that made our car fast. We won all our Pack and District races, but, before each race I always looked my son in the eye and said, "**Win or lose, we did our best and that's what counts the most.**"

As the Cub Scout motto says, ***Do Your Best***.
This book will help you do just that.

My philosophy has always been to help others, to volunteer, and to donate back to Scouting, which I have done every year since I started Pinewood Pro in 1999. I am proud to have helped so many people and to have been fortunate enough to be able to give back to the BSA and other organizations that run these races. I am a strong supporter of the Cub Scouts, Boy Scouts, Girl Scouts, Awana, YMCA, Royal Rangers, Trail Life, Pintwood® Pro Derby for adults and many others; organizations that prepare boys and girls for life in so many ways. Through scouting and my many years promoting Pinewood Derby racing, I've made many friends and am proud to be able to support these youth organizations along with many businesses, non-profits, and even the US Military, that use Pinewood Derby racing for fun, for fund raising, or as a challenging team-building event.

Happy racing and I look forward to hearing YOUR Pinewood Derby story!

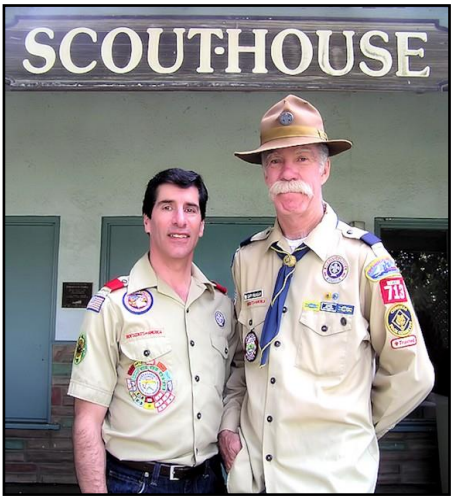
PINEWOOD DERBY HISTORY AND THE JOYS OF RACING

The first Pinewood Derby race was held at the Scout House in Manhattan Beach, CA, May 15,1953. Don Murphy, Cubmaster for Cub Scout Pack 280c, wanted to create a father-son activity with his 10-year-old son who was too young to race in the Soap Box Derby that was sweeping the country. In the Soap Box Derby, the boy sat inside a little car and raced it down a hill. Don, a creative model maker, came up with the idea of racing miniature 7" cars down a track for the younger boys that were not old enough for Soap Box Derby.

1st Pinewood Derby race, Manhattan Beach Scout House 1953

"I wanted to devise a wholesome, constructive activity that would foster a closer father-son relationship and promote craftsmanship and good sportsmanship through competition". - Don Murphy, 1953

The event was an instant hit and within 6 months, the Pinewood Derby spread over the Los Angeles area. Don, realizing that he had created something exciting and fun, wrote a complete PINEWOOD DERBY plan and submitted it to the Boy Scouts of America. Within two years BSA launched Pinewood Derby nationally and it became the premier event for Cub Scouts. You can read the entire, fascinating History of the Pinewood Derby on Pinewood Pro's website.



(left) *Pinewood Pro founder Joe Gargiulo at the Scout House where 1st Pinewood Derby race was held in 1953.*

(top right) *Joe Gargiulo with Donn Murphy, son of Pinewood Derby inventor, Don Murphy. Joe is holding his son's first car (left) and his own 1968 car. Donn is holding a replica of his car, the 1st Pinewood Derby car raced in 1953.*

(bottom right) *Joe's and Gary's 1960's Pinewood Derby cars*

Since that famous day in 1953, Pinewood Derby racing has been adopted by many youth organizations for both boys and girls. Adults have also used Pinewood Derby racing for fund raisers, by companies to build teamwork, and even the U.S. Military has held Pinewood Derby races to build morale. Outside of the Cub Scouts, Pinewood Derby is also known as the Pinewood Derby Grand Prix, Kub Kar Rally, Awana Grand Prix, Pine Car Rally and Indian Princess or Powderpuff Derby for girls, to name a few.

When I was a Cub Scout, each year I looked forward to working with my Dad to design and build a cool car. It was "our time". We always tried to figure out what would make it fast, hoping to win some races. I have vivid memories of the fun and excitement building my car with my Dad. While our car didn't win a single race, I was proud of my cool little car. But like so many other childhood toys, I lost track of my Pinewood Derby car over the years and was sure it had been discarded. Forty years later, while cleaning out my parent's house, I found that little car in the attic. It was in perfect condition. I had lost my Dad when I was only 22, so you can

understand how precious that little car is to me. I keep it on my desk so I will never lose it again. I encourage you to keep the cars you build with your child. Someday your son or daughter may come looking for it.

Pinewood Derby, along with the other Cub Scout building projects, developed my keen desire to "build things," and this desire to build (and take apart) things stayed with me as I progressed through my schooling years. When it came time to choose a college major, I chose engineering because I knew that engineers "build things." Perhaps building my Pinewood Derby lit the spark that led me to pursue engineering. So, if your child is excited about building a Pinewood Derby car, you may have a budding engineer too!

As an adult leader in our Cub Scout Pack, I managed the Pinewood Derby race for my son's Cub Scout Pack. Because we were the reigning champions year after year, I also helped other people design and build their cars. When my son advanced to Boy Scouts, I wrote **Winning Pinewood Derby Secrets** using our speed secrets. My son (now an Eagle Scout) and I still volunteer to help the local Cub Scout Packs with their Pinewood Derby races. I will never get tired of watching the faces of the boys (and parents) light up as their cars race down the track.

The rest of this book is devoted to explaining and describing in full detail the speed secrets that I have developed and the speed products that I have invented over the years. These secrets have put us in the finals every year and helped thousands of people have more fun, be more competitive and win Pack and District Championships. Please take a moment to read our Winning Stories. While no one can guarantee you will win all of your races, this book will give you secrets that have helped us, and countless others, win races.

I know you are ready to jump right in, but I recommend you read (or at least check out) the rest of this book before beginning. Then you will know how to plan your project and build your car for speed.

"Winning Pinewood Derby Secrets" *is full of great hints…it's part of the pinewood tradition. Anybody that's really interested in Pinewood Derby racing needs a copy of your book to complete their pinewood experience."*

- Donn Murphy, The First Pinewood Derby Racer 1953
and son of Pinewood Derby inventor, Don Murphy, Sr.

Step 1: Doing It Right

I'll never forget my son's first Pinewood Derby. We were ecstatic to win a ribbon by placing first (out of six) in our Cub Scout Den. Wow, we did it - a ribbon! Later that evening I thought about the three boys (out of 100) that walked off the stage with those big trophies by placing 1st, 2nd, and 3rd for speed. How did they do it? What were their secrets? As an engineer, I had to figure it out.

That first year, my son and I spent quite a few hours on our car's appearance - aerodynamic shape, cool paint job, sharp stripes, and nice decals. (A little trivia secret - that car is featured in the Pinewood Pro logo.) Steven was not old enough to paint a straight line, so I put masking tape on the car so he could paint the straight lines. All he had to do was paint the car body without regard for making straight lines. When I pulled the tape off…Voilà! Straight lines. He picked the colors, car number, and put on the decals.

We were both proud of our cool looking car. Well, looks do count-- and some clubs present awards for appearance. But the big trophies are won for ***speed***.

The following year, we had a new mission - ***speed***. I thought about the principles of physics and came up with ways that "should" give us a fighting chance for one of those trophies. In addition, I used a little engineering brainstorming and invented some "speed tricks" of my own.

The next year it was a close race. But we did it -- 1st place in the Pack! I don't know who was more thrilled, my son or me. When we came home that night after the excitement had worn off and he calmed down, my son said, "*Dad, I'll never forget this night*." It was a touching father-son moment that I'll never forget. We went on to win first place in the District Race a month later. After that, we won a trophy in every race we entered.

While winning is fun and is the ultimate goal, keep in mind that the Pinewood Derby experience is not just about winning, as there can only be one 1st place winner. **It's the parent-child bond that develops working together** for weeks to build a cool little race car you can both be proud of. I believe this with all my heart.

We were always confident going into our races: as we were the reigning champions and the team to beat. However, I never let it go to my son's head. He had to learn sportsmanship -- win or lose. Every year that we raced, I repeated the same words to him before entering the race, ***"Win or lose, we did our best. And doing your best is what counts the most."*** This book will help you do your best (and vastly improve your chances of winning!).

So, have fun, do your best, and enjoy the ride!

Safety First

When building your Pinewood Derby, always remember rule number one: ***Safety first.***

"Safety first" means children should not use power tools unless under adult supervision.

It means everyone should wear gloves to protect against splinters or sharp tools, goggles to protect your eyes and a breathing mask when sanding to avoid inhaling sawdust.

Be sure to clamp your block down when sawing, drilling or sanding to prevent the block from slipping while you are working on it.

When clamping your block, you may want to put a piece of cardboard or scrap wood on the clamp so it doesn't dig into the block.

Weights are essential because your car moves down the track from the force of gravity. I mention weights under Safety

because lead is a dense material and can be used for weighting your car. However, lead is poisonous. DO NOT handle lead with bare hands and DO NOT melt lead! Instead of lead, I recommend using zinc or tungsten weights.

Weights come in various shapes and size. To get the exact weight you need, zinc can be broken off with pliers. New composite weights can be cut with a scissors! The picture shows just some of the various zinc and tungsten weights available.

Weighted race car driver

Tungsten is a very good choice because it is twice as dense as lead so it can fit into smaller places, plus it is also non-toxic. But tungsten is expensive! Tungsten comes in 3/8" cylinders or cubes (1/2oz each) and smaller BB's and putty for small incremental weight adjustments. We cover weights thoroughly in the section titled, *Weight Secrets to Maximize Speed*.

PLAYING BY THE RULES

As in any competitive event, there are many rules. It is critical to read your rules thoroughly and abide by them. Each Pinewood Derby race may have slightly different rules, that are set by the local race committee. Typical rules include limitations on maximum weight, car dimensions, use of washers or bearings, and wheel modifications. Failure to follow the rules could result in your car requiring last minute adjustments or even being disqualified. Some race managers interpret rules loosely and others are very specific. So read them carefully and follow them. If you have questions, ask your race manager!

HAVE FUN

Third ground rule: Have fun! The Pinewood Derby is a great project for a parent and child. So, take your time and enjoy the "togetherness" time.

Building a Pinewood Derby car can teach a child many life-long lessons. For example, such as how to plan a project (hint: start early), teamwork, sportsmanship, commitment to completing a challenging job, and having fun even when things are not going so well. You get to teach and set a good example so the lessons from this small project will help them throughout life.

Building the car also gives the child a chance to develop creativity, for example, by thinking up different car designs, color schemes, a car name and finishing touches for decorating the car.

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SHARE THE JOY

If you are working with your son or daughter, let them do as much age-appropriate work on the car as possible. The more they do, the more they will feel it is their own and the more satisfaction they will get out of the experience.

Even when my son was seven years old, he picked the car design he wanted, and did all the painting decorating and sanding. Since he was too young to use a saw on his own, I asked him to place his hands over mine while I used the handsaw to cut the block. Then he could get the feel of using the saw and cutting out his own car.

Every year he would do more and more. In his last year, he was able to build the entire car by himself. Dad only did the intricate axle modifications that required using a power drill (more on that later).

Your Pinewood Derby experience also teaches parents to be patient with their child (mine has ADD, so paying attention is a constant challenge for him.) Likewise, your child will have learned to be patient with their parent. It is truly a bonding experience.

And after the race, be sure your child keeps the car in a safe place. He, or she, may ask for it 20 years from now!!

How to Save Time and Help You Win

I have tried **to be clear and concise** while including the most up-to-date speed secrets and products. You don't need a 100-page book to build a winning Pinewood Derby car! The following describes some of my objectives:

- To be Fun, Clear and Concise
- A list of Winning Speed Secrets to make your car the fastest it can be
- Tips to save time
- Mistakes to avoid
- Focus on having fun
- First highlight what you need to do, then explain the physics.

Other notes:

- Web Links – For your convenience, I have embedded links throughout this book to take you directly to the www.PinewoodPro.com website. There you can find additional information on a tool or product and have the convenience of immediately ordering what you need. You may already have appropriate tools and supplies at home -- or perhaps you can borrow them. But if you don't want to spend time searching or driving around to hardware stores, we offer everything you need from speed products to paints and decals.

- If there is something we have missed or you have comments about this book, please email proteam@pinewoodpro.com so we can improve the book and you can help others.

Icons:

One finger up draws your attention to a car building **tip, hint** or additional information

Crossed fingers means, simply, "**do not do this**".

Palm up is the "stop" symbol. It represents a clear **warning**.

The Scout Sign indicates a **smart thing to do**.

The racing car indicates an important speed tip**.**

Step 2: Making it Cool

Designing your car

Every good project starts off with an idea, a goal and a plan to reach that goal. Your goal is to make a cool, fast car and have a good time doing it! The first step is to have fun brainstorming ideas about what your car should look like.

Kids usually have some idea about what they want, even if it is a simple idea, like "I want my car to have flames or stripes or tailpipes." Or "I want a NASCAR" or "I want mine to be a piece of cheese." One year my son wanted "grooves on the sides." Another year he wanted a "bubble on top." I always worked with him to add whatever design he wanted to his car. Letting the child come up with the car design and colors he or she wants is what gives them "ownership" of the car.

To help you get started with your car design, I have written a short car design idea guide and put it on our website for reference.

You can find **over 100 car design ideas** by visiting Pinewood Derby Car Design Guide.[1].

Many people who struggle getting started or are looking for car ideas, have found our Car Design Guide helpful.

If you have a website or, facebook please **LIKE** Pinewood Pro, or add a link to our website: https://www.pinewoodpro.com
to share with friends.

Many people who struggle getting started or are looking for new ideas have found our **Car Design Guide** helpful, so we encourage you to share it with friends.

To get started designing your car, write down ALL the car design ideas you or your child come up with on a piece of paper. Then make rough sketches

[1] https://www.pinewoodpro.com/pinewood-derby-howto-design.htm

showing the car from the side and top to get a better idea of how that design will actually look. This is fun and takes very little time.

Once you have decided on the overall look, it's time to consider how practical it will be to build your car. Each person has different skills, different tools, and different amounts of time to work on it. So, consider the amount of detailed woodworking that may be required to make the car you envision. Some people might enjoy the challenge of cutting and shaping that rectangular block of wood into a cool-looking car. Others may dread it from the first cut! If you are "tool challenged, erase some of the intricate details in your car design or round off some edges to simplify the design.

Time Saver Hints

The more you (and your child) do, the more they will get out of the project, but if you don't have the time, tools or skills, here are some time-savers.

1. The simplest car design is called the wedge car. It takes only one cut! Just cut the block from the top edge to the opposite bottom edge so the car is shaped like a wedge of cheese or an axe blade.
2. Consider purchasing a pre-cut car if you don't want to spend time cutting and shaping.
3. Consider purchasing a car design plan that shows how to cut and shape your car step-by-step.

On the following page see a few of our more popular car designs… the Batmobile, the red Drag racer, a camouflaged Army Tank, an Army Humvee, a NASCAR, a BSA Cub Scout Wolf or Tiger car, the Inferno, Police Car, The Flash and a Skateboard car. visit our car designs webpage to see over 30 car designs[2] .

Each design plan includes cut-out templates and 3D images of each cut so you can't make a mistake. We show you the weight placement, car finishing touches and full 3D images of the finished car with five different painting schemes. These are the only plans on the market that feature 3D AutoCAD images. We even show you an animation of the finished car rotating 360 degrees so you can see it from all angles.

[2] www.pinewoodpro.com/pinewood-derby-car-design-plans-with-templates.html

A Sample of over 30 Pinewood Pro Car Design Plans

If you are a beginner or don't have much time, you might consider purchasing a pre-cut Pinewood Derby car body…you only need to paint and decorate it. These cars include the NASCAR, Corvette, Mustang, Firebird, Sport Coupe, Street Rod, Stock Car, Cheetah, and many more.

Pre-cut cars come in a variety of styles, such as the NASCAR, Corvette, Mustang, Firebird, Sport Coupe, Street Rod, Stock Car, Cheetah, Viper, and Cobra to name a few. Most of these cars also have pre-drilled weight holes to save you time.

If you don't want to sand, paint and install weights, or don't have the time, consider a **pre-cut and pre-weighted** car like the Grey Ghost or Surfboard cars.

Based on your skills and the car design you choose, the following chart will guide you to the appropriate place to build your car.

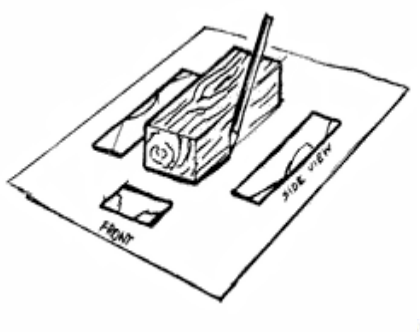
You	Your Options	How it helps you
Skilled or have lots of time	Dream it up, read this book and get busy!	You are a do-it-yourselfer
Some skills, reasonable amount of time	Design your car, or consider downloading a car design plan	Car plans show you how to cut out the car step-by-step, includes template patterns and painting schemas
"tools challenged" or no time	Consider purchasing a pre-cut car	Just needs light sanding and you're ready for paint!
Pinewood Derby for Dummies!	Complete Car Kit or fully built car	Pre-cut car kit with decorative parts, decals, paint and weights

Design Hints:

- A car with a pointed needle-like front will not rest against the starting pin and it may not trip the sensor immediately at the finish line.
- Be sure the design clearly distinguishes which end is the front and which is the back! I've seen cars placed at the starting gate backwards because the car handlers couldn't tell the front from the back!

Don't use a so called, "cheater bar". Your car will look ugly and most likely be disqualified, causing you to scramble to remove it before your car is allowed to check in.

Rough it Out



When you've selected a design, the next step is to make the rough-cuts. Place the pine block on a sheet of paper and trace it. This is the top view. Next, place the block on its side and trace it again. This shows the side view of the car. Last, trace the front and back.

Now that you have the outline of the block on a piece of paper, you can draw the outline of your car on paper. This will allow you to visualize what the car will look like when it is cut. These are the rough-cut lines.

Now that you have the rough-cut lines drawn, use scissors to cut out the design and use it as a template. Place the template on the car block and then draw the cut lines on the block.

Use a T-square or ruler to help draw lines that are perfectly straight or perfect 90 degree lines.

It is safer and easier to cut the block if it is secured in a vice or adjustable workbench**.**

For safety reasons, these cuts should be made by an adult. If your child is old enough to handle a saw, be sure it is always under adult supervision.

Block secured with clamp

The best saw for Pinewood Derby cars is the coping saw (pictured) because the thin blade can easily turn to make intricate cuts. In addition, it is easy for a child to handle and is safer than a bigger saw because it cuts slower. For longer straight cuts, use a fine-toothed wood saw.

Coping Saw

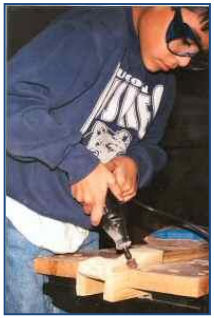
Midway There

Unless you are a master woodworker, you will inevitably have some intermediate smoothing to do after the rough cuts.

You can use several different tools for the intermediate work. Once again, a coping saw works well to make curved cuts and to cut off sharp edges.

A wood rasp is your best tool for shaping and rounding sharp edges.

Wood rasp



A dremel tool is an excellent way to introduce a youngster to using power tools. This versatile tool comes with many attachments, making it ideal for shaping, sanding as well as precision detailing.

Hint: Be sure to set the dremel to the slowest speed because it takes material off very fast!

Using a dremel rotary tool with the car secured in a work bench

Do as much smoothing as you can with the intermediate tools because your next step requires hand sanding. Inevitably, you will have some nicks and gouges or even a few cutting mistakes on your beautiful car.

Wood putty [3] is the answer! Just dip your finger into the wood putty and fill in the holes. Let the wood putty dry and sand it smooth.

Remember,
"There's no mix-up,
that wood putty can't fix up"!

Fine Tuning

The final steps in woodworking are to sand, sand, and sand. Start with 100 grit sandpaper for rough sanding.

Hint: To make sanding easier, use a sanding block, or wrap the sandpaper around a piece of scrap wood. The sanding block will help you make smooth, straight sanding and also save your fingers!

Once you have the major gouges out, repeat sanding with a finer 220-grit sandpaper to create a smooth surface for painting. Fill in any small holes or scratches with wood putty. Perfectionists, looking for that showroom look, can go over the car with 400-grit paper to get a perfectly smooth surface.

[3] https://www.pinewoodpro.com/pinewood-derby-car-building-supplies.htm

MORE CONSTRUCTION TIPS

Check for Roundness

Check your wheels for roundness before you attach them by rolling them, one at a time, on a table top. They should roll straight and smooth with little or no wobble. If a wheel veers or wobbles, it should be replaced or trimmed. You can consider using a mandrel tool which is used to secure your wheel in a drill to sand the wheel tread or consider purchasing lathed wheels that are precision trimmed on a lathe machine.

Check for Square-ness

Test your block to see if it has been cut square. I've seen MANY blocks that are not.

Place each surface of the block on a flat surface and try to rock the block. If it rocks, the block is not square. If it is not square, the block should be replaced because your car will be out of balance. Also, if the block is not square, chances are the axle holes are not square either. This makes it extremely difficult for your car to go straight.

Check for Chips and Splits

When designing, and cutting out your car, be sure to leave **at least ¼" of wood** around the axle slots so the wood doesn't split when axles are inserted.
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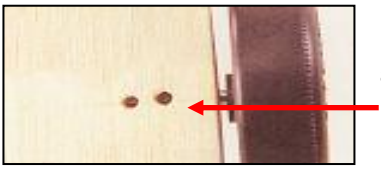
Glue - Don't get gummed up:



Very important tip!

Here is a simple trick for gluing down your axles without getting glue near your wheels.

If your axle holes are drilled (rather than having an axle slot), drill two small holes underneath the block -- in line with the axle hole and about ½" from the edge of the block. When your car is completed and the axles are inserted with the correct wheel spacing, lock them down with one or two drops of glue in each hole…safely away from your wheels.

PRO Wheel Spacer Tool

The PRO Wheel Spacer is a "feeler gauge" with the exact thickness for the spacing you need between your wheels and car body. Wheel spacing is an easily overlooked, yet **critical adjustment**. If your wheels are too tight, they bind against the car body, acting like brakes, significantly slowing down your car. If your wheels are too loose, your car wobbles, causing you to lose precious speed.

To use the PRO Wheel Spacer insert the open end over your axle and against the car body. Then push the axles in until they are snug against the Spacer. Pull the Spacer out and you have perfect wheel spacing for optimal speed. The two circles are a perfectly spaced drill guide for drilling 3/8" weight holes, so your car weight is perfectly balanced.

PRO Axle Puller and Inserter Tool

When you are building your car, you will most likely have to insert and remove your axles/wheels more than once. Quite often, the axles are very tight in the block and difficult -- or nearly impossible -- to insert and remove by hand without hurting your fingers or damaging your axles or wheels.

Pinewood Pro's specialty tool called an PRO Axle Puller and Inserter Tool is perhaps the most useful tool for Pinewood Derby racers.

The Axle Puller and Inserter Tool is two tools in one. The U-shaped end is inserted under the axle head to easily remove the axle without damaging your wheels or axles. The other end, near the handle, has a cavity that fits the axle head perfectly for pushing your axles in (without hurting your fingers!)

Axle Puller end

Axle Inserter end

If you have BSA Ultra-Lite wheels, the Axle Puller is essential because these wheels are thin and can break easily.

Step 3: Making It Sharp

Prep

Now that you have completed the woodwork, it's time to make your car look cool. Before you paint a fancy design on your car, you should paint the bare wood with a sanding sealer. Pine wood is very soft and porous. Sanding Sealer, as the name implies, prevents the wood from soaking up your finish coat, giving you a smooth base for your finish coat. If you apply paint to the raw wood without sealing the wood first, the paint will seep deep into the wood, producing a rough, faded finish.

After the sanding sealer dries, use high-grit 400 sandpaper to sand off small bumps. If you want a deep shine, put on multiple coats of. Lightly sand between each coat to get a showroom, polished look.

Painting and Detailing

No matter what your child's age, they can choose the colors and paint with very little help. My son came up with some very "interesting" and flashy color schemes for his car that I wouldn't dream of, but I left it entirely up to him. Once again, this gave him further ownership of his car, and will give your son or daughter the same.

Let your child think up a name for their car. My son named his cars after his color scheme. For example, Blue Avenger, Golden Retriever, Silver Bullet, and Neon Demon

To complete the detailing, add decals and numbers. Here again, this is something a child of any age can do. Kids love to decorate their car with decals, stripes, flames, or a symbol of their own, like a red lightning bolt, nuke symbol, or biohazard sign.

Finishing Touches

After the decals are on but before inserting the wheels, it is a good idea to spray the car with a clear lacquer sealer. This will protect your fancy paint job from scratches and from graphite sticking to the paint.

Ownership: Have your child go into their toy chest and pull out what they think is an interesting hood ornament like a helmeted driver, a lizard, airplane parts, etc. Small parts will not affect speed and, once again, it personalizes the car and makes is fun for the child.

The last step is to insert the axles and wheels, but first you must read the speed secrets below. When the car block is completed, you should begin implementing these speed tricks. The speed tricks, especially the PRO Winning Secrets will, set your car apart and send you to the winner's circle.

Step 4: Making it *Fast*

The secrets disclosed in this section will separate you from the pack. It has taken me years to learn, research, and test these techniques and products. Since, I take my research very seriously, I can guarantee your car will go faster with these modifications.

The underlying secret to most speed improvements is to reduce friction and maximize potential energy. You've probably heard the saying, "*Friction is the enemy of speed."* Friction occurs when two surfaces rub against each other -- slowing down your car. The objective is to identify every source of friction, and then to minimize or eliminate each one (yes, they can be eliminated!).

I consider the speed tricks in the following sections to be the bare essentials. Some of them may surprise you, but almost everyone who has built two or more cars will have learned these tricks from other racers or found them on the internet. **The modifications in these sections are a must.**

The last Speed Secrets Section, **PRO Winning Secrets*…will get you to the finals.*** They are the race winners, and will separate you from the Pack.

Speed Secrets for a Fast Car Design

Aerodynamics Myth

Certainly, an aerodynamic shape reduces air resistance, which is a source of friction. However, I view aerodynamics of the Pinewood Derby car almost on the same level as choosing a fast color! It sounds good, but pinewood cars are not going fast enough nor long enough for wind resistance to play much of a role. Many, many more sources of friction have a far greater impact on speed than aerodynamics.

Let your son or daughter have fun coming up with their own unique car design. It is far more important that the child select the car design and feel good about it, than attempt to find an optimal aerodynamic design.

Besides, if we were to attempt to find this "optimum" aerodynamic design or the "ultimate car," each car would look exactly the same! That would take all the fun and creativity out of Pinewood Derby. So, have fun designing your car, and don't get hung up on aerodynamics. That is the ***least*** important part of making a fast car.

Just Like Baking Bread

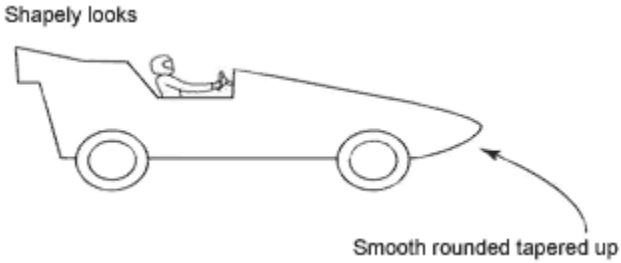
Pine is a light, very porous wood. Therefore, it actually holds water inside! Why is this a concern? Because the heavier your block of wood, the more weight that will have to be distributed throughout the car. You want the weight of your car to be accurately placed for optimal speed (more on weighting your car later). So, to remove this excess water, you can bake the block to evaporate out the water.

To bake out the water, pre-heat your oven to about 200 degrees. Then place the car on a sheet of tin foil inside the oven, **furthest away from the heating elements**. Leave it there for about an hour, turning it over every 10 minutes or so. When you turn it over, look at it carefully to be sure it is not too hot and your block is not turning brown!

Caution! This should only be done by an adult. Be sure the block is far from the heating elements. Remove the block with a pot holder or baking glove because it will be hot when it is "done".

Shapely Looks

Be sure the **front of the car is tapered** so it comes off the starting gate smoothly. Your car could actually come off the starting gate slightly slower than the other cars if it is not smooth and rounded.



Steer Straight! PRO Driller – Bent Axles

Making your car roll straight is one of the most important and perhaps the most difficult task to accomplish. So test your car to see if it rolls straight. Most kitchen floors or hardwood floors have straight lines that you can use to check if your car is rolling straight. Line the car up on a floor that has a straight line on it. You can also put something under two legs of a table so the table is angled up slightly on one side so the car rolls down.

Give your car a very slight nudge and **it should roll nearly perfectly straight for 6 to 10 feet**. If it veers to the left or right, the car will hit the track guide rail before it reaches the bottom. This will have a braking effect and cause the car to lose valuable speed. If you have this problem, you need to adjust one, or both, of the front axles to the left or right to make it go straight. Just as you would when driving a car or bicycle.

This task can be tricky. Fortunately, there are several options at your disposal. Here are your options listed from easiest to most difficult;

Drill Press

If you have a drill press, or know someone with one, you can **re-drill the axle holes**. The drill press will drill perfectly straight axle holes that are square to the block. Then your car will roll straight.

Precision Drilled Block

Purchase our **precision drilled block** that has all axle holes drilled on a drill press. It also has several other speed advantages. It includes an optional hole for raising a front wheel to reduce friction (more on that later), and also an extra set of holes in the rear for extending the wheel base which gives your car greater stability.

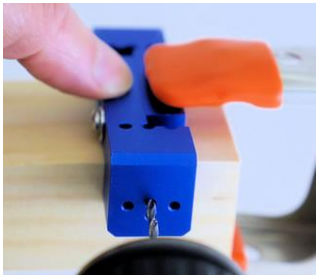
PRO Driller – straight and 2.5 degree axle holes

The new **PRO Driller** is our patented mini-drill jig that helps you make your car faster in five ways:

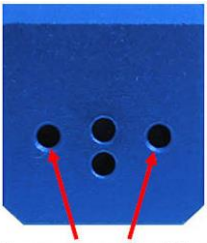
1. Drill **perfectly straight axle holes** so your car steers straight. You can drill the axle slots or drill new axle holes so your axles are tight.
2. Drill a **raised wheel hole** to make a 3-wheeler car. Cars that run on three wheels are faster because it takes less energy to run on three wheels.
3. Drill new axle holes to make an **extended wheelbase** car for more stability. Stable cars are faster.
4. Drill **2.5 degree angled axle holes** to cant your axles so your wheels tend to migrate towards the axle head where there is less friction than if the wheel rubs against the car body. Less friction = more speed!
5. Use all of the above techniques to create a **rail rider car**. (See our *PRO Secret: Riding the Rail*)

The PRO Driller is easy to use and includes a perfectly sized #43 drill bit so you can insert your axles easily with the push of your finger. Lastly, the PRO Driller is adjustable for a tight fit on any pinewood derby car block.

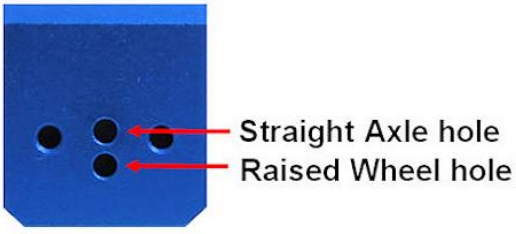
PRO Driller with drill bit



Using PRO Driller



2.5 degree angled holes.
Cant axles to reduce friction!



Pre-bent axles

Consider getting a pre-bent axle to adjust your car steering with a 1.5 Degree bent Axle or a 2.5 Degree Bent Axle. This will cant your rear axles so they ride away from the car block toward the axle head where there is less friction. Simply replace your axle with a pre-bent axle and use a screwdriver to adjust the axle left or right.

Pre-Bent Axle with screw driver slot in the head

HINT: This will need to be done by trial and error. Only rotate the axle a few degrees one way or the other. Roll the car on an incline (or gently push it) to see which way it is steering. Turn the axle again very slightly if you need to adjust the steering. Once you have the car steering exactly the way you want, put a drop or two of glue **at the tip of the axle** to hold it in place.

How to Bend Your Axles

1. You can bend the axles yourself. But it will require some patience. With the axle in the car, draw a small vertical line with a fine point marker on the axle head -- from the top to half-way down the head. The line should go only half way down so you can re-insert the axle in the exact same position.
2. Gently remove the wheel and axle by putting a flat blade screwdriver under the wheel and prying. It should come out easily.
3. Secure the bottom half of the axle in a vice so the head is sticking out. Be careful to only secure the lowest part closest to the point so you do not scratch the axle near the head!
4. Put a piece of tape on the tip of a flat blade screw driver, so you don't scratch the axle in the next step.
5. Rest the flat head screwdriver against the top of the axle head, and GENTLY tap the screw driver with a hammer to bend the axle ever so slightly in the direction you want to steer your car. That is, if your car is steering to the right, bend the axle to the left.
6. You may have to repeat this process a few times to get your car rolling straight, but it is important and well worth your time.

Shim the Axle

Yet another trick is to make the axle slot a little wider and then **insert small pieces of shim wood** (or other material) to angle the axle right or left to get your car steering straight. This takes patience and even more "trial and

error," but eventually you can get your car to roll straight. Once you do, glue the axles in place so they can't move

Don't Get the Point

Be sure the **front of the car is not shaped to a sharp, needle point.** It may also not position well at the starting pin. It also may not trip the photo sensor immediately at the finishing gate if your track is equipped with an electronic gate timer.

Beware of the Paper Tiger!

Instead of painting your car, you can cover it with stick-on paper (also called a body skin) that comes in assorted designs, such as "fire and flames", tiger skins, alligator, military camouflage, etc. I've seen some awesome looking cars with body skins…BUT BEWARE! You must **be sure the paper does not cover the car where the wheel makes contact with the block**. This will act as a brake and significantly reduce speed.

Be sure to cut out the skin where the wheel comes in contact with the car block.

Don't Fly Into the Wind

Don't mount flying flags, streamers, or banners on your car. While they may look cool, they will act like a parachute and slow down your car.

Speed Secrets for Fastest Wheels

The wheels that come with the BSA kit are mass produced by the millions. As a result, they have many imperfections: like a mold mark that leaves a bump on the outside tread, non-concentric tread circumference and axel bore, "mold flash" that is extra plastic in various parts of the wheel, and other differences that can make your wheels unbalanced. To compound the problem, each wheel is slightly different. The net result is increased friction, thus making your car run s-l-o-w-e-r.

Below are some things you can do to correct most of these problems yourself. You also should consider "lathed" wheels where all such imperfections have been removed

Nobody's Perfect

Your wheels are created in plastic molds that leave imperfections on the wheel. BSA wheels could have defects on the tread, and Awana wheels have a similar defect from the mold-framing that leaves "flash" on the outer tread.

If you roll the wheel on a flat surface, you can see if it rolls straight or jumps.

You can use a nifty little device called a mandrel that secures your wheel and allows you to chuck it in a drill.

The mandrel secures the wheel in a drill bit so you can spin the wheel with your drill. You then gently touch 600-grit (or higher) sandpaper to the wheel while it's spinning to remove the mold mark. This allows you to sand uniformly. ***It is a delicate operation, so only do it if you are comfortable with power tools.***

Another problem with BSA wheels is that the hub is coned to a point…this is "too much of a good thing." It results in wheel wobble when the wheel hits the car body (see below). Our BSA Speed Wheels and Ultra-Ultra Lite wheels are precision lathed to square the hub. Plus, the outside tread, inside tread, and hub stem are trued, thus reducing wheel weight to give a faster start and precision balance as it rolls down the track

Hub Rub – The Hub

The wheel hub contains imperfections that will slow your car down when the wheel rubs against the car body.

The left wheel in the picture shows an unmodified BSA wheel. The right wheel is our BSA Lathed Speed Wheel. It may be hard to see in these pictures. But notice that the left wheel

hub is rounded, which will cause wobble when the wheel makes contact with the car. The Ultra Lite wheel on the right is squared so it has a flat surface to eliminate wobble when the wheel makes contact with the car body.

Pinewood Pro BSA Lathed Speed Wheels have been turned on a lathe so they are "trued" to make them perfectly concentric. The hubs are squared, as shown above. They weigh slightly less and have 5 other speed improvements to create a perfectly balanced wheel for optimal performance.

The Perfect Match

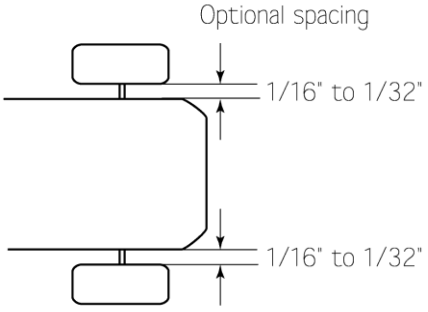
BSA wheels have a little number on the inside. This number represents the mold cavity where the plastic was poured to make the wheel. If you use wheels from the same mold, then each wheel will have the same exact characteristics, theoretically helping with stability. I must caution you that the advantages of using simply mold matched wheels is only marginal and I've never seen any controlled and statistically valid experiments that prove how much speed advantage there is from simply matching wheels of the same mold.

There is an additional problem of finding wheels with all the same mold numbers. You could buy replacement wheels, but would need dozens of wheels to find four from the same mold.

The only true way to get perfectly matched wheels is to purchase a set of wheels that have been lathed so they are all exactly the same.

Optimal Spacing

The distance between the wheel and the car is critical. If the wheel is too close, it will rub against the car and grind like a brake. If the wheel is too far out, it will cause the car to wobble back and forth as the car goes down the track. You do not want either of these situations!



Wheel spacing from the car should be 1/16" to 1/32" from the car body. This is the optimum distance to minimize rubbing if the wheel gets too close to the car, as well as to minimize wheel wobble.

Another easy way to get proper wheels spacing is to place a paper match (from a book of matches) against the car body. Next, push the axle and wheel into the car until it is snug against the matchstick; and then to pull the match stick out. It is not as precise as our Wheel Spacer feeler-gauge, but it works in a pinch.

Wheel and Axle Alignment

To help with wheel spacing and alignments, consider our Pinewood Derby Wheel and Axle Alignment Guide that provides you with six possible adjustments. The thickness of the plastic on this guide is designed to give you perfect wheel clearance. This is an excellent way to get perfect wheel spacing. It is as easy as first slipping the guide between your car body and wheel. Next, inserting your axle/wheel into the car until it is snug, and then removing the guide.

Below are the other checks you can make with this handy tool:

- Wheel Clearance
- Axle alignment
- Camber
- Toe in, toe out check
- Track clearance
- Length and Width dimensions

Pack Light

You may be allowed to change the wheel design. (Check your rules because most race rules do not allow this!). **Lightly sand off as much of the wheel as possible** to lighten it. For example, you could sand off the lettering

around the outside edge of the wheel that rides on the track, and even sand a groove in the wheel to reduce the amount of wheel that touches the track.

Reducing weight reduces the energy (wheel inertia) needed to start the wheel turning at the starting gate and allows it to turn easier (i.e., faster) as it goes down the track. Remember - when it comes to wheel travel…pack light!

Speed Secrets for the Fastest Axles

The BSA car kit comes with four "axles" that are, unfortunately, not axles at all – they are nails…very rough-cut ones at that! If we consider that the biggest source of friction in your car is the wheel rubbing on the axle as it races down the track, then you must fix the many flaws in these nails if your car is going to make it to the bottom of the track. Follow the steps below to turn these rough-cut nails into flawless, shiny axles.

BSA nails have many flaws!

Crookeder Than a Dog's Back

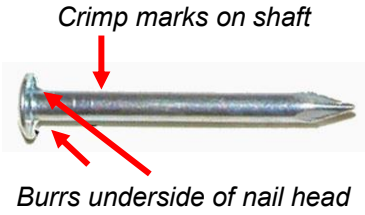
A major problem is that some of the nails are crooked. This will severely decrease your car speed. To check if it is straight, chuck the nail in your drill and spin it. Watch the nail head as it spins. You can easily see which nails are spinning straight and which are wobbling.

If the nail is wobbling, you have two options.

1. Get replacement axles and pick the straightest ones using the above spin technique.
2. Purchase axles that are already straight, such as our BSA Speed Axles or one of our machined PRO Speed Axles.

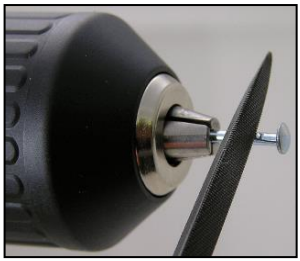
Two Black Eyes

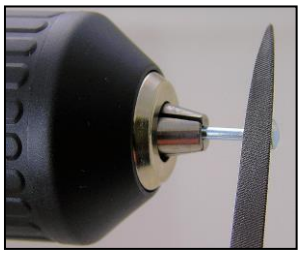
BSA axles have glaring flaws -- like two black eyes they stare at you. These must be fixed if your car is to make it to the bottom of the track. One is crimp marks on the nail shaft and the other is burrs on the underside of the nail head. They are caused when the nail is "stamped out" from the nail machine. **These flaws are in all of the nails and must be removed.**



To remove the crimp marks and burrs, follow these steps:

1. Secure your drill in a workbench or padded vice, being careful not to damage your drill case when you secure it. Be sure the drill cannot move or slip, but don't make it too tight or you will damage the case!
2. Chuck the nail in the drill with the head sticking out, as shown.





3. Turn on the drill.
4. As the nail spins, gently touch a small file to the crimp marks for a few seconds to file them off. You can find the perfect "square file" for this operation here[4].
5. Next apply the file to the underside of the nail head until the two burrs are filed off smoothly.
6. Stop the drill and examine the nails with a magnifying glass. If the crimp marks and burrs are not fully removed, repeat until they are totally removed.
7. Repeat the above steps for all four nails.

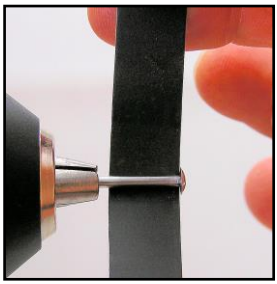
Remember, power tools should not be used by children. They can be tricky to handle and dangerous.

If you don't have a drill or don't want to use a drill for these steps, you can secure the tip of the nail in a vise and gently file the seam away until it is smooth. It is safer for children to file the axle if it is secured in a vice, but do not let them use a drill.

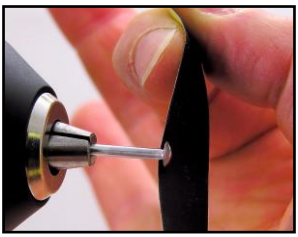
[4] https://www.pinewoodpro.com/pinewood-derby-car-speed-supplies.htm

Polish Makes Perfect

After the burrs and crimp marks are removed from the nails, the next step is to polish them to a mirror-like finish. Place the nail in your drill to spin it and perform the following steps:



1. Cut a ½" strip of 400 grit wet-dry sandpaper and apply it to the shaft and underside of the nail head. This will remove the rough marks from the file that you used in the step above. Stop the drill and examine the axle under a magnifying glass. Repeat until the big scratches are gone.
2. Next cut a strip of 800 grit wet-dry sandpaper. Dip it in water and once again sand the shaft and underside of the nail head.



3. You can repeat step 2 with an even finer grade of sandpaper, like 1200 or 2000 but you quickly get to the point of diminishing returns. You can also use 0000 steel wool, which is good for getting under the axle head. Your "nails" should now be highly polished "axles" with no visible imperfections when you look at them with a magnifying glass. If you still see imperfections, repeat this step until they are gone.

4. The last step will add a mirror shine to your axles. For this step I like to use a sheet of anti-static cloth like the one you use in your dryer. It is both slightly abrasive and sturdy. Apply a metal polish, like Rottenstone, pumice or brass polish, to the cloth. Then apply the cloth to the axle as it spins in your drill, and be sure to pull it against the axle head. You can do this for several minutes at a time to polish the axle. You will see the cloth turn black as it polishes the axle. Once again, stop the drill, wipe the axle clean and examine it with a magnifying glass. Repeat this polishing step until your axle is polished to a mirror-like finish.

If you prefer, you can purchase an Axle Polishing Kit. This includes pumice (powdered, crushed rock) that you mix with water to create an abrasive polish. It is easy to use and will give your axles a mirror finish. It also includes 400 grit wet-dry sandpaper, spare axles, and instructions.

Turned and Polished BSA Axles

If you don't want to modify your own axles, you can get them from Pinewood Pro already modified.

Our BSA Speed Axles have been hand selected so they are straight. We have then turned them on a lathe to remove the burrs and crimp marks; we then taper the underside of the head to reduce friction further. Lastly, they are polished.

Polished BSA Axle

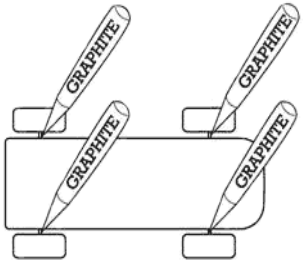
Lube Secrets to Maximize Speed

Slick Lubrication

Wherever two surfaces rub, there is friction. *Friction is the enemy of speed.* Identify every source of friction and lubricate these surfaces with graphite to make your car faster. The biggest source of friction is where the wheel spins on the axle. Apply graphite to your axles near the head and entire shaft.

The best graphite is a mixture of powdered graphite together with something called molybdenum disulfide, or "moly" for short. The moly has properties that adhere to metal, whereas pure graphite will slide off after every race down the track. Pinewood Pro's PRO Graphite is a custom-blended dry ultra-fine graphite with sub-micron molybdenum disulfide is the ultimate graphite lubricant for Pinewood Derby racing.

Warning! Graphite is very messy and difficult to remove. When adding graphite, do it in a safe area away from food and good furniture. If possible, do it outside.



Apply graphite where the axles pass through your the wheel bore, especially closest to the car and around the head of the axle. This will allow the graphite work into the wheel bore and axle from both sides. Put your car on its side and squeeze the puffer tube with a pointed tip so you can squirt graphite into the wheel bore. Add more graphite and repeat for 5-10 minutes.

Pinewood Pro **Track Tests** showed that **adding graphite is the single most important thing you can do to increase your car speed.**

A Slicker (and cleaner) Lubricant

If your rules allow oils, NyOil II is a thin-film oil that works extremely well. NyOil's advantage is that it stays on your axles throughout all your races. **BUT use** only one or two drops per axle to create an even, thin coat to the shaft and nail head. Wipe off excess oil. When it comes to NyOil, remember, "Less is more!" **DO NOT use NyOil on graphite-coated axles**.

BAD Lubes – Don't Do This!

White Teflon powder – not only doesn't work, it is a BAD lubricant. I've tested it and it simply doesn't work well at all…don't use it.

Graphite Packing – don't mix alcohol with graphite and "pack" the wheel bore. It may sound like a good idea, but the graphite just crumbles the first time down the track and spills graphite all over the track.

Graphite Pads – Again, I've tried them, and they actually slow your car, especially after a few runs when the graphite wears down to the pads causing more friction than if you didn't have these pads.

Weight Secrets to Maximize Speed

The Skinny on Weight: Newton's First Law of Motion

Be absolutely sure to add enough weight to your car to bring it up to the **maximum amount of weight allowed,** usually 5 oz. The following describes the physics behind this.

Your car moves down the track from the force of gravity, but contrary to popular belief, adding extra weight does not increase the **speed** that the car goes down the track. All objects, regardless of their weight, fall at the same rate of speed in a frictionless environment. So why add weight? Weight is added to increase the property of inertia[5] of the car.

What is inertia? Inertia is a property by which an object resists change of motion. Consider that the heavier the object, the harder it is to make it speed up or slow down. Let's take the example of a light object, like a house fly, traveling at 20 mph versus a freight train traveling 20 mph. It is much easier to stop the house fly than to stop the freight train, even though they are traveling at the same speed. This is because the freight train has more inertia.

In terms of your Pinewood Derby car, a heavier car will maintain its rate of speed through the flat part of the track more than a lighter car, thereby passing the lighter car when it runs out of inertia.

Weight – Don't Wait! (How to Weight Your Car)

As the race manager for countless races, our biggest bottleneck before race time was people scrambling to add or remove weight because their car was either too light or too heavy. Try to weigh your car before going to the race. The scale should be accurate to .1 oz. If you don't have a small scale, ask friends if

[5] Newton's First Law of Motion states: "An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force." This tendency of an object to resist change in their state of motion is described as inertia.

they have a postal scale or a food scale you can borrow.

If you don't know anyone with a scale, you can always go to the post office to weigh your car on a postal scale.

Put your car, wheels, and axles on the scale. Next, add the weights that you plan to use to the scale. Your car, wheels, axles, and weights should weigh 4.9 oz, not 5.0 oz. You must underweight by .1oz to allow for scale differences/tolerances with the official scale that will be used at the race.

Next, drill a few small holes on the bottom of your car near the rear axle. These holes will be used for incremental weight adjustments when your car is weighed on the official scale at check in. Add Tungsten BB's, Tungsten Putty, or stick-on Flex Weights to the bottom of your car so it weighs exactly 5.0 oz. When your car is weighed at check in, you can easily remove these small weights if it is over 5.0 oz or add additional weight if it is under. Remember, you want your car to weigh exactly 5.0 oz on the official scale.

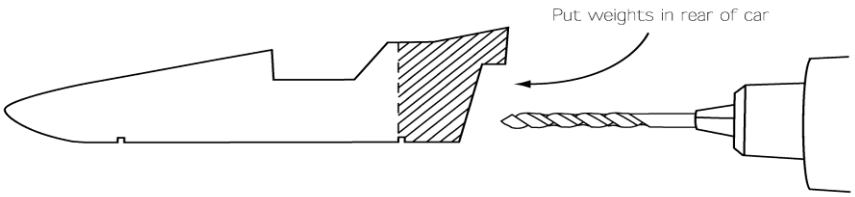
If you are in a pinch and not concerned about looks, you can use pennies or dimes to add small amounts of weight at the last minute.

You may want to consider buying a scale or share the cost with other Scouts. With your own scale, you can make precise weight adjustments at home rather than at the frenzy of check in.

Weight Placement: part 1 – Center of Mass

Weights should be centered in your car and placed as far to the rear as possible so that the Center of Mass (or balancing point), is **1" to 1 ¼" in front of the rear axle**.

To determine the Center of Mass, hold your index finger out (or use a pencil) and place your car on it. (Do this over a desk so you don't drop your car on the floor!) The car should balance about 1" in front of the rear axle. To achieve this balancing point, you need to put weights in the back of the car.



Weights should be placed in the rear so that the car will get an extra three-quarters of a car-length of momentum at the bottom of the track where the track levels off. Gravity is still working for rear-weighted cars, while front-weighted cars receive no more pull from gravity because the weight has stopped "falling" once the track levels level off.

If you have weights that mount to the bottom of your car, be sure there is enough clearance, so they don't rub on the track. You need a minimum of 3/8" clearance from the track to the bottom of the weights to clear the center track guide. Normally this isn't a problem, but if weights protrude and rub, it will severely reduce speed. I've seen cars that needed last minute adjustments due to weights dragging across the track.

Weight Placement: Part 2 – Getting Jiggy With It

Be sure your car doesn't have **too much** weight in the rear, or the front of the car will not be stable. It may even pop wheelies that could make it jump off the track, hit the center rail, or do a jiggy combination making it unstable. Once again, be sure the center of mass is 1 ¼" to 1 ½" in front of the rear axle.

Weight Placement: Part 3 – Hold the Line

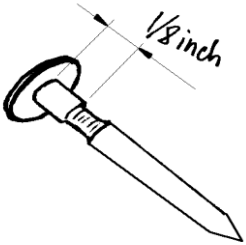
Be sure to place the weights so they are centered from the left and right sides of the car, to keep the car is balanced. If it is unbalanced, the car will lean toward one side and bang against the center rails as it goes down the track.

PRO Winning Secrets: ...to put you into the finals

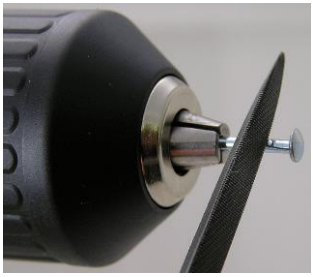
The following race-winning speed secrets will help put you in the finals. Remember: only a fraction of a second separates winners from losers. Thus, every tiny incremental speed improvement gives you a better chance of winning. Our Pack uses an electronic timer that clocks to 1/1000th of a second. Twice I've seen cars come in tied down to one thousandth of a second! One little puff would have made one of them a winner!

Some of the tricks in this section are my own inventions. You won't find them anywhere else. I designed the PRO Speed Axles and the graphite coated PRO Speed Wheels mentioned below.

PRO Secret #1: Nothing is Better

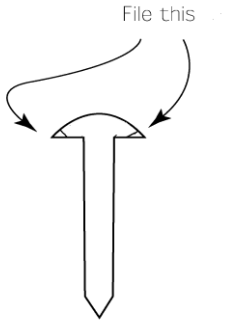


The best way to reduce and eliminate friction on the axle is to remove part of the axle! By cutting back that part of the axle you can remove the surface that rubs against the wheel as it turns. Take a file and starting about 1/8 inch from the nail head, file away about ¼ inch of the nail. This will eliminate and redistribute friction in that area. This change, combined with lubrication, reduces overall friction and will increase your car's speed. Warning! Don't file too deep as this weakens the axle. You need to go only a fraction of an inch deep.



However, this is a delicate operation that should only be done by an adult. Chuck the axle in your drill and secure the drill to your workbench. Be careful not to damage the drill case! Start the drill spinning and carefully touch the edge of a small, fine file to the axle as it spins. Once again, this may seem like a small adjustment - but every little reduction in friction will improve speed. Be sure to polish your axle after this cut is made.

PRO Secret #2: Max Head Room

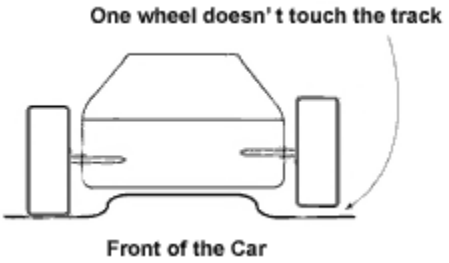


File the underside of the axle head at a slight angle (to flange it) so less of the axle touches the wheel when it rubs against the axle head. Chuck the axle in a drill, secure the drill and press the drill lock button so the drill spins continuously. Then gently and carefully apply a fine-grade file to the outside edge of the head to file a little bit of it away.

Be careful! Do not cut the head all the way back to the shaft! That is "too much of a good thing." I've seen axles being sold with the head trimmed

back to the shaft. This will make your wheels wobble because the wheel does not have a flat surface to rest on when it hits the axle head.

PRO Secret #3: Triple Threat



Another way to eliminate friction is to lift one of your front wheels so it doesn't touch the track at all! If your wheels are well-aligned, the car doesn't need one of the front wheels. Simply cut the axle groove in the block ¼ inch deeper so one of the front wheels is higher than the others; or drill a hole 1/8" higher on the block. You will have effectively eliminated the friction from that wheel touching the track, along with the energy it takes to rotate that wheel. (If your rules state, "*All wheels must touch the track",* then you cannot take advantage of this speed trick.

PRO Secret #4: Heavy Construction

Most people stop adding weight when their scale reads 5.0 oz because their scale is not accurate enough to register hundredths of an ounce. Even after the scale reads 5.0, you can continue to add small amounts of weight until the scale reads 5.1 oz. Then remove an ever so slight amount of weight to keep the scale under the 5.0 maximum weight. This tiny amount of extra weight will give your car a little extra inertia during the rollout on the flat part of the track.

Be prepared to remove some weight during check-in if your car exceeds 5.0 oz on the official scale! You can easily remove small amounts of weight if you added Tungsten Putty, BB's or stick-on Flex Weights to the bottom of the car.

PRO Secret #5: Hub Rub – the HUB!

The surface on the car where the wheel rubs is a big source of friction. This area acts like anti-lock brakes, slowing your wheels each time they make contact. The **wheel hub surface**, the part of the wheel that rubs against the car, can be treated with graphite to create a slippery surface, thereby reducing friction when it makes contact with the car.

PRO Secret #6: Hub Rub – the RUB!

Likewise, where the wheel rubs the car can be **treated to further reduce friction**. So be sure that the area on the car where the wheel rubs is made extra smooth by sanding it with very fine sandpaper. Next, apply a final coat of paint or sealer that is glossy and hard. Finally, apply graphite to this area and spin your wheels to ensure that this area is smooth and slick.

You now have both surfaces (the wheel and the car) treated with graphite to minimize friction.

PRO Secret #7: Basis for Spaces

The BSA pine block comes with two predrilled axle slots. You will notice one is closer to the edge than the other. You can **extend the wheelbase** by moving the slot that is furthest from the edge back toward the edge of the car. Now both axle slots will be the same distance from the edge of the car. This will make your car more stable. To expand the wheelbase: drill new axle holes 1" for the slots that are furthest from the edge of the block. Now all four wheels are the same 1" from the edge of the block. Use the PRO Driller or a drill press to be sure the axle holes are perfectly straight.

PRO Secret #8: The Right Angles

There are two advantages to angling your rear wheels (also known as negative camber).

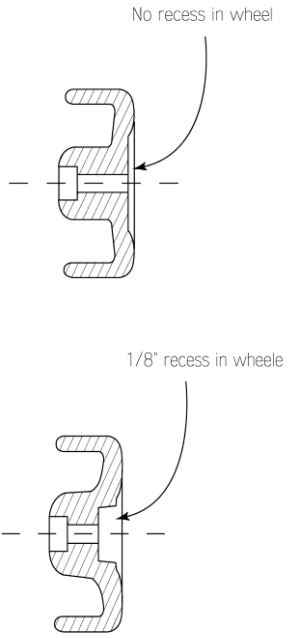
First, the wheels will tend to ride towards the nail head. There is less friction against the axle head than if the wheel rubs against the car body. Less friction = more speed.

Second, only the edge of the wheel will be riding on the track, thereby reducing friction as the wheel rolls down it. There are two ways to angle your wheels. The easiest way is to purchase 2.5 degree bent axles. Just replace the rear axles with a bent axle and use a screwdriver to turn the axle. The other method is to drill axle holes that are angled up (looking at the car from the rear). Once your axles are set, be sure your car is rolling straight, the apply glue to secure them in place.

There are two ways to angle your rear axles. The easiest is to use the PRO Driller Tool, which has drill guide holes to precisely angle the axle hole 2.5 degrees.

You can also angle your axles using 2.5 degree bent axles.

PRO Secret #9: Cap it Off (Not for BSA Wheels)



Everyone adds graphite to the axles before the race. As your car races, the graphite falls off. You are not allowed to add graphite after your car is entered. The following trick will keep a steady source of graphite on your axles through to the last -- heats long after everyone else's axles are grinding! But first you must determine if you have the proper wheels. **BSA wheels do not have a deep enough hub!** This trick will **only work on Pinewood Pro's exclusive PRO Wheels** that have a deeper hub than BSA wheels. If you have Pinewood Pro's PRO Wheels, put the car on its side and pour graphite into the recessed area of the wheel until it is about ¼ full. Then place a small, ¾" round sticker over the hub. These small round stickers can be purchased anywhere you find stationary. These stickers are the exact size to fit on your wheel. Use a pencil to trace the edge of the sticker to secure it to the rim of the wheel hub. It will look like a hubcap and no one will know that the wheel hub is full of graphite!

Graphite slides onto the axle as the car rolls down the track during the race, giving you fresh graphite while the other cars lose their graphite and slow down. This trick gives you a significant advantage with every heat.

PRO Secret #10: Don't Get Railroaded

No matter how straight your car runs, it will inevitably rub against the track guide a few times before it hits the finish line. To reduce this friction, be sure the inside edge of the wheel is sanded smooth and apply graphite to this inside edge to further reduce friction.

PRO Secret #11: Simulation Stimulation

To "wear in" your wheels and axles, spin them on the car as much as possible. I use a Dremel tool with a cotton-buffering wheel to power-turn the wheels. Gently touch the cotton-buffering wheel instantaneously against the

pinewood wheel to make the pinewood wheel spin. Be sure to do it quickly with your Dremel set to the **slowest speed** and put graphite on the axle between spins. This operation simulates hundreds of races. It wears-in the wheel to the axle and also wears down small imperfections on the wheel plastic, again reducing friction.

PRO Secret #12: Riding the Rail

When your car speeds down tracks that have a center guide rail (you can only use this trick with tracks that have a center guide rail!), the car's wheels will inevitably hit the guide rail. When this happens, the car loses speed due to rail friction and drag on the wheel's rotation. Even a car that "steers straight" can hit the rail a few times. Rail Riding, if done correctly, addresses "rail banging" by guiding the car gently into the rail; thus, making it ride the rail all the way down the track. Riding the rail has less friction than banging off the rail.

But be careful! Rail riding is not the "be all or end all" for everyone. There are dangers, so I don't recommend it for everyone…see caveats at the end of this section.

So how do we ride the rail?

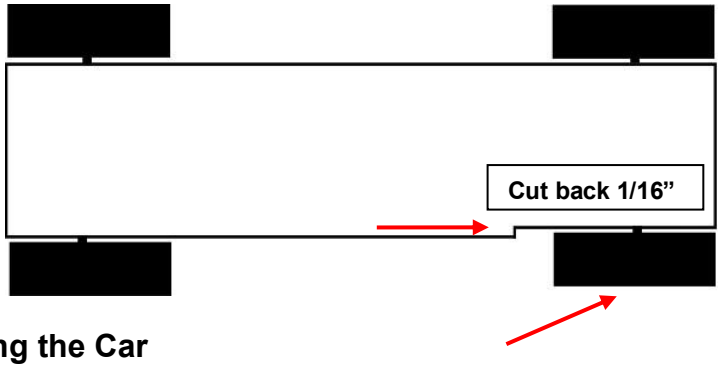
First, let's assume the right front wheel is your dominant wheel (the one that will ride against the rail).

What do you need?

- One 1.5 degree bent steering axle for the right front dominant wheel.
- Two 2.5 degree bent axles to cant the rear wheels.

Preparing the Block

- Cut the right front of the car body back 1/16". This insures that the right front wheel will hit the rail first, keeping the rear wheels away from the rail.



Steering the Car

- Insert one of our 1.5 Degree Steering Axles into the right front wheel and into the block. Align the screwdriver slot in the axle head vertically, so the slot is straight up and down.
- Next, measure the car's drift to steer it for rail riding. You will need a long table or wide board to roll the car on. Put something under the table legs or under the board to lift it about 3" to make an incline. Create a "lane" for your car by putting two pieces of masking tape about 6" apart. Now, place the car on the incline and release it so it rolls. Adjust the steering axle left or right so the car drifts gently to the left about 1" over 4' (or 2" over 8' if you have a longer "track"). Your car is now configured to drift into the rail…but you are not done!

Canting the Rear Axles

- Insert 2.5 Degree Bent Axles into the rear wheels. Again, start with the axle slot in the axle head vertical. Turn the bent axles until the rear wheels migrate toward the axle head when you roll the car down your simulated track. This canting reduces friction of the wheel against the car body and moves the rear wheels away from the center rail so only the front wheel is riding the rail.
- When your car is adjusted properly, glue the axles in place with a good epoxy so they won't get knocked out of alignment during the race.

Added advantage of Rail Riding

- Riding the rail stabilizes the car as it runs down the rail, which allows you to bias the center of gravity further back. So instead of the Center of Gravity (COG) being 1.25" in front of the rear axle, you can achieve 1" or even a little less. Moving COG further back converts more potential energy to kinetic energy. Basically, your car goes faster, longer.

DON'T Make a Rail Riding Car if…

- If your track **sections do not mate perfectly** and a lower section sticks out, even slightly, your rail riding dominant front wheel will slam into the lower section. This will potentially damage the wheel or knocking the wheel out of alignment. In the worst case, the car could hit the bump and jump off the track. If your track sections don't have clean transitions where the sections meet, don't make a rail rider car!
- If **you don't make all the modification above!** You must make ALL of the modifications above for your car to ride the rail properly. For example, if you ONLY steer your front wheel into the rail, your car will **actually be slower** than if you just adjusted your car to steer straight! That is because the other wheels will hit the rail and cause more drag than if you had made the car run perfectly straight.
- If your **track does not have a center guide rail**! This may go without saying, but it doesn't hurt to double check that your track has a center rail. Some plastic tracks, or home-made tracks, have just left and right lane guides, so the car rides freely down the middle of the lane. It would be too late to change your car on race day if you made a rail rider and there was no center rail to ride!

Do you need to raise a front wheel to make a rail rider?
No. **Raising** a front wheel is another proven speed advantage (see Triple Threat above) but is not required for rail riding.

Bottom line: Rail Riding works if the car is adjusted properly, and your track sections match perfectly when it is assembled. If you don't have a test track, I suggest running the car dead-on straight. If you have a test track, or access to one, run your car

as a rail rider several times, then run it straight several times. Use whichever is fastest.

PRO Secret #13: Set and Match

Once you match a wheel and axle, keep them together. Spin them often so they wear into each other. This may sound simple, but I've tested it and it gets a little more speed out of your wheel sets. Minute imperfections in the wheels and axles wear in together to minimize friction and drag.

PRO Secret #14: Light as a Feather

If your rules allow, you can modify your wheels to reduce weight, thereby reducing inertia. This results in a quicker start with less force needed to keep the wheels rolling down the track.

One way to reduce wheel weight is to lathe the outside wheel tread to form a very shallow U-shape. Basically, the center of the tread is lathed down about 1mm so only the edges of the tread touch the track.

Another way to make your wheels lighter is to lathe the tread to an upside-down V-shape so the point _/_ is at the center of the wheel. The wheel tread is then shaped so only the narrow point touches the track.

Yet another way to lighten the wheel is to sand away plastic inside the wheel, under the wheel tread.

Once again, you must be sure your rules allow these modifications – **most Cub Scout rules DO NOT allow these wheel modifications!** Note also that all of these modifications must be done with a lathe to get the precision needed to keep the wheel balanced.

PRO Secret #15: Slim Down

While aerodynamics doesn't have a significant effect on your car's performance (See the Aerodynamics Myth above), making your car slimmer DOES have an effect! Why? Physics!

Your car has potential energy at the top of the track because it has mass and that mass is at a height of about 4 feet off the ground. The force of Gravity will make that mass fall when the starting gate pin drops. In other words, it wants to convert its potential energy to kinetic energy by falling.

Well, the equation for Potential Energy is PE = M*G*H
Where M = Mass, G = Gravity, H = Height

We know Gravity is a constant force at 32 ft/s$^{2.}$

And we know that the weight of your car is a constant (5 oz.) and the height of your car is 4 feet high at the starting gate.

So, what do we have control over that will maximize your potential energy? It is actually the Weight and Height!

First, if you make a slim car design, you can transfer more weight to the rear of the car. (But it is important to let your child pick the car design to make the car their own. You can always remove wood from the bottom of the car and maintain the design of your choice on the top.)

Secondly, the height of your car is distributed across 7 inches, with the bulk of the weight at the rear of the car. When you move the center of gravity further back along that 7 inches, you are effectively increasing the height that the weight "falls". Once again, be careful not to move the weight so far back that your car pops wheelies! The optimal Center of Gravity is about ¾" in front of the rear axles, but this depends on your car design. Don't make the front end of your car so light that it pops wheelies and become unstable.

This is a long explanation for a simple hint: **Slim your car body to transfer more weight to the rear of your car.** More potential energy, results in more kinetic energy (speed!) when the car moves.

PRO Secret #16: Starting Gate Placement

Here is a simple, yet critical, tip. Some races allow racers to place their own car at the starting gate so only the car builder handles that car. This gives them more involvement and the sole responsibility for handling the car.

If you are allowed to handle your own car, carefully place the car so the **wheels are not touching the guide rails** and **be sure the car is straight.**

Get this wrong and your car will bang against the rails, losing valuable speed. Get it right, and your car will take off unimpeded, fast and straight. Simple and effective.

PRO Secret #17: PRO Super Speed Axles (*Only from Pinewood Pro)*

Pinewood Pro has designed what we believe to be the perfect axle, the PRO Super *Speed Axles*. I designed these axles with my mechanical engineering friends. They are designed to minimize friction and wheel wobble. They are tooled to perfection and then polished and nickel plated to minimize friction.

Note: These are not the BSA nails that come in the BSA kit, so they may not be allowed in your race. Check your rules!

They are the fastest axles on the market, guaranteed! Here is why:

First, they are machined, so they are perfectly straight and have no burrs, like the nails that come in the kit. This means there are no imperfections because they never had any to begin with. For the same reason, there are no crimp marks like you find on the BSA nails.

We added a groove under the head to eliminate wheel wobble when the wheel contacts the axle. This area also holds graphite and reduces friction because there is less material to rub on the wheel.

The underside of the head is flanged so there is less wheel contact surface area.

We added another groove in the middle of the axle to reduce friction even further and to act as another graphite store.

Lastly, these axles are nickel plated for a mirror-like finish…you can't get a better finish. Slide your PRO Super Speed Axles in, spin your wheels, and you will be amazed!

PRO Secret #18: PRO Graphite-Coated Axles

One of the problems with graphite powder is that it does not stick to your axles. As your car races, the graphite comes off. You may have seen black streaks on tracks after an evening of races. If you are lucky enough to be in the finals, most of the graphite will have

fallen off. We have a solution…graphite coated "Black Lightning" axles, only from Pinewood Pro!

We start with either our Pro Super Speed Axles or our BSA Polished Axles, and then use our secret multi-step process to coat your axles with graphite so that the graphite stays on the axles, right through the race. They are so slick, smooth, and fast that we like to call them "friction-free"!

PRO Secret #19: PRO Graphite-Coated Wheels (*Only from Pinewood Pro)*

This speed tip is so secret that it has a patent pending…

Our *PRO BSA Speed Wheels* and *PRO BSA Ultra-Lite Wheels* with our exclusive graphite-coating.

We start with Official BSA Wheels from the Cub Scout kit and then perform the following improvements:

Wheel Improvement	What it does for you	Speed Improvement
Lathe the outside and inside treads	Wheel is trued to the center bore	Perfect balance, ***greater speed***
Lathe the hubs	Square hub so it rests squarely against car body when it makes contact	Less friction, greater speed
Make wheel lighter	Wheel requires less inertia to start and roll down the track.	Faster start, higher speed
Mold matched	All wheels in perfect balance	Not critical, could help alignment
Perma-coated graphite on hubs	Less friction when hub touches car	More Speed
Perma-coated graphite on treads	Less track friction	Makes these wheels the fastest wheels on the market!

Note that anybody can apply graphite to his or her wheels (IF your rules allow graphite!). But our secret process finds a way to keep it there, right through the district race! These wheels helped us win many Pack and District races…and they will help you too.

PRO Secret #20: Polish (Your Bore) Like a PRO

Just like your axles, your wheels have small imperfections in the plastic in the center (or bore) of your wheel. You can remove these imperfections by polishing the bore with a slightly abrasive plastic polish using a compact cotton swab.

Don't use pipe cleaners because they usually have a metal center that could scratch the plastic. The bristles on pipe cleaners also don't work very well because they are not dense enough.

The best way to polish the wheel bore is with a dense cotton swab, that looks like a little spear. Chuck the little spear in your drill, put a drop of polish on the spear and polish the bore for no more than 15-20 seconds.

When you are done, thoroughly wash and dry the wheel so no abrasive polish residue is left inside the wheel.

Next, rub a clean spear in graphite and polish the bore with graphite… This simple, quick process is yet another proven speed secret that will reduce friction and speed up your car.

STEP UP TO THE WINNER'S CIRCLE

Here are a few final notes and hints…

- Apply extra graphite and DON'T spin your wheels just before the race, so the graphite stays in the wheel bore. More graphite is better!

- Carry your car to the race in a padded box to insure it is not dropped or the wheels get bumped out of alignment. The slightest bump can misalign your wheels or scratch your cool paint job.

- Consider building your own track. This is a Saturday project, but it is worth the time for the serious racer. You can race cars against each other to fine-tune the fastest car or invite friends over for some friendly competition.

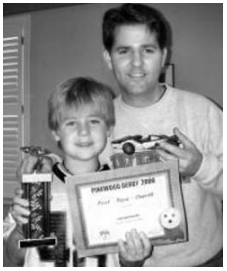
- Be prepared to add or remove a small amount of weight when you go through check-in. Your scale may not weigh the same as the official weigh-in scale. I always put Tungsten putty, a few small BB's or stick-on Flex weights on the bottom of my car that could easily be removed if the car weighs too much. Drill a few small holes on the bottom of your car to add weight if needed. If you don't have any weights handy at check-in and your car is underweight, you can glue (or tape) a coin on, in a pinch. Below is a handy little table with coin weights:

Coin	Grams	Ounces
Dime	2.3g	.081 oz.
Penny	2.5g	.088 oz.
Nickel	5.0g	.176 oz.
Quarter	5.7g	.201 oz.

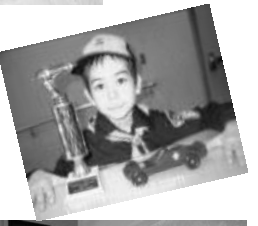
- Always remember Pinewood Derby is typically a parent – child project. As Don Murphy states, Pinewood Derby was designed to, "…*foster a closer father-son relationship and promote craftsmanship and good sportsmanship through competition".* Take a little extra time with your children and let them do as many "age appropriate" tasks as they can under your supervision. The more they do, the more they will get out of the project and the more they will remember the experience. Yes, it is a race, but the primary objective is to have fun together!

- Keep your car! Let your child play with it AFTER the race but advise your child to keep it in a safe place because they will forever remember building this car with you! Hopefully, they will someday repeat the experience with their son, daughter, or even grandchild.

- Look on www.pinewoodpro.com for the latest speed tips, free guides, speed supplies, PRO tools, and our new LEGO® Derby chassis, PRO Brick Wheels Assemblies and Zinc Bricks to add weight to a LEGO derby car.







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Start with the Pro's …. To win at the Finish.

Visit www.pinewoodpro.com for the latest Pinewood Derby products

Speed Products – To Build a Fast Car

PRO BSA friction-free Speed Wheels 	Precision lathed with 9 speed advantage! These wheels are perma-coated with graphite using our secret process to make them "friction-free"! Read about our 9 speed advantages. We also offer: Lightly Lathed wheels - with 7 speed advantages! Ultra Lite wheels – our lightest wheels for the fastest start!
PRO Speed Axles 	"Fastest Axles on the market, guaranteed!" Lathed to remove crimp marks, axle head is angled to reduce friction, secret grooves reduce friction more and store graphite, polished and nickel plated. NEW! Now offered in a Steel version, for the strictest rules that require that axles be magnetic. Now offered with a Friction-Free graphite coating!
BSA polished axles 	Official BSA Axles from the Cub Scout kit, that have been lathed to remove crimp marks, axle head is angled and then they are polished. Just slide them in and you are ready to race!
Graphite Coated Axles! 	Official BSA axles are now offered with a Friction-Free graphite coating! We use a multi-step coating process that results in a smooth graphite finish…so graphite remains on your axles right through to the District Race!

Speed Products - To Build a Fast Car (Cont'd)

NEW!
1.5 and 2.5 degree bent axles

Use bent axles to easily adjust steering and create a rail rider car. Includes "easy-turn" screwdriver slot in axle head to easily make fine steering adjustments without damaging your axles or wheels, like you would with a pliers.

Graphite and NyOil Lubes

The best lubes give you the racer's edge

Special formulated dry graphite powder with sub-micron moly is the best graphite lube you can buy

…or try thin film NyOil lube. It's clean, invisible and stays on your axles through to the District Race!

PRO Tools – Save Time, Build a Fast Car

PRO Tools

Pinewood Pro's PRO **"Blue Tools"** help you drill straight axles holes, sand your wheels, insert / pull axles and get perfect wheel spacing to maximize speed.

PRO Driller is used to drill precision axle holes (it even comes with a #43 drill bit)
PRO Axle Puller and Inserter - insert and remove wheels without damage
PRO Axle Guide – helps insert axles into axle slots
PRO Wheel Gap Gauge – for perfect wheel spacing
PRO Mandrel is used to sand the wheel tread

Finishing Touches and Accessories

Coping Saw, Sandpaper, Sealers, Glue, Wood Putty

All the tools you need to cut, shape, sand and paint your car.

Cool Accessories

Make your car stand out with cool racing accessories.

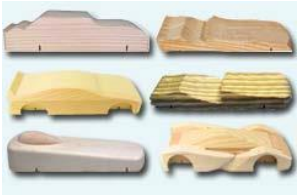
Mount your car to show it off with a car stand.

Decals, DVDs, Accessories

Browse our store to see the latest decals, Down and Derby DVD movie, car fenders, race car drivers, spoilers, engine blocks and other accessories.

Pre-cut cars, Kits – Save Time, Build a Fast Car

Pre-cut car blocks



Many different pre-cut car blocks to choose from…just paint and go!

Car kits and Fully Built Cars

Pre-cut cars, paints, decals, accessories all in one kit.
Many to choose from!

Build the coolest car with over 30 car design plans that include step-by-step 3D illustrations, printable template patterns, painting schemes, speed hints, 360 animations and more.

Many of these plans have won design awards!

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If you want to be competitive, Pinewood Pro's Winning Secrets gives you the easiest and most cost-effective way to give yourself a chance at winning.
~Eric W. Cruz
Endorsement from one of our valued customers,
a Formula Car racer and Eagle Scout

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Just go to www.youtube.com and **search for "Pinewood Pro"**

	PRO Driller video shows how to use all of its features and how it gives you five speed advantages. https://youtu.be/f6pMdieQOOI
	PRO Axle Guide video shows how to easily insert your axles into the axle slot straight and with perfect wheel spacing. https://youtu.be/14W-jtR4ty0
	The PRO Axle Remover and Installer shows you how to easily insert and remove axles without damaging your wheels or axles. https://youtu.be/XeAFsH945M8
	The PRO Wheel Spacer video shows how to easily set perfect wheel spacing for the fastest speed. https://youtu.be/FLONzLlMiJE
	The PRO Bore Polisher shows you how to make your car faster by polishing your wheel bores to reduce friction https://youtu.be/WVM0WUzrkCw

Work hard, do your best and have fun
as you race to the Winner's Circle!

Special thanks to my family,
Nancy, Julia, Sara and especially Steven, who inspired this book as a Cub Scout and was the first in our rather large extended family to achieve Eagle Scout.

NEW!

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- Amanda and Jason

The look on my daughter's face was priceless! I cannot begin to thank you.
- Lisa and Alice

You should have seen my son's eyes light up! It doesn't get better than that!
- Adriana & Luca

My Tiger Cub blew away the entire Pack! Thanks for making Dad look good!
- Randy and Steven

The look on my son's face was worth a million bucks. He came in first place in the District finals. Your tips are the BEST.
- One ecstatic Father, Dr. Andy & Siena

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