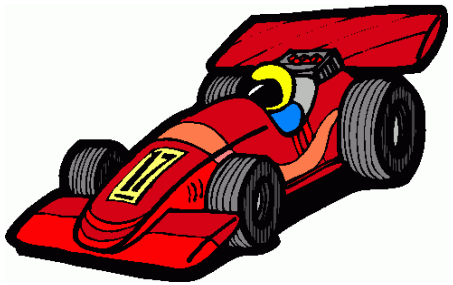
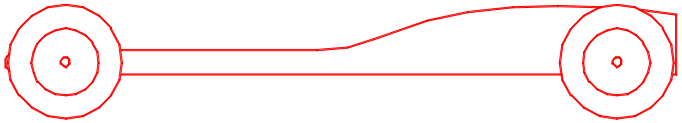


# Pinewood Derby Car Design

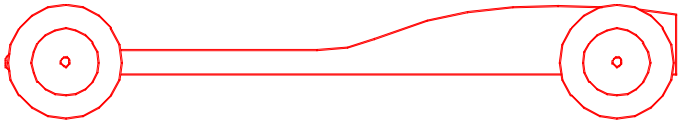
Joel Simansky

# Pinewood Derby Car Design



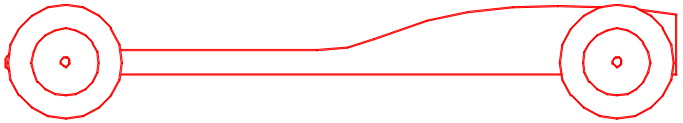
# Father AND son project

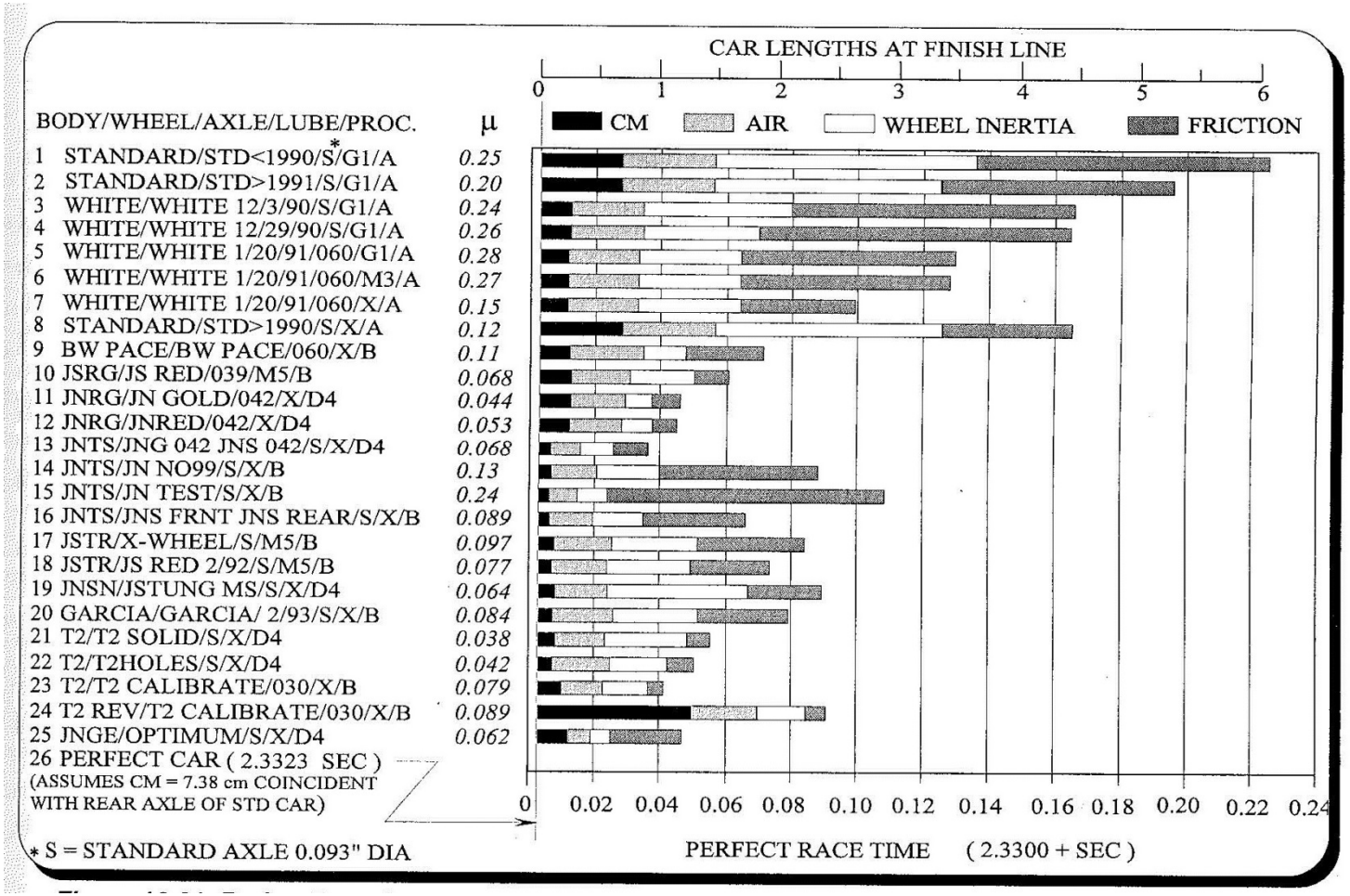

# Pinewood Derby Car Design



- Split Labor
  - Cub Scout
    - Car shape (clearly this is what makes the car fast!)
  - Adult
    - Wheels and axles.

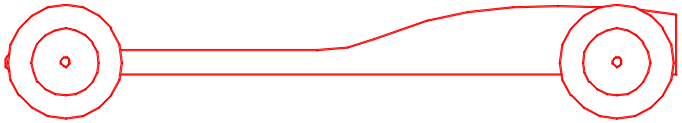
# Pinewood Derby Car Design






From: The Physics of the Pinewood Derby, John D. Jobe

# Pinewood Derby Car Design

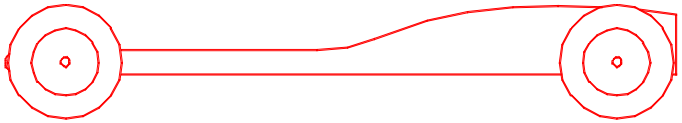


- Times

| Average | Ranking |
|---|---|
| 2.553 | 1 |
| 2.573 | 2 |
| 2.578 | 3 |
| 2.585 | 4 |
| 2.588 | 5 |
| 2.593 | 6 |
| 2.595 | 7 |
| 2.598 | 8 |
| 2.600 | 9 |
| 2.603 | 10 |
| 2.610 | 11 |
| 2.610 | 11 |
| 2.615 | 13 |
| 2.615 | 13 |
| 2.618 | 15 |
| 2.620 | 16 |
| 2.620 | 16 |
| 2.623 | 18 |
| 2.625 | 19 |
| 2.628 | 20 |
| 2.628 | 20 |

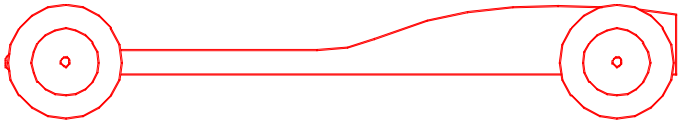
Pack 16 2012 Pinewood Derby Results

# Pinewood Derby Car Design

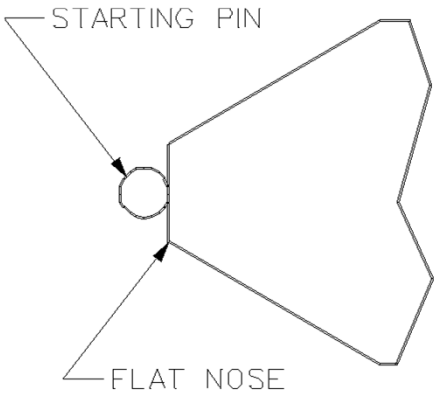


- Car Body Design
  - Nose Shape
  - Nose Color
  - Nose Height
  - Wheel Width
  - Adding Accessories to the Front or Back
- Speed Tips
  - Car Body
    - Center of Gravity Location
    - Wheel Base
    - Lift a Wheel
  - Wheels/Axles
    - Axle Prep
    - Wheel Prep
    - Lubrication
      - Type
      - Application
  - Steering
  - Wheel-Body Clearance
- References
- Doesn’t have to be about the winning

# Pinewood Derby Car Design



- Car Body Design
  - Nose Shape

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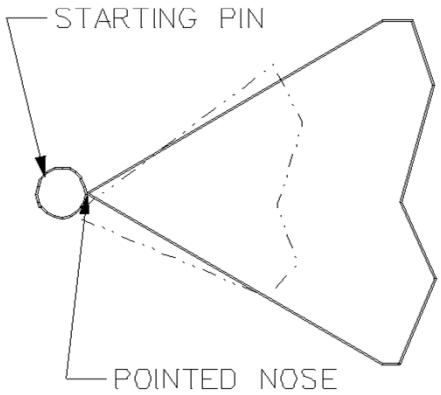
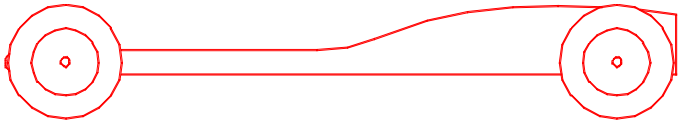
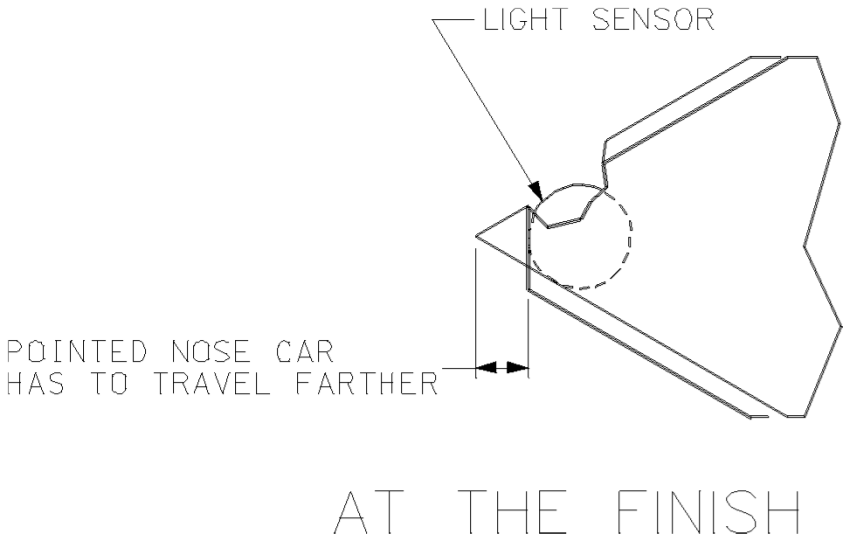



NOT THIS

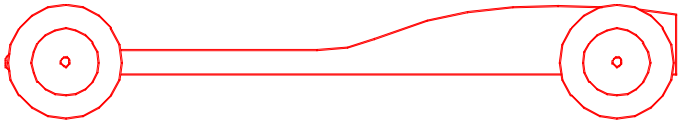
# Pinewood Derby Car Design



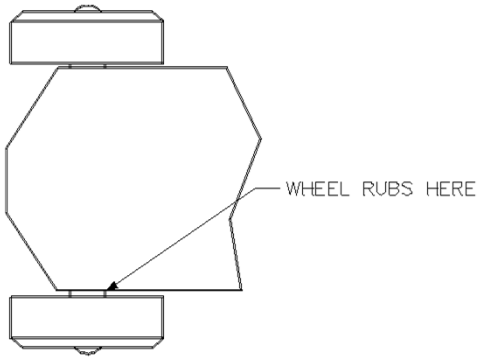
- Car Body Design
  - Nose Shape



# Pinewood Derby Car Design



- Car Body Design
  - Nose Shape
    - Make sure body is flat where wheel comes into car (no contour or angle).
      - Failure to do this will mean outer edge of wheel will rub against car body and be VERY draggy!

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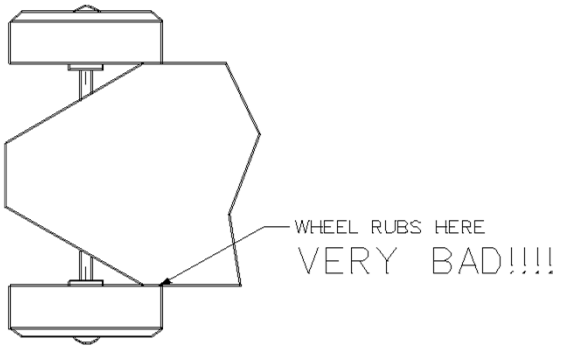


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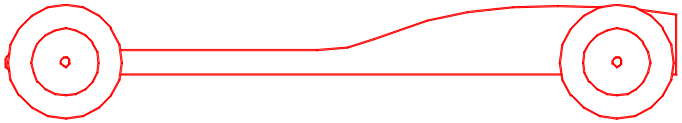
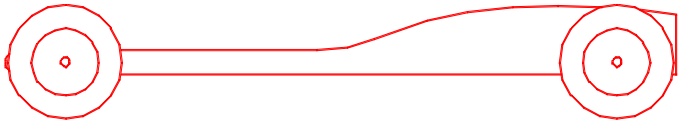
# Pinewood Derby Car Design

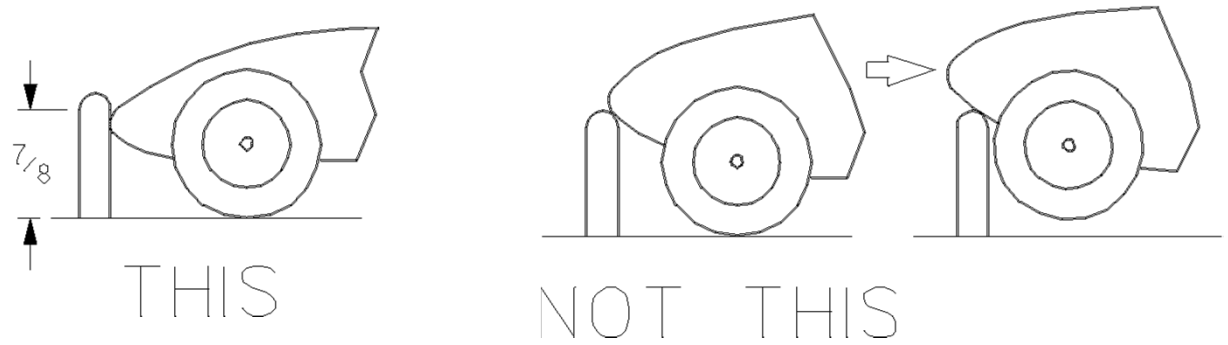


- Car Body Design
  - Nose Color
    - Paint bottom a dark color
      - Sensor works by detecting a drop in light intensity
      - Lighter colors tend to reflect light and delay this effect

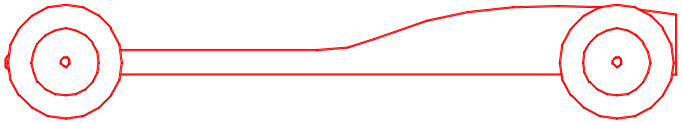
# Pinewood Derby Car Design



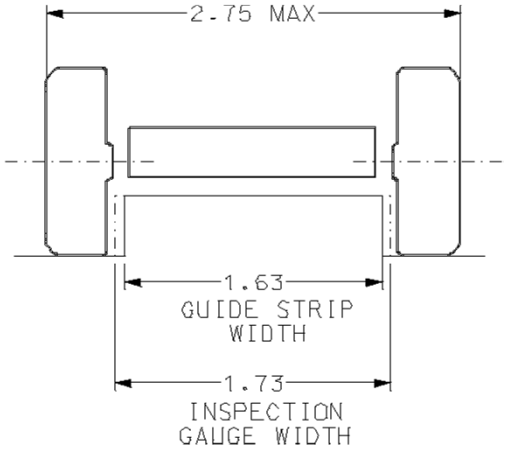
- Car Body Design
  - Nose Height
    - The car is held in the starting gate by a pin that sticks out of the track 7/8”. If the car nose is too high, the car won’t be restrained by the pin. We have to either turn the car around, or glue something to the bottom to hit the pin.



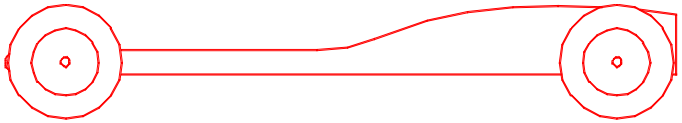
# Pinewood Derby Car Design



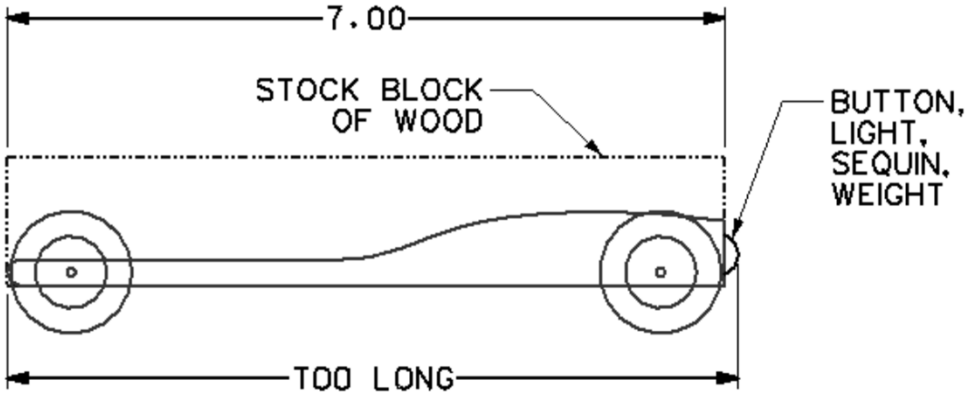
- Car Body Design
  - Wheel Width
    - Maximum width of car is 2¾”
    - ABSOLUTE MINIMUM distance between inside of wheels is 1.63 inches, and should probably use 1.73 inches (gauge width)
      - If you use the stock block of wood, you’ll be fine.



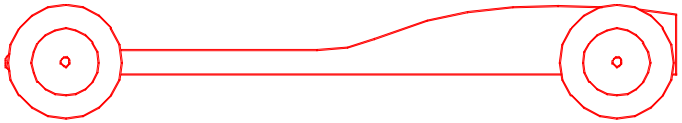
# Pinewood Derby Car Design



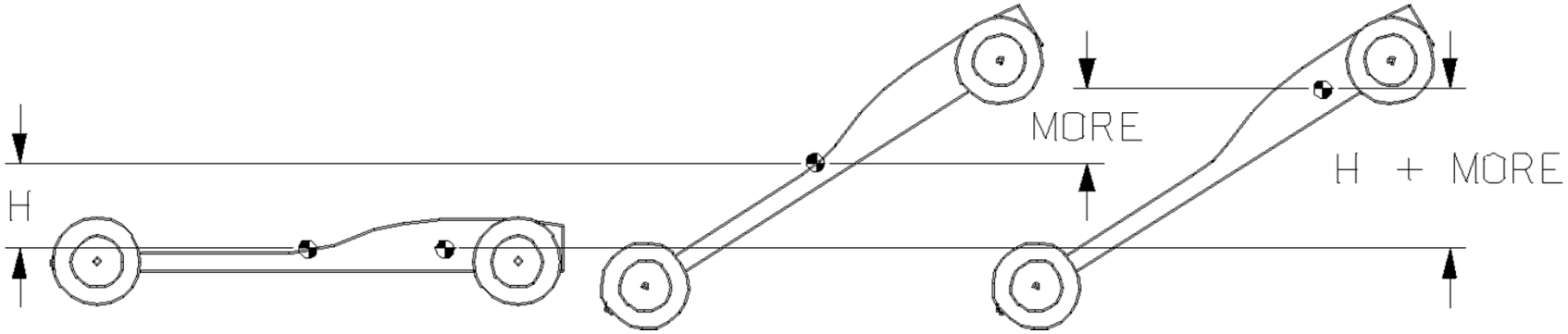
- Car Body Design
  - Adding Accessories to the Front or Back
    - The stock block of wood that comes in the car kit is pretty much 7” long.
    - Anything you add to the front or back will then make the car too long.
    - If you want to add tail lights, headlights, sequins, rocket exhausts, or ANYTHING to the front or back of the car, you should shorten the body a little to make sure you are under the 7” maximum length.



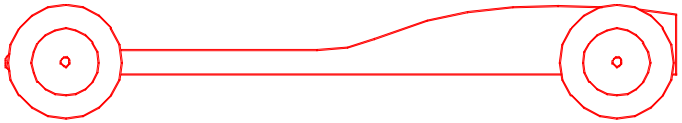
# Pinewood Derby Car Design



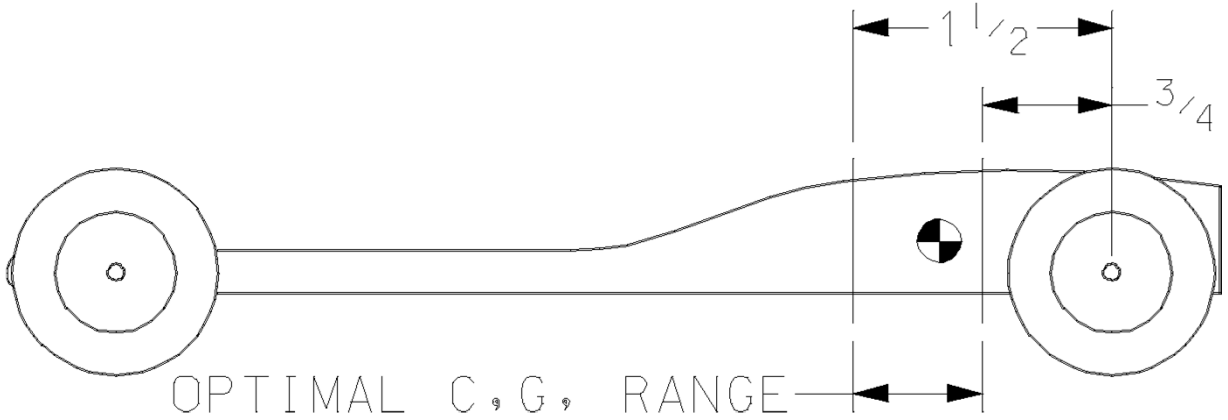
- Speed Tips
  - Center of Gravity
    - ALL power comes from how “high” the car is falling.
    - The higher up the center of gravity, the more speed you get at the bottom.
    - Center of gravity should be as far back as possible.



# Pinewood Derby Car Design



- Speed Tips
  - Center of Gravity
    - However, if center of gravity is TOO far back, car will get light on the front wheels and will rattle down the track, killing speed.
    - Don't know "best" place.
    - Have heard anywhere from ¾"- 1 ½" forward of real wheels
    - Personally use about 1"



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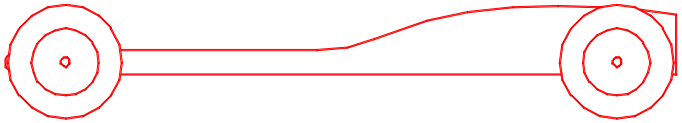
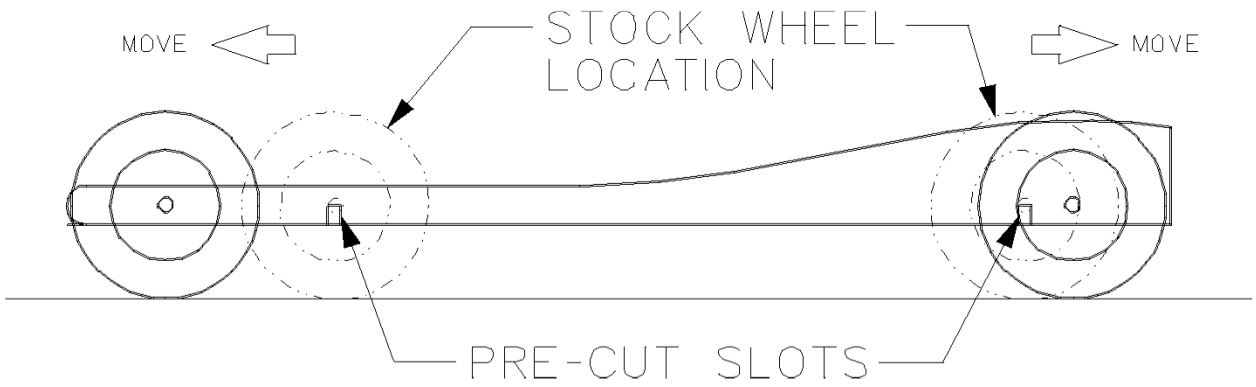
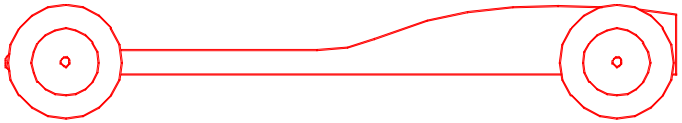


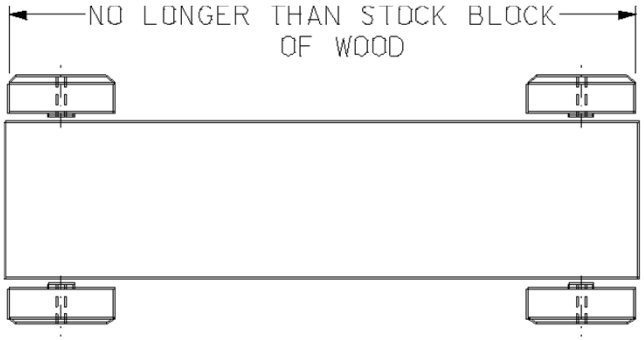
- Speed Tips
  - Wheel Base
    - One way to get c.g. further back is to move rear wheels back.
    - Nothing in rules says axles have to go in the slots cut in the wood.
    - Also move front wheels forward to improve stability.



# Pinewood Derby Car Design



- Speed Tips
  - Wheel Base
    - Do NOT move wheels to edge of block of wood!
      - Car will then be too long

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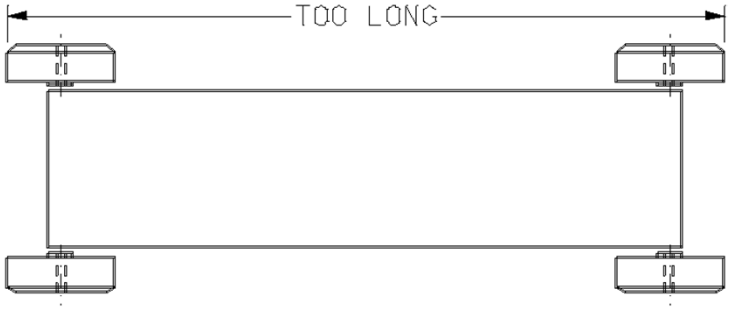


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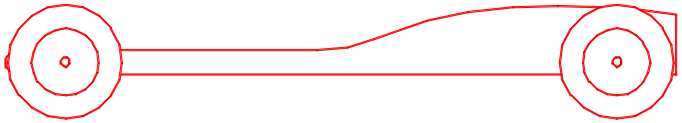
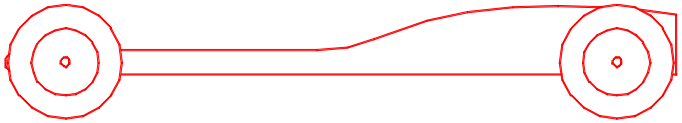
# Pinewood Derby Car Design

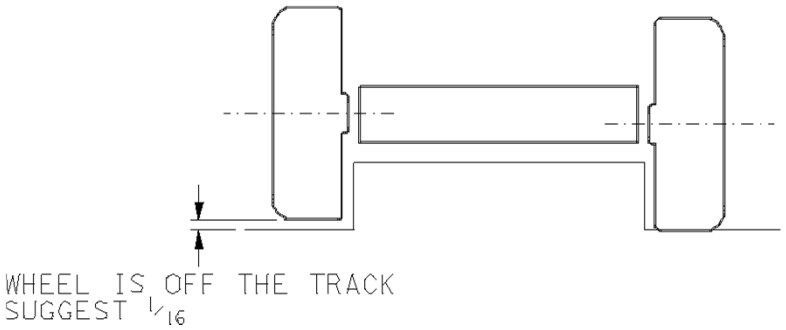


- Speed Tips
  - Lift a Wheel
    - Contrary to popular belief, lifting a wheel does NOT reduce the friction on the car.
      - Same friction regardless of number of wheels touching.
    - What it does do is prevent the wheel from spinning up.
    - See slide 4 for effect of wheel inertia on times.
    - Imagine what would happen if you reduce the white area by 1/4.
    - That is what lifting a wheel does.

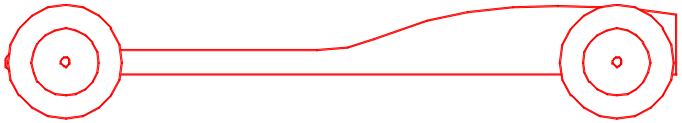
# Pinewood Derby Car Design



- Speed Tips
  - Lift a Wheel
    - Nothing in rules says all four wheels must be touching
      - In fact, this is nearly impossible. It is very difficult to get all four wheels to line up on a flat surface. Nearly any car has some "rock" to it.
    - Simply drill the hole for one of the front wheels a little higher than the rest.

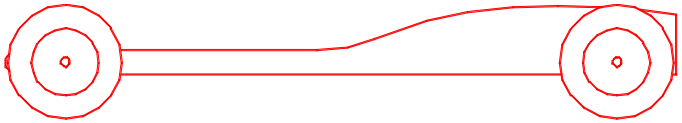


# Pinewood Derby Car Design

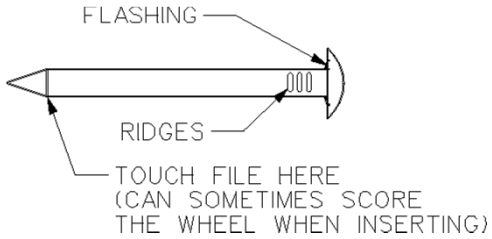


- Speed Tips
  - Lift a Wheel
    - Of course to make this work, you have to KEEP the wheel from spinning up, meaning the wheel can't touch the center guide strip
    - Need to "steer" the car towards the lifted wheel.
    - See "Steering" slide

# Pinewood Derby Car Design

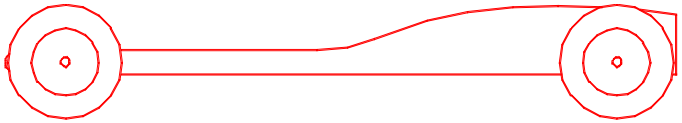


- Speed Tips
  - Axle Prep
    - Every axle comes with some flashing under the head.



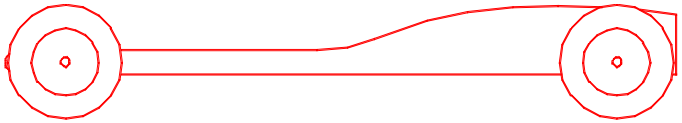

    - Need to file the flashing off and get a smooth under surface.
      - Do this by chucking nail in a drill press or hand drill, and spinning it while you hold a jewelers file to it.
      - Also file where point is formed. Sometimes this can be shaped such that it is slightly larger than the wheel bore hole and you'll score the wheel when you put in the nail.
    - Don't need to file off of ridges, although I normally have.

# Pinewood Derby Car Design

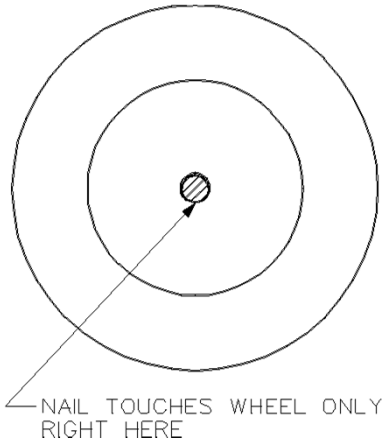


- Speed Tips
  - Axle Prep
    - Once the flashing is off, you need to polish the axle.
      - Starting with 150 grit sandpaper, polish with successively larger grits.
      - Polish under head as well.
      - Clean nail after each grit.
      - Although personally I go much finer, my own tests show that you don't get much benefit going finer than 1000 grit.
    - When all done and axle is clean, rub shank of nail in lubricant.

# Pinewood Derby Car Design



- Speed Tips
  - Axle Prep
    - Don’t need to go too crazy.
      - Remember the nail is only contacting the wheel along a very narrow line.



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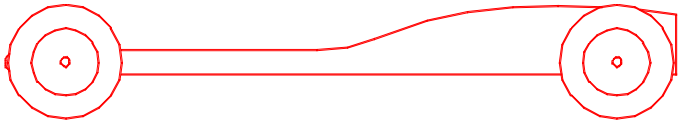
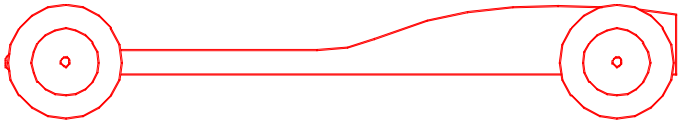
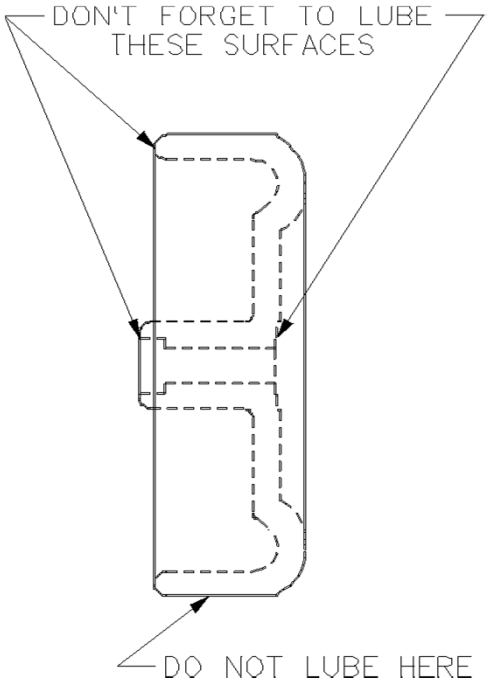


- Speed Tips
  - Wheel Prep
    - Rules forbid any modifications to the wheels.
      - Do so at your own peril
        - » Don't get much benefit from shaving off outside of wheel to "true it up".
          - In fact, this could be detrimental because it reduces the radius of the wheel.
    - Look at inside of wheel bore with a magnifying glass.
      - Can see all kinds of debris in there.
    - Blow out bore with a stream of 91% isopropyl alcohol.
    - Don't really need to polish.
      - Newer wheels look pretty good in the bore.
    - If you want to polish, don't recommend using a pipe cleaner.
      - They always seem to leave a fiber or two in there.
    - Recommend using a Q-tip shank, slightly sanded down.
    - Lube

# Pinewood Derby Car Design



- Speed Tips
  - Wheel Prep
    - Lube
      - Don’t forget to lube where wheel contacts car, where nail head rubs against wheel, and where edge of tread contacts center guide strip.
      - Do NOT lube tread of wheel.
        - » Want wheel to roll down the track, not slide.



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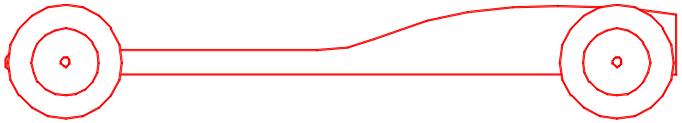
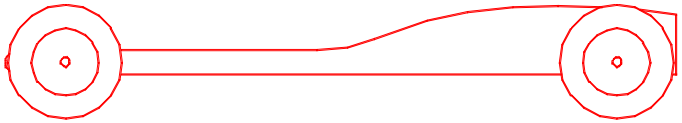


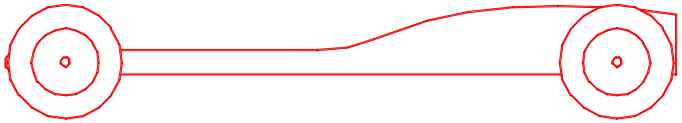
- Speed Tips
  - Lubrication
    - Piasa Bird rules state that only dry lubes are allowed.
    - NO oil lubrication is allowed (even “BSA” approved oils).

# Pinewood Derby Car Design

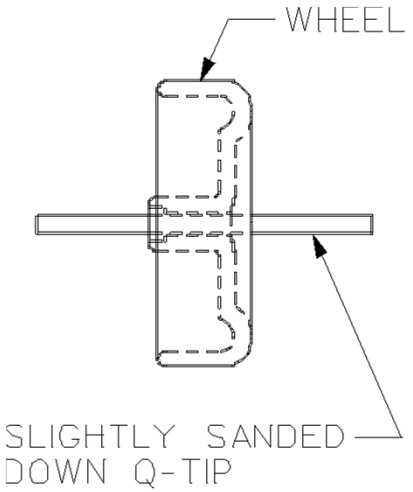


- Speed Tips
  - Lubrication
    - Hob-E-Lube is the stuff to use
      - You can try whatever other lube claims to be the best. Regardless, get a tube of Hob-E-Lube and compare for yourself.

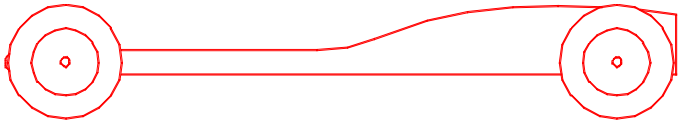
# Pinewood Derby Car Design



- Speed Tips
  - Lubrication
    - Application
      - Axle
        - » Use lint free cloth or chamois, pour some graphite in a small pile, and roll nail in it.
      - Wheel
        - » Pour graphite into bore, insert Q-tip shank, and roll wheel along table surface
        - » Tap out any remaining graphite.
        - » Don't forget to lube edges shown in slide 24
      - Insert nail into wheel and test ONCE. If satisfied, install in car and leave alone.

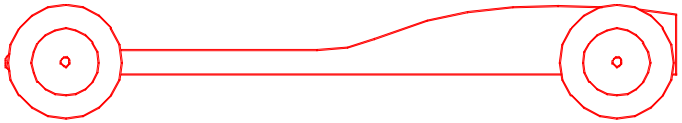


# Pinewood Derby Car Design



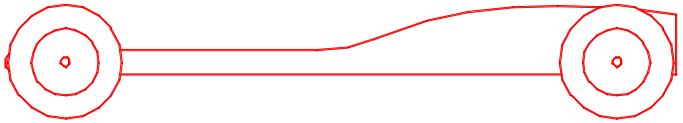
- Speed Tips
  - Lubrication
    - Once you get ready, resist urge to spin wheels. The graphite layer only lasts so long.
    - Generally a bad idea to “pour” graphite into gap between wheel and axle. You wind up with diminishing returns.
      - (Although we do this at the race on some cars that have REALLY stiff wheels to get them to spin freely.)

# Pinewood Derby Car Design

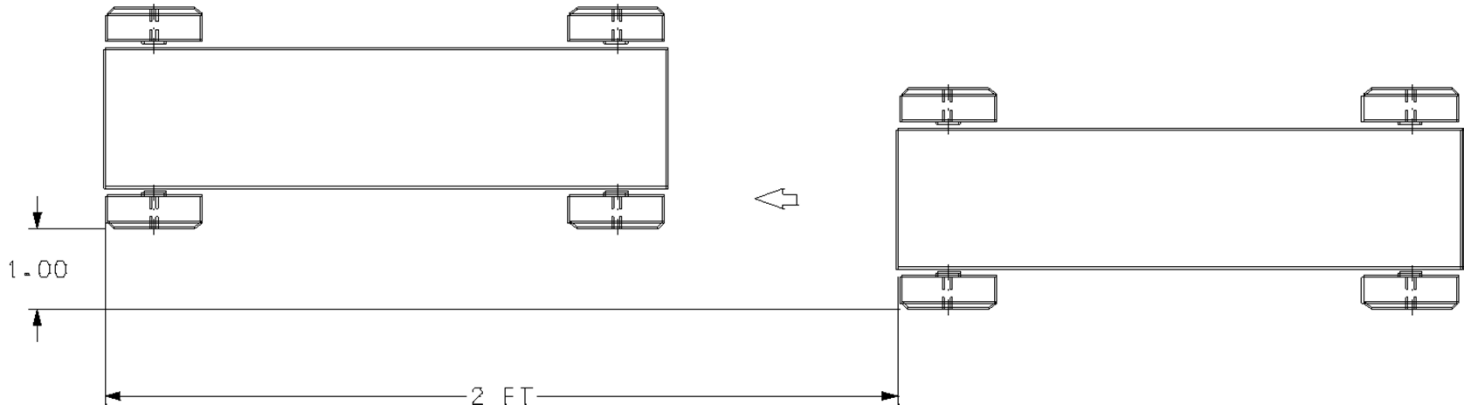


- Speed Tips
  - Steering (Rail Riding)
    - Even the most perfectly aligned car will “rattle” as it goes down the track, bouncing off the center guide strip a couple of times.
    - This sucks off a little speed with each bounce.
    - It is actually beneficial to “force” the car to one side so it stays against one side of the guide strip and doesn’t rattle.
    - Also, if you steer toward the side that has the raised wheel, that wheel will never touch the center guide strip and thus never spin up, giving you a little more speed.

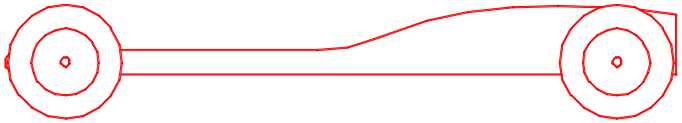
# Pinewood Derby Car Design



- Speed Tips
  - Steering (Rail Riding)
    - Don’t know optimal steering rate, but I have used 1 inch of side travel for every 2 feet of track.

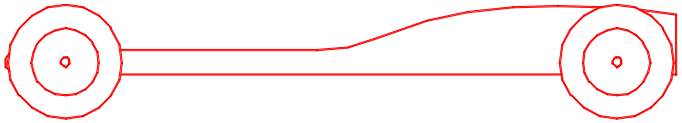


# Pinewood Derby Car Design

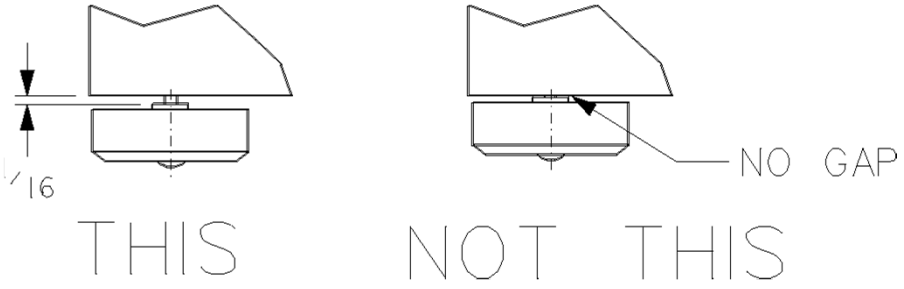


- Speed Tips
  - Steering (Rail Riding)
    - To set up steering, slightly bend nail (3 degrees or so) on forward wheel (the one that contacts the track). Rotate to get desired steering rate.

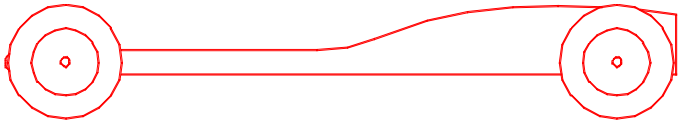
# Pinewood Derby Car Design



- Speed Tips
  - Wheel-Body Clearance
    - It is generally not a good idea to insert the nail such that the wheel barely clears the body.
    - Want that wheel free-running.
    - Don't know optimal clearance, but I generally use 1/16".
      - (Can use playing cards for spacers-5 cards.)

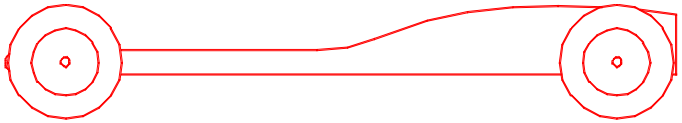


# Pinewood Derby Car Design



- References
  - There are many good on-line references for car design and speed tips.
  - Personal favorite is:
    - http://www.pinewoodderbyphysics.com/lectures.shtml
    - Detailed description of how to build a fast car with nearly no tools.
      - The car shown on every slide of this presentation is based on his "Simple but Fast" car.
    - Also delves into the physics of the speed tips described here, and why they result in a faster car.

# Pinewood Derby Car Design



- As you can see, you can expend a LOT of effort trying to build a “winning” car.
- It doesn’t have to be about the winning.
  - It’s about doing something with your cub and having fun!
  - You can build some really cool cars!