



# **WINNING PINEWOOD DERBY SECRETS™**

by  
Joe and Steven Gargiulo



# **WINNING PINEWOOD DERBY SECRETS™**

*Published and Distributed by:*  
Pinewood Pro™  
10 Highwood Place  
Trumbull, CT 06611  
www.pinewoodpro.com

Winning Pinewood Derby Secrets™  
14th Edition  
Copyright © 1999-2014 by Joseph L. Gargiulo

This book has been specially adapted for screen readers to help the vision impaired.

Pinewood Derby®, Blastcar®, Cub Scouts® and Boy Scouts of America® are registered trademarks of the Boy Scouts of America. Awana® is a registered trademark of Awana Groups International.

*All rights reserved, including the right to reproduce this book or portions thereof in any form whatsoever without the prior written consent of the author. While every precaution has been taken, the publisher and authors disclaim any liability for any errors, omissions, loss, or any injuries or damages caused in any way by the content of this book or use of tools used for this project.*

# WINNING PINWOOD DERBY SECRETS

About the author and Pinewood Pro.....	5
Pinewood Derby History and The Joys of Racing .....	6

## STEP 1: DOING IT RIGHT ..... 8

Safety First .....	9
Playing by the Rules.....	10
Have Fun.....	10
Share the Joy .....	10
How this book is written.....	12

## STEP 2: MAKING IT COOL ..... 13

Designing your car .....	13
Rough it Out .....	15
Midway There.....	16
Fine Tuning .....	17
More Construction Tips .....	17
Check for Roundness .....	17
Check for Squareness .....	17
Check for Chips and Splits.....	18
Glue – Don't get gummed up .....	18
PRO Axle Inserter and Puller Tool.....	18
PRO Wheel Spacer Tool.....	18

## STEP 3: MAKING IT SHARP ..... 19

Prep.....	19
Painting and Detailing.....	19
Finishing Touches .....	19

## STEP 4: MAKING IT FAST ..... 20

### SPEED SECRETS FOR A FAST CAR DESIGN ..... 20

Aerodynamics Myth .....	20
Just Like Baking Bread .....	20
Shapely Looks .....	21
The PRO Driller - Driving Straight.....	21
Don't Get the Point.....	23
Beware of the Paper Tiger! .....	23
Don't Fly Into the Wind.....	23

### SPEED SECRETS FOR FASTEST WHEELS..... 23

Nobody's Perfect .....	23
Hub Rub – the Hub .....	24
The Perfect Match.....	24

Optimal Spacing .....25  
Wheel and Axle Alignment.....25  
Pack Light.....26

**SPEED SECRETS TO GET THE FASTEST AXLES.....27**

Crookeder Than a Dog’s Back.....27  
Two Black Eyes .....27  
Polish Makes Perfect .....28  
Turned and Polished BSA Axles .....29  
Slick Lubrication.....30  
A Slicker (and cleaner) Lubricant.....30  
DON’T use this Lubricant!.....30  
The Skinny on Weight – Newton’s First Law of Motion .....31  
Weight – Don’t Wait! How to weight your car.....31  
Weight Placement: part 1 – Center of Mass .....32  
Weight Placement: Part 2 – getting jiggy with it .....32  
Weight Placement: Part 3 – hold the line .....32

**PRO WINNING SECRETS... TO PUT YOU INTO THE FINALS.....33**

PRO Secret #1: Nothing is Better .....33  
PRO Secret #2: Max Head Room.....33  
PRO Secret #3: Triple Threat .....34  
PRO Secret #4: Heavy Construction.....34  
PRO Secret #5: Hub Rub – the HUB! .....34  
PRO Secret #6: Hub Rub – the RUB! .....34  
PRO Secret #7: Basis for Spaces .....35  
PRO Secret #8: The Right Angles .....35  
PRO Secret #9: Cap it Off.....35  
PRO Secret #10: Don’t Get Railroaded .....35  
PRO Secret #11: Simulation Stimulation .....36  
PRO Secret #12: Be Boring! .....36  
PRO Secret #13: Set and Match.....36  
PRO Secret #14: Light as a Feather .....36  
PRO Secret #15: Slim Down.....37  
PRO Secret #16: Starting Gate Placement.....37  
PRO Secret #17: PRO Speed Axles, *only from Pinewood Pro*.....38  
PRO Secret #18: PRO Graphite-Coated Axles, *only from Pinewood Pro*.....38  
PRO Secret #19: PRO Graphite-coated Wheels, *only from Pinewood Pro*.....38

**STEP UP TO THE WINNER'S CIRCLE .....40**

Pinewood Pro wants to link with you! If you have a pinewood derby themed web page, insert <http://www.pinewoodpro.com> into your web site and label it **Pinewood Derby Cars**, we will send you any Pinewood Pro wheel or axle set **FREE**. You can also copy-and-paste the [Pinewood Pro link info and logo from here](#) and put it on your site. Then send me an [email](mailto:info@pinewoodpro.com) at [info@pinewoodpro.com](mailto:info@pinewoodpro.com). You can also share pictures and stories with friends on [www.facebook.com/pinewoodpro](http://www.facebook.com/pinewoodpro) and [Google+](#).

# WINNING PINEWOOD DERBY SECRETS



*Dad, I'll never forget this night.*  
Steven Gargiulo, 1<sup>st</sup> place, District Race

## ABOUT THE AUTHOR AND PINEWOOD PRO

Thank you for choosing Pinewood Pro and the #1 best seller for over 15 years, *Winning Pinewood Derby Secrets*! 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 from car design to building your car and adding the finishing touches. Its real value is showing you how to make your car fast. Yes, even a first time car builder can win their race! Just read our many testimonials and product reviews on [www.pinewoodpro.com](http://www.pinewoodpro.com). But this project is not just about winning. It is about having fun and spending quality time together with your son, daughter or grand-child.

The pinewood derby experience builds memories that 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 tool skills and explain how to do the simple things that they may take for granted, the experience is particularly enriching for the child. Children will have fun, no matter what, but what they will remember the most is being close to their parents and sharing valuable, quality time together. I encourage you to take a little extra time and let your child do as many “age appropriate” things as they can. The more they do, the more they will get out of it. 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 but still, it is one of my most prized possessions...it is 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 this experience my son. I went on to earn a degree in engineering, so 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 of our Pack and District races, but before each race, I repeated these words, “**Win or lose, we did our best and that’s all that counts**”. As the Cub Scout motto says, *Do Your Best*. This book will help you do your best.

Winning Pinewood Derby Secrets is full the techniques and products that I invented that will help you design and build a fast car.

As a parent and former Pinewood Derby event Pack Leader, I’ve seen many parents and children struggle with building their car. It is so gratifying to publish this book knowing it has helped thousands learn how to build a competitive pinewood derby car. I hope you have as much fun as Steven and I had building and racing our pinewood derby cars.

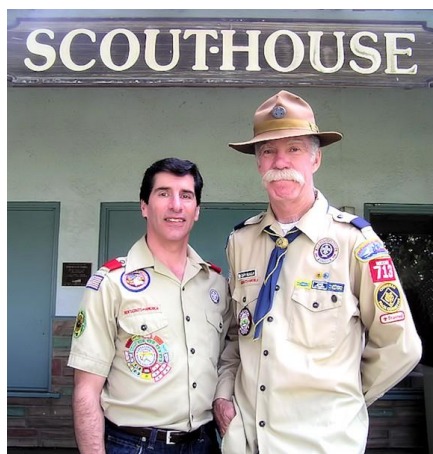
My philosophy has always been to help others, to volunteer and to [donate back to Scouting](#), which I have done every year since I started Pinewood Pro in 1999. We are proud to have helped so

many people and to have been fortunate enough to give back to the Boy Scouts and other organizations that run pinewood derby races. I am a strong supporter of the Cub Scouts, Boy Scouts, Girl Scouts, Awana, YMCA, Royal Rangers and similar organizations that prepare boys and girls for life in so many ways. Throughout my scouting and pinewood derby racing years, I've made many friends and learned about these youth organizations along with many adult, business and the US Military that use pinewood derby racing as a fun and challenging team building event.

Happy racing and I look forward to hearing from you.

## **PINEWOOD DERBY HISTORY AND THE JOYS OF RACING**

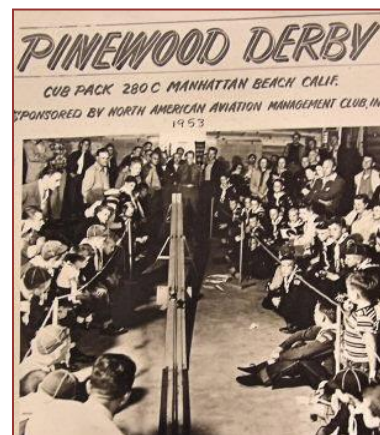
The [first Pinewood Derby](#) race was held at the Scout House in Manhattan Beach, CA, May 15, 1953. Don Murphy, Cub Master for Cub Scout Pack 280c wanted to create a father-son activity he could do with his 10 year old son who was too young to race in the soap box derby. Don, a creative model maker, came up with the idea of racing miniature cars down a track. The event was an instant hit with his Cub Scout Pack. Within 6 months, pinewood derby spread around the Los Angeles area. Don, realizing that he created something exciting and fun, wrote a complete PINEWOOD DERBY plan and submitted it to the Boy Scouts of America. Within two years pinewood derby was launched nationally and soon became the premier event for the Cub Scouts. You can read the entire, fascinating [History of the Pinewood Derby](#) on Pinewood Pro's website.



*Manhattan Beach Cub Master and Pinewood Pro founder Joe Gargiulo at the Scout House where the 1<sup>st</sup> pinewood derby race was held in 1953.*



*Joe Gargiulo with Donn Murphy, son of Pinewood Derby inventor, Don Murphy. Joe is holding his son's car (left) and his own 1968 car. Donn is holding a replica of his car, the 1<sup>st</sup> pinewood derby raced in 1953.*



**Original Pinewood Derby Plan** written by Don Murphy in 1953.

Since that infamous day in 1953, pinewood derby racing has been adopted by many youth organizations for both boys and girls. Pinewood Derby racing has been used by adults for fund raisers, by companies to build teamwork and 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 for girls, to name a few.



As a young Cub Scout, I built Pinewood Derby cars with my father. Each year I looked forward to designing and building a cool car, while trying to figure out what would make it fast hoping to win some races.

Pinewood Derby, along with the other Cub Scout projects, developed my excitement and keen desire to “build things”, to put it simple, and this desire stayed with me as I

progressed through my schooling years. I found that I loved to build (and take apart) things. Since we didn't have computers in those days, I played with erector sets (pre-cursor to legos) and chemistry sets, took apart radios and was constantly borrowing my father's tools. When it came time to choose a college major, I choose engineering because I knew that engineers "build things". While I know that my brain is fundamentally wired as an engineer, I know that the excitement of the annual pinewood derby along with the many other Cub Scout projects fueled my innate desires and led to lifelong experiences...the projects just kept getting bigger and more complex! These experiences were enriched because I got to do them with my Dad.

Now, as a father, I got to relive these exciting, fun experiences with my son. Designing and building a Pinewood Derby teaches a child so many different things and in a fun way. It is a great way for a parent and child to bond, spend quality time together, learn how to plan a project, learn from mistakes, get creative with car designs or painting/decorating, learn how to use tools, learn sportsmanship and even learn about basic physics principles.

As an adult leader in our Cub Scout Pack, I managed the Pinewood Derby race for my son's Cub Scout Pack. I also helped people design and build their cars because we were the reigning champions year after year. When my son advanced to Boy Scouts, I wrote **Winning Pinewood Derby Secrets** to help others design winning cars using our speed secrets. My son (now an Eagle Scout in Troop 65) and I still volunteer to help the local Cub Scout Packs with their Pinewood Derby race. It is still a thrill to watch the boys (and parents) faces as their cars race down the track.

**Winning Pinewood Derby Secrets** is chock full of the speed secrets that I developed and speed products that I invented over the years. These secrets put us in the finals every year and helped thousands of people have fun, be competitive and countless people win Pack and District Championships. Please take a moment to read our [Winning stories](#). While no one can guarantee you will win, this book will give you the secrets that helped us and countless others win their race.

I know you are ready to jump right in, but I recommend you read (or at least glance through) the entire book before beginning so you know how to plan your project and build your car for speed.

Most of all, have fun and I wish you the best of luck in your race. Please join the others that have shared their pinewood derby experience by sending your story and pictures of the smiling team, to [joeg@pinewoodpro.com](mailto:joeg@pinewoodpro.com) ...and don't forget to "Like" us on [facebook](#) and [Google+](#)

***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 would need a copy of your book to complete their pinewood experience.*

**- Donn Murphy**, 1<sup>st</sup> pinewood derby racer in 1953 and son of the inventor of Pinewood Derby, 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 that walked off the stage with those big trophies by placing 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> for speed in the entire Cub Scout Pack (about 100 kids). . 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. (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 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 physics principles and discovered 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 – 1<sup>st</sup> 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 either. 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 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.

Spending quality time with your child, developing their creativity, having fun doing a relatively difficult project (for a child), learning how to plan a project (hint: start early), learning to use tools, and building self-esteem by making something you can be proud of, are just as important as the competition. I believe this with all my heart.

We were always confident going into our races, as we were the reigning champions and team to beat. However, I never let it get to my son's head. It is also important to learn sportsmanship, win or lose. To manage my son's expectations, 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.

Note: 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 here because lead is a dense material and can be used for weighting your car, however, lead is toxic. DO NOT handle lead with bare hands (use gloves) and DO NOT melt lead! Instead of lead, we recommend using zinc or tungsten weights.



*Weighted race car driver*

Weights come in various shapes and sizes that can be broken off with pliers, or cut with a hack saw, to get the exact weight you need. Pictured are various zinc and tungsten weights.



Tungsten is a very good choice because it is twice as dense as lead so it fits in smaller places, plus it is non-toxic...but tungsten is expensive! Tungsten comes in 3/8" cylinders (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 rules. It is important to read your rules thoroughly and abide by them. Each pinewood derby race may have slightly different rules 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 before the race or even being disqualified. Some rules are loose and others are very specific, so read them carefully.

## HAVE FUN

Third ground rule: Have fun! The Pinewood Derby is a great project that gives a parent an opportunity to spend precious quality time with their child. Take your time and make the best of it.

Building a Pinewood Derby car can teach a child many life-long lessons, such as how to plan a project (hint: start early), teamwork, sportsmanship, and commitment to completing a challenging job. It also gives the child a chance to develop their creativity by thinking up different car designs, color schemes and adding finishing touches for decorating their car.

Have fun, be creative and enjoy the time you spend together building your car.

## 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 that 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, so 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).

Teach your child as much as possible throughout the project. There is so much to learn about planning a project, using tools, safety precautions, taking ideas and implementing them, sportsmanship, and of course, having fun even when things are not going so well. You get to teach and set a good example so that the lessons from this small project will truly help them throughout life.

Your pinewood derby experience also teaches a parent to be patient with their child (mine has ADD, so paying attention is a constant challenge for him.) Likewise, your son or daughter will have patience with their parent! It is truly a bonding experience.

I never forgot building my first pinewood derby car with my father. Likewise, my son and I will never forget the time we spent designing and building his pinewood derby cars. Try to set aside special time to work on the car together so you don't feel rushed and can have fun working side by side.

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 THIS BOOK IS WRITTEN

The objective of this book is to save you 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! Here is a bullet list of my objectives:

- Fun, Clear and Concise
- Complete 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
- We highlight what you need to do in the first paragraph, then explain the physics.

### Other notes:

- Web Links – For your convenience, I have embedded clickable links throughout this book to take you directly to the [Pinewood Pro](http://Pinewood Pro) website where you may find additional information on a tool or product and have the convenience of ordering what you need immediately. You may already have 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 have everything you need from speed products to paints and decals.
- I want to emphasize that if this is a parent-child project, it is important to let the child do as many “age appropriate” things as possible, to make the car their own.
- If there is something we have missed or you have comments about this book, please email [joeg@pinewoodpro.com](mailto:joeg@pinewoodpro.com) so we can improve the book and you can help others.



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



Crossed fingers means, simply, “**don't do this**”.



Palm up is the “stop” symbol, which draws attention to a **warning**.



The Scout Sign draws attention to a **smart thing to do**.

The



racing car icon draws your attention to 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. It is especially important to let the child come up with the car design and colors they want. This 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](#).

If you have a website, [facebook](#) or Google+  page, please [Like](#) Pinewood Pro, or add a link to our website: <http://www.pinewoodpro.com>

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 too.

To get started, write down all the car design ideas you or your son/daughter have on a piece of paper. Then make rough sketches showing the car from the side and top to get an idea of the exact design you have in mind. This is fun and only takes a few minutes.

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 their car.

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 only takes 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. Below are just some of over 20 car designs we offer.

Here is 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](#). Click on any of these links to see these cars.

Each design plan includes a cut-out templates and 3D images of each cut so you can see your car taking shape. 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.



If you are a beginner or don't have much time, you might want to consider purchasing a [pre-cut pinewood derby car](#)...you only need to paint and decorate. These cars include the NASCAR, Corvette, Sport Coupe, Street Rod, Stock Car, Cheetah and many more.

Based on your skills and the car design you choose, the chart below will guide you to the appropriate place for help.

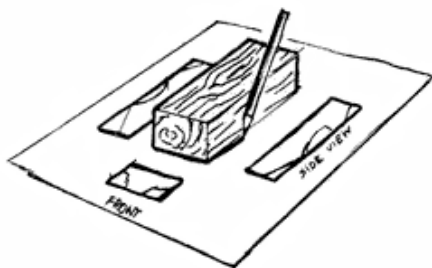
You	Your Options	How it helps you
Skilled or have lots of time	Dream it up, read this book and get busy!	You are a do-it-yourselfer
Some skills, reasonable amount of time	Design your car, or consider downloading a <a href="#">car design plan</a>	Car plans shows how to cut out the car step-by-step, includes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

## 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, lie 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 or if your child is old enough to handle a saw, be sure they are under adult supervision.



*Block secured with clamp*



*Coping Saw*

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 it is safer than a bigger saw, although it cuts slower. For longer straight cuts, use a fine-toothed wood saw.

## **MIDWAY THERE**



*Wood rasp*

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.



*Using dremel rotary tool with car secured in work bench*



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





Do as much smoothing as you can with the intermediate tools because your next step is hand sanding. Inevitably, you will have some nicks and gouges or even cutting mistakes in your beautiful car. [Wood putty](#) 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 Detroit showroom look, can go over the car with 400-grit paper for a perfectly smooth surface.

## MORE CONSTRUCTION TIPS

### Check for Roundness

Check your wheels for roundness before you attach them to your car by rolling them, one at a time, on a table top. They should roll straight and smoothly 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 Squareness

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. 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 your car, be sure to leave at least ¼” of wood around the axle slots (or drill holes) so the wood doesn’t split when your axles are inserted.

## Glue – Don’t get gummed up

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



If your axle holes are drilled (rather than the 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 Axle Inserter and Puller 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.



*Axle Puller end*

*Axle Inserter end*

The Axle Puller and Inserter Tool is two tools in one. One end has a U shaped slot that inserts 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!).

If you have BSA Ultra-Lite or Awana Ultra-Lite Wheels, the Axle Puller is essential because these wheels are thin and break easily. Awana wheels, in particular have hub spokes in the center making them structurally weak at the joints.

## PRO Wheel Spacer Tool

The [PRO Wheel Spacer](#) is pictured on the right. The spacer is a “feeler gauge” set to the exact spacing you need between your wheel 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. Just put the Spacer against your car body, push your axles in until they are snug against the Spacer, then pull it out...quick and easy for perfect spacing.



# 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 a very soft, porous wood. Sanding Sealer, as the name implies, seals 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, resulting in a rough, faded finish.

After the sanding sealer dries, use a high-grit 400 sandpaper to sand off small bumps. If you want a deep shine, put multiple coats of paint on your car. 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 ownership of his car, and will give your son or daughter ownership of their car.



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 by painting on a symbol of their own, like a red lightning bolt, nuke symbol, or biohazard.

## FINISHING TOUCHES

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



**Ownership:** Let your child reach into their toy chest and pull out 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 it more fun for the child.

The last step is to insert the axles and wheels, but first, read the speed secrets below. When the car block is completed, you can begin implementing the speed tricks listed below. These 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. As an engineer, I take my research very seriously. I 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 happens 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, it can be eliminated!).

I consider the speed tricks in the following sections to be the bare essentials. Some of these may surprise you, but almost everyone that 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...to get you to the finals**, are the race winners. Those secrets 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 make much of a difference. There are many, many more sources of friction that have a far greater impact on speed than aerodynamics.

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

Besides, if we were to attempt to find the "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, but don't get too hung up on aerodynamics. Believe me, this is the **least** important part of making a fast car.

### Just Like Baking Bread

Pine wood is a light, very porous wood. As a result, it actually holds water inside! Why is this a concern? Because the heavier your block of wood, the more weight there will 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 the water out of it.

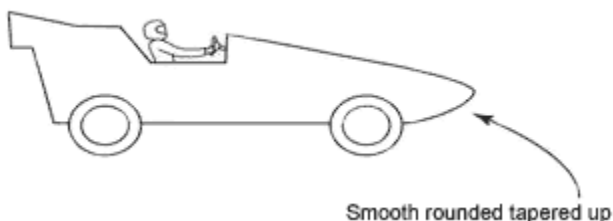
To bake the water out, pre-heat your oven to about 200 degrees, and then place the car on a sheet of tin foil inside the oven, **furthest away from the heating elements**. Leave it there for about an hour, turning it over every 10 minutes or so. When you turn it over, look at it carefully to be sure 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

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.

## The PRO Driller - Driving Straight



Making your car roll straight is one of the most important and perhaps the most difficult task to accomplish. You need to 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 it.

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 on the car and cause it to lose valuable speed. If your car has 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 a little tricky. Fortunately, there are several options at your disposal. Here are your options listed from easiest to most difficult;

1. 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 so your car rolls straight.
2. 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 it includes an extra set of holes in the rear for extending the wheel base which gives your car greater stability.

3. If you don't have a drill press, you can use our handy [PRO Driller](#) mini-jig for drilling straight axle holes. It is easy to use, provides an optional **raised wheel** hole and comes with a #43 drill bit, which is the perfect size for a pinewood derby axle. It features our exclusive **View Port** so you can look through the top of the tool to easily align it with the existing axle slot to re-drill it, making your axles go in easier and more importantly, **straight**. Or you can use it to drill new straight axle holes near the axle slots, or new holes to create an extended wheelbase for greater car stability. It is adjustable to fit your block tightly. Lastly, the PRO Driller adjusts wide enough so you can drill holes for the new CO<sub>2</sub> powered Blastcar™ block for Boy Scouts so you can use it for years to come.



4. **Bend the axle slightly.** This is a delicate operation, but it works.
  - a. With the axle in the car, place a small vertical line on the axle head from the top to halfway down with a fine point marker. The line should go only half way down, so you can re-insert the axle in the exact same position.
  - b. Gently remove the wheel and axle by putting a flat blade screwdriver under the wheel and prying. It should come out easily.
  - c. 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!
  - d. 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.
  - e. 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 that you want to steer your car. Thus, if your car is steering to the right, bend the axle to the left.
  - f. You may have to repeat this process a few times to get your car rolling straight, but it is well worth your time!
5. 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 in order to get your car steering straight. This takes patience and lots of "trial and error" but eventually you can get your car to roll straight. Once you do, glue the axles in place so they don't move.

## Don't Get the Point



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

## 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 done this way...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 to 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 to 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, these wheels have many imperfections such as a mold mark that leave a bump on the outside tread, non-concentric tread circumference and axel bore, "mold flash" which is extra plastic in various parts of the wheel and other differences which make your wheels unbalanced. To compound the problem, each wheel is slightly different. The net result is increased friction, making your car run s-l-o-w-e-r.

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

## Nobody's Perfect

Your wheels are created in plastic molds that leave imperfections in 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.

One problem with the BSA wheels is that the hub is coned to a point...this is “too much of a good thing”, resulting 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 while reducing wheel weight to give you 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 picture on the left shows an unmodified BSA wheel. The wheel on the right 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 are slightly lighter weight and they have 5 other speed improvements to create a perfectly balanced wheel for optimal performance.

## The Perfect Match

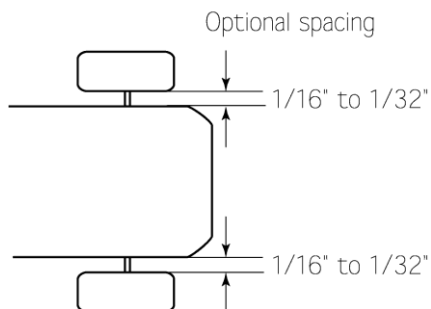
BSA wheels have a little number on the inside of the wheel. This number represents the mold cavity where the plastic was poured to make the wheel. If you use wheels from the same mold, then each wheel will have the same exact characteristics, helping with stability. The only problem is getting hold of 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 easiest way to get mold matched wheels is to purchase a [mold matched set](#), though I caution that the advantages of simply mold matching wheels is only marginal. If you are going to purchase wheels, I would recommend [Lathed Speed Wheels](#). They are lightly lathed, precision tuned and mold matched so all of the wheel imperfections fixed, while abiding by all but the strictest rules.



## 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. Both of these situations are bad.



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

Another easy way to measure spacing is to place a paper match stick (from a book of matches) against the car body, push the axle and wheel into the car until it is snug against the match stick, then 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 you with wheel spacing and alignments, consider our pinewood derby [wheel and axle alignment guide](#) that helps you with six adjustments. The thickness of the plastic on this guide is designed to give you perfect wheel clearance, so this is another way to get Wheel Spacing. It is as easy as slipping the guide between your car body and wheel, inserting your axle/wheel into the car until it is snug and then removing the guide for perfect wheel spacing.



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**

If you are allowed to change the wheel design (read your rules) **lightly sand off as much of the wheel as possible** to lighten it. For example, you could sand off the lettering, round 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 (Check your rules because most race rules do not allow this!).

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

# SPEED SECRETS TO GET 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 those rough cut nails into flawless, shiny axles.



*BSA nails have many flaws!*

## Crooked Than a Dog's Back

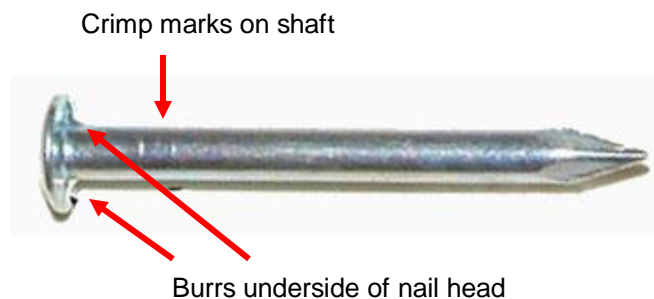
The first problem with your nail is that some of them are crooked. This will severely decrease your car speed. To check if the nail is straight, chuck the nail in your drill and spin it. Look at the nail head as it spins. You can easily see which nails are spinning straight and which are wobbling.

If the nail is wobbling, you have three options;

1. Get replacement axles and pick the straightest ones using the spin technique above.
2. Use an axle straightener, what else? Yes, there is such a tool! It is called the [Pro Axle Press](#). This little tool is a bit expensive, but it does the job of straightening your axles, plus angling the nail head which reduces friction. You can also use this tool to secure the axle in your vice to make steering adjustments if your car is not rolling straight.
3. 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 two glaring flaws, like black eyes staring at you, which must be fixed if your car is going to make it to the bottom of the track. They are crimp marks on the nail shaft and burrs on the underside of the nail head. These flaws are in all of the nails and must be removed. They are caused when the nail is “stamped out” from the nail machine.



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 can not 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](#).



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 with small hands and could be 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.

## 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 for this step, 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 that you use in your dryer because it is slightly abrasive and sturdy. Get a metal polish, like Rottenstone, pumice or brass polish, and apply it to the cloth. Apply the cloth to the axle as it spins in your drill. 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 don't have a metal polish, you can purchase an [Axle Polishing Kit](#). This kit includes pumice (crushed rock) that you mix with water to create an abrasive polish. It is easy to use and will polish your axles to a mirror finish. This kit 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, we have done them for you.

Our [BSA Speed Axles](#) have been hand selected so they are straight. The axle is then turned on a lathe to remove the burrs and crimp marks. We then taper the underside of the head to reduce friction further. Finally, they are polished.

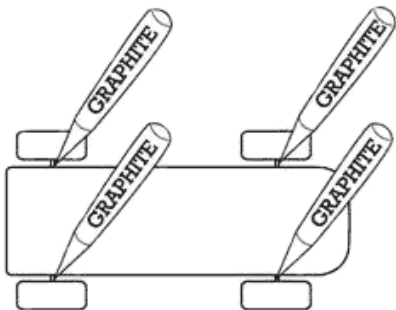


*Polished BSA Axle*

# LUBE SECRETS TO MAXIMIZE SPEED

## Slick Lubrication

Wherever two surfaces rub, there is friction. Your objective is to identify every source of friction and lubricate these surfaces with graphite. The most obvious location of friction is axle friction when the wheel turns. Apply graphite to your axles near the head and the entire shaft.



The best graphite is actually a mixture of powdered graphite along with something called molybdenum disulfide, or “moly” for short. The moly has properties that adhere to metal, whereas pure graphite will slide off after one race down the track. Pinewood Pro’s custom blended dry ultra-fine graphite with sub-micron molybdenum disulfide is the [ultimate graphite lubricant](#) for pinewood derbies.



Before mounting your wheels to the car, pour graphite on a pip cleaner and run it through the wheel bore. This polishes the bore and adds a thin layer of graphite to the wheel bore.

**Warning!** Graphite is very messy and difficult to remove. Be sure you work over newspaper in a safe area, away from food and good furniture!

**Apply graphite to the inside of the wheel bore**, closest to the car, and also around the head of the axle so the graphite works 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.



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

Some race rules only allow a dry lubricant (eg, graphite). If your rules allow oils, [Nyoil II](#) is a thin-film oil that works extremely well. It has an advantage in that it stays on your axles throughout the races and it leaves no black-powdery mess. Note: Only one drop per axle to create an even, **thin coat**. Too much oil can actually slow your car, “*less is more*”! Wipe off excess oil.

## DON'T use this Lubricant!



White Teflon powder from BSA is not only a poor lubricant, it is a BAD lubricant. I’ve tested it and heard from many of my customers. It simply doesn’t work well at all...don’t use it.

## ***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. Following is 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<sup>1</sup> 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 our Cub Scout Pack, I can speak from experience when I say that our biggest bottleneck before race time was people scrambling to change their car weight because it is either too light or too heavy. You need to weigh your car before going to the race. The scale should be accurate to .1 ounce. If you don’t have a small scale, ask friends if 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. Weigh your car, wheels, axles, and weights to bring your car to 4.9 oz, rather than 5.0 oz to allow for scale tolerances with the official scale 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 at check in on the official scale. Add [Tungsten BB’s](#) or [Tungsten Putty](#) to the bottom of your car so it weighs exactly 5.0 oz. You’re your car is weighed at check in, you can easily remove these small weights if it over 5.0 oz, or add a small amount of weight if it is under. Remember, you want your car to weigh exactly 5.0 oz.

Tungsten can be expensive, so if you are not concerned about looks, you can use pennies or dimes to add small amounts of weight.

---

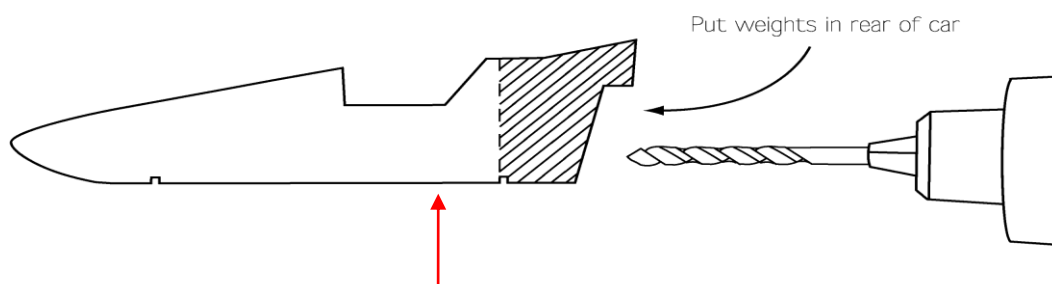
<sup>1</sup> Newton’s First Law of Motion states: "An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force." This tendency of an object to resist change in their state of motion is described as inertia.

Lastly, consider buying an [inexpensive scale](#) or share the cost with other scouts. Having your own scale allows you to make your car weight precise. It also allows you to take your time weighing your car and adding weights exactly where you want them.

## 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 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 right in front of the rear axle. To achieve this balancing point, you need to drill holes (or mount) weights behind the rear axle.



The reason weights are placed in the rear is 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 get no more pull from gravity because they level off sooner.

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. The track guide sticks up about 3/8". Normally, this isn't a problem but if something protrudes and rubs, it will severely reduce speed. I've seen cars that needed last minute adjustments due to weights dragging across the track. If you have bottom mounting weights, use a wood chisel to dig out ¼" of wood on the bottom of your car to recess the weights.

## Weight Placement: Part 2 – getting jiggy with it

Be sure that 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, so 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.

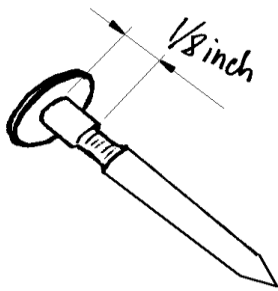


# PRO WINNING SECRETS... TO PUT YOU INTO THE FINALS

These race-winning speed secrets will help put you in the finals. Keep in mind that only a fraction of a second separates winners from losers, so every little incremental speed improvement gives you a better chance of winning. Our Pack uses an electronic timer that clocks to 1/1000<sup>th</sup> 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 those cars a winner.

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

## PRO Secret #1: Nothing is Better



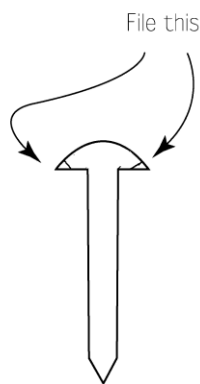
The best way to reduce friction on the axle is to eliminate it by removing part of the axle! In essence you are cutting back a part of the axle thereby removing a surface that rubs against the wheel as it turns. Take a file and file away about 1/4 inch of the nail about 1/8 inch from the nail head, thereby eliminating friction in that area. Friction is redistributed but this change, combined with lubrication, reduces overall friction to increase your car's speed. Don't file too deep as this weakens the axle. You only need to go a fraction of an inch deep.



This is a delicate operation that should only be done by adults. Chuck the axle in your drill and secure the drill in your workbench. Be careful not to damage the drill case! While the drill is spinning, 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.

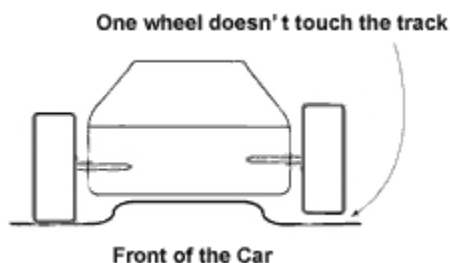
## PRO Secret #2: Max Head Room

File the head of the axle at a slight angle (to flange it) so less of the axle touches the wheel when it rubs against the axle head. Once again, put 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! This is “too much of a good thing”, i.e. this is bad. I’ve seen companies selling axles 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 aligned, the car doesn't need one of the front wheels. Simply cut the axle groove in the block  $\frac{1}{4}$  inch deeper so one of the front wheels is higher than the others, or drill a hole  $\frac{1}{8}$ " higher on the block. You have effectively eliminated the friction from one wheel rotating since only three wheels are turning.

### PRO Secret #4: Heavy Construction

Most people stop adding weight when their scale reads 5.0 oz since 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 ever so slight an amount of weight to keep the scale under the 5.0 maximum weight. This small amount of extra weight will give your car a little extra inertia during the rollout on the flat part of the track. Warning! Be prepared to remove some weight during check-in if you car exceeds weight on the “official” scale! You can do this with Tungsten Putty or by gluing BB's to the bottom of the car, then removing them one at a time until your car registers 5.0 oz on the official scale.

### 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, the area of the car where the wheel rubs can be **treated to reduce friction** further. To minimize this resistance, be sure the area on the car where the wheel rubs is extra smooth by sanding it with very fine sandpaper. Then make the final coat of paint, or sealer, glossy and hard. Apply graphite to this area and spin your wheels to make this area on your car smooth and slick.

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

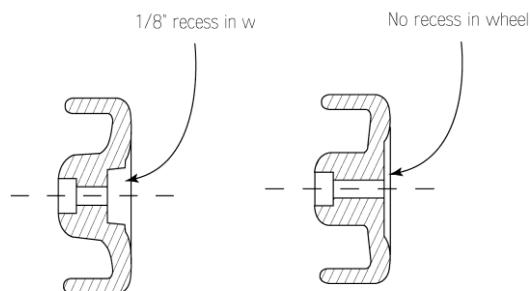
## PRO Secret #7: Basis for Spaces

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. In this way, both axle slots are the same distance from the edge of the car. This will make your car more stable. To expand the wheelbase, drill new axle holes closer to the end of the block, the same distance as the axles slot on the other end. A drill press should be used if one is available. The old axle slot can be covered with wood putty.

## PRO Secret #8: The Right Angles

Some people like to angle the two rear wheels upward slightly. This can be tricky, so allow plenty of time before your race for adjustments. There are two advantages to angling your wheels. One is that the wheels will tend to ride towards the nail head, which generates less friction than if the wheel rubs against the car body. The other reason is that only the edge of the wheel is riding on the track, thereby reducing friction as the wheel rolls down the track. To angle the wheels, adjust the axle up (looking at the car from the rear) and carefully secure it with glue. Note that this is a delicate operation and may take some time. Be sure that your car is rolling straight before applying glue!

## PRO Secret #9: Cap it Off



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 submitted. The following trick will keep a steady source of graphite on your axles through 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 for this!** This trick will **only work on Pine-Pro wheels** that have a deeper hub than BSA wheels.

This only works on wheels with a 1/8" deep hub (the part where the nail head protrudes). If the nail head does not sit 1/8" deep into the wheel hub, then your wheel does not have a deep enough cavity. In that case, **DO NOT use this trick**. If you have deep hub wheels, after your wheels are inserted into your car, put the car on its side and pour graphite into the recessed area of the wheel until it is about 1/2 full. Then place a small, 3/4" round sticker over the hub. These small round stickers can be purchased at a stationary store and they 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 hub cap 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. Your axles will always have fresh graphite being applied to the axles while the other cars lose their graphite.

## 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 friction when the wheel rubs against the inside rail, be sure

the inside edge of the wheel is sanded smooth and apply graphite to this inside edge to 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. 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 thereby reducing friction.

## **PRO Secret #12: Be Boring!**

Another way to get incremental speed is to polish the inside bore of your wheels, where the axle slides through. The plastic inside your wheels can have minute imperfections that will cause friction, thereby slowing your car. You can use a pipe cleaner soaked with pumice to polish the wheel bore. This is tedious but will help. You can also consider the [Wheel Bore Polisher](#) that fits into your drill and includes one-micron plastic polish so you can polish the inside bore to a flawless shine.

## **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. While this may sound simple, but I’ve tested it and it works to get 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 resulting in a quicker start with less force required to keep them 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 1 or 2mm so that 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 where the point of the V is at the center of the wheel. The wheel is actually shaped to a narrow point so only the point touches the track.

Yet a third way to lighten your wheels is to remove material under the wheel tread, on the underside of the wheel tread.

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

## PRO Secret #15: Slim Down

While aerodynamics don'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' off the ground. This mass wants to fall to the ground due to the force of gravity. In other words, it wants to convert its potential energy to kinetic energy by falling.

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

We know Gravity is a constant force at  $32 \text{ ft/s}^2$   
And we know that the weight of your car is a constant (5 oz) and the height of your car is fixed at the top of the track (~4')...but are they constants??

We know that moving the center of gravity further back gives your car more momentum, but we can't move it too far back or your car will pop wheelies.

So what do we have control over here that will maximize your potential energy? It is actually the Weight and Height! The reason is that the Height of your car is distributed across 7 inches, with the bulk of the weight at the rear of the car. If we transfer even more weight to the rear of the car, we have more weight falling from the rear of the car where it is higher than the front, thereby getting more energy when that weight "falls" down the track.

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 the racer to place their own car at the starting gate. This is done so only the car builder is handling their car, which gives them more involvement, but also gives the responsibility of handling the car to the car owner.

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 Speed Axles , *only from Pinewood Pro*

If you want to save some time, Pinewood Pro offers [PRO Speed Axles](#). These axles were designed by myself and mechanical engineers to minimize friction and wheel wobble. They are tooled to perfection to minimize friction, then polished and nickel plated.



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



First, they are machined, perfectly straight parts, not deburred nails, which means there are no imperfections from burrs because they never had any to begin with. For the same reason, there are no crimp marks like you find on the BSA nails. Second, there is an undercut at the head that eliminates wobble, holds graphite, and reduces friction because there is less material to rub on the wheel. Third, there is another secret cut in the middle of the axle to reduce friction even further and act as another graphite store. Fourth, these axles are nickel plated for a mirror-like finish...you can't get a better finish. Slide your PRO Speed Axles in, spin your wheels and you will be amazed. We were, right through the district championship!

## PRO Secret #18: PRO Graphite-Coated Axles, *only from Pinewood Pro*

One of the problems with graphite powder is that it does not stay on your axles. As your car races down the track, 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 district 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 treads	Wheel tread is trued to the center line	Perfect balance, <b>greater speed</b>
Lathe the hubs	Remove imperfections in plastic; less material rubs on car	Less friction, greater speed
Make wheel lighter	Wheel turns easier, faster off the starting line	Faster start, higher speed
Mold matched	All wheels in perfect balance	Car goes straighter
Perma-coated graphite on hubs	Less wheel friction on 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.

# 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 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 to race their cars for some friendly competition.

◆ Be prepared to add or remove a small amount of weight when you go through check-in because your scale may not weigh the same as the official weigh-in scale. I always put Tungsten putty or a few small BB's 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 on hand 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

◆ I just want to reiterate that pinewood derby is typically a parent – child project which, as Don Murphy states is designed to, “...*foster a closer father-son relationship and promote craftsmanship and good sportsmanship through competition*”. If you are working with a child, take a little extra time with them and let them do as many “age appropriate” tasks as they can do, with your adult supervision. The more they do, the more they will get out of the project and the more they will remember the experience, like I did with my Dad. Yes, it is a race, but the primary objective is to have fun together!

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

◆ Look on [www.pinewoodpro.com](http://www.pinewoodpro.com) for the latest speed tips, free guides, speed supplies and PRO tools.





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

*Special thanks to my family; Nancy, Julia, Sara and especially my son, Steven, who built five winning pinewood derby cars with his Dad in Cub Scout Pack 468.*

*Steven went on to become an Eagle Scout,  
the only one in our (rather large) family to do so.*

## BE FAMOUS!

Hold up your car, smile wide and [email](#) us your picture for the...

[Pinewood Pro Derby Car Picture Gallery](#)

or

[Pinewood Pro Winners Gallery](#)

or

Share your stories and pictures on [Pinewood Pro's](#)  wall

or

Share on [Google+](#) 

Show the world your creation!

Pinewood Derby products to help you build your car and make you a winner!

Visit [www.pinewoodpro.com](http://www.pinewoodpro.com) for the latest Pinewood Derby products

## Speed Products – to win your race

### [PRO BSA friction-free Speed Wheels](#)



**“Fastest Wheels on the market, guaranteed!”** 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:

[lathed wheels](#), with 7 speed advantages!

[Matched wheels](#) – when rules allow NO modifications

[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, then they are polished and nickel plated.

**NEW!** The PRO Speed axles are 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!

**NEW!** Official BSA axles are now offered with a [Friction-Free graphite coating!](#)

**NEW!**

### [Graphite Coated Axles!](#)



We use a multi-step coating process that results in a smooth graphite finish...so graphite remains on your axles right through the District Race!

### [Precision drilled blocks and wedges](#)



Drilled axle slots so your car rolls straight. Optional raised front wheel....see our precision drilled wedge block with weight holes.

Read about our [7 speed advantages](#) over standard blocks.

### [Graphite and NyOil lubricants](#)



Special formulated dry graphite with sub-micron moly is the best graphite lube you can buy....or try thin film NyOil lube for. Lubes give you the racer's edge!

## Tools - to Build Your Car Faster, Easier

### PRO Tools



Pinewood Pro's PRO Tools help you modify your axles, wheels and car block 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 damaging them

**PRO Wheel Gap Gauge** – for perfect wheel spacing

**PRO Mandrel** is used to sand the wheel tread

**PRO Axle Guide** – helps insert axles into axle slots

**PRO Rail Rider** – special technique to make wheels ride-the-rail

### Wheel and Axle Alignment



PRO Wheel and Axle alignment gauge gives you [six adjustments](#) in one.

Wheel spacing is the easiest thing to fix and perhaps the adjustment that most people get wrong. This tool makes it a snap, along with the other simple 5 measurements you can make to align your wheels and axles.

### Coping Saw, Sandpaper, Sealers, Glue, Wood Putty, etc.



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

## Car Kits, Accessories, etc – for the Final Touches

### [Pre-cut pinewood derby car blocks](#)



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

### [Complete car kits](#)



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

### [Paint kits](#)



Acrylic paints to get the exact colors you want. Safe and Easy cleanup with water.

### [Decals, DVDs, accessories](#)



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

Lots more!

Visit <http://www.pinewoodpro.com> often for the latest and greatest speed tips and products.

[Link your site to Pinewood Pro](#) or “Like” us on Facebook, where you will find free derby help, like our Car Design Guide, How to Build a Fast Car, Derby Certificates, Pinewood Derby Driver’s License, How to Build a Derby Car Stand, and lots more!

**And don’t forget to share with friends!**

LIKE us on [Facebook](#) and [Google+](#)

*Good luck, God Bless and all the best from Pinewood Pro.*