



# Trolley Design Advice

## Wheel Type

- The lighter a wheel is the more acceleration it will have but a wheel must also be strong enough to withstand the forces of steering and braking.
- The smaller the area of contact the wheel has with the track, the less drag the ground exerts on the wheel. This is great for acceleration but dire for braking - you see, it is all a compromise.
- Wheel bearings play a critical part in the speed of a trolley. Make sure your bearings are clean and use light oil.
- Your choice of wheels determines your rolling resistance. This is the amount of resistance your wheels have to the unavoidable pull of gravity that is trying to make your trolley career down the hill.
- The perfect trolley wheel is a compromise between weight, strength, contact area, braking performance, rolling efficiency and cost.
- Old motor mower wheels are fine but don't usually have bearings. Pneumatic (air-filled) and solid trolley wheels with bearings can be bought for about \$60 a pair from Bunnings or Mitre 10 Mega
- We strongly recommend the use of Pneumatic tyres, that is inflatable tyres, with decent bearings on your wheels. Aim for at least an 8-inch wheel -You can run solid rubber tyres however the roughness of the track surface doesn't make for a good ride. Small wheels can often be unstable at high speed and harder to control.
- Most bike wheels use a 3/8-inch axle however there are some that use a 1/2-inch axle which tend to be much stronger. If using bike wheels, it is recommended to have some sort of support on the outside of them to stop them "tucking in" when cornering or under speed.
- Spoke strength also affects the strength of the wheel - BMX wheels are designed for a bit more sideways punishment so tend to have stronger spokes/more spokes, and stronger rims. The larger diameter the wheel the more likely it is to buckle if your trolley is very heavy and/or your spokes or axles are weak. The course has corners, bumps and adverse camber which also put side load on the wheels. You may be required to take "evasive action" and the axles and spokes may not "handle the 'jandal' when asked to turn.
- If you want the full Monty and can find some wheelchair wheels these are very good as they generally have a very strong axle that is self-supporting, they normally have very good bearings, and strong spokes. These are generally quite large so aren't always the best for acceleration however may give you a higher top speed.



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## Brakes

There are two common braking systems:

### Deadman Braking

This is where the brakes are held in the 'brakes on' position by a spring, bungee or bike inner tube. To race, the driver pushes the brake lever, and the wheels are released. This is a great system for young drivers as the brakes only stay off while the driver is in control ~ the instant they freak out and move their feet, the trolley slows down.

### Active Braking

Cars & bikes use an active braking system.

There are many ways to create rudimentary versions, for example:

- A large piece of car tyre rubber on a lever activated by the driver's foot
- A hinged lever carrying the foot pressure via a rod to the back wheels.

If you use 10-speed or wheelchair wheels, it will be possible to have brakes on all wheels. If you have a fixed rear axle you can incorporate a bike disc brake.

## Steering

Rope steering is not permitted.

Steering should be smooth and without excessive free play. You should limit your steering angle to prevent over-steering which is the primary cause of flipping carts.

## Need ideas or stuck for what to do?

Google probably provides the best source of info and images for inspiration.

However, trolleys have many different names – in the USA Soap box derby racing, in Australia Billy Cart racing, in NZ we've kind of adopted everything, Trolley derby is probably the favourite in NZ however Soapbox, trolley billy cart go kart, gravity racers are all recognised names.

If you want to build a good tried and tested Trolley that was specially design for the Nelson Trolley Club, check out the Formula NZ Trolley Design on the internet. These trolleys make a great first time trolley that is very competitive and relatively easy to build and drive and can be modified over several years as the driver grows in confidence.



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## Cart Stability

The axle track and wheelbase of your trolley can also majorly affect stability and control at high speed. If a trolley has a long wheelbase and narrow track it is usually very stable but slow to change direction. A short wheelbase and wide track meanwhile will change direction easily but sometimes too quickly and even when you don't want it to.



Your axle "track" is essentially the width from one wheel to the other. Your wheel base is the distance between your front and rear axles. Generally speaking, the wider your "track" the more stable your trolley and the easier it is to steer. If your track is too narrow and wheelbase is short the trolley can flip easily and steering is too jerky. However keep in mind that wider trolleys often have more frontal area so worse aerodynamics and more drag = slower speeds. In widening your track, try and keep the main body of your trolley narrow for optimum aerodynamics.

## Centre of Gravity

The height of your trolley and its centre of gravity can also majorly affect your stability. If you have a high "sitting on top" driver's setup this will increase your centre of gravity and you will require a wider track otherwise you can flip your trolley. The lower your centre of gravity, e.g. the lower the seated driver, the more stable your trolley will be. The Omana course is grassy and bumpy, so too low and you won't clear the bumps in the grass.

Our design guide has been put together to help you design everything from the most basic trolley up to a real speedster so you get out there and play with gravity.

Trolleys can be as simple as the old soapbox with 4 pram wheels (but please no rope steering) or a purpose-designed, 3-wheeler recumbent with an aerodynamic carbon fibre body. 3 Wheelers have less friction and drag so generally go the fastest – Though may not be as stable as 4 wheelers. If you are designing and building your trolley to participate in the derby, then you need to ensure that your trolley design complies with the rules.

Remember, Safety First, then worry about maximum grins.



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## Shaping

There are essentially two types of vehicle construction: Chassis and Body or Monocoque. A chassis and body structure has all strength in the chassis and the skin or body is cosmetic. In a monocoque design the chassis and body elements are combined to create a more rigid and lighter vehicle. Airplanes are an example of extremely efficient monocoque design.

Both systems work well for trolley building as long as the weight and type of material is used not only to maximize performance but also to ensure the safety of the occupant, other drivers and spectators.

For a Monocoque design, 3mm - 5mm plywood makes a great overall skin structure, which can then be filled out with polystyrene, cardboard and brown paper. A design that uses chassis and body construction can really take advantage of lightweight skinning materials.

With the rigid structure taking the weight of the driver and the stresses of the braking and steering systems you can use polystyrene, cardboard, sticky tape, PVA glue and paint to create an elaborate and aerodynamic skin.

Make sure you provide clear lifting points for loading on and off the trucks!!  
Ensure any sharp or solid protrusions inside or out are well padded for yours and others safety.  
For stability and reduced air drag, position as much of your weight below the axle as possible.  
And remember, a light trolley is a fast trolley.

All carts must have an A5 size flat area on the back of the cart for your race number. We learnt in 2017 that if the Race Director and Timekeeper can't see your number, it becomes really hard to tell who is coming next and to get a quickly published time

## More Build Tips

A really great book full of plans and trolley designs that can be found in most libraries is "The Billy Cart and Trolley Bible", by Glyn and Jane Bridgewater. It can also be purchased online through [Fishpond.co.nz](http://fishpond.co.nz)

- For Basic Trolley Design Ideas check out Brian Fangio Smiths suggestions
- Some Basic trolley and kart plans can be found here - [kartbuilding.net](http://kartbuilding.net)
- If you're really keen why not try building a trolley size 1932 Ford Sedan - check out the [Instructables.com](http://Instructables.com) website
- For traditional All American Soapbox Derby carts and plans check out the official website for plans (pretty complex but great tips on steering and brakes in these plans) - [AASBD.org](http://AASBD.org)
- <http://nelsontrolleyclub.co.nz/> Plans and advice.