Formula NZ Trolley Design Tips

A safe and easy to build, cheap, entry level trolley for kids from 2 to 10 years of age.

This is a "ONE design" trolley built almost entirely from a single sheet of 12 mm construction plywood.

This will be a great project for you and your kid and will get them interested in the Derby and some basic construction techniques.

They will also get a chance to race in a One-Off Class against each other each year at the Derby.

	
Prototype	Rear view showing "parental hand hold" (a very handy feature!)
	
The Robertson's boys have tested it out and it PASSED !!	Side view show wheels - caster wheels from a wheel chair - or you can use buggy wheels but nothing over 300mm in diameter

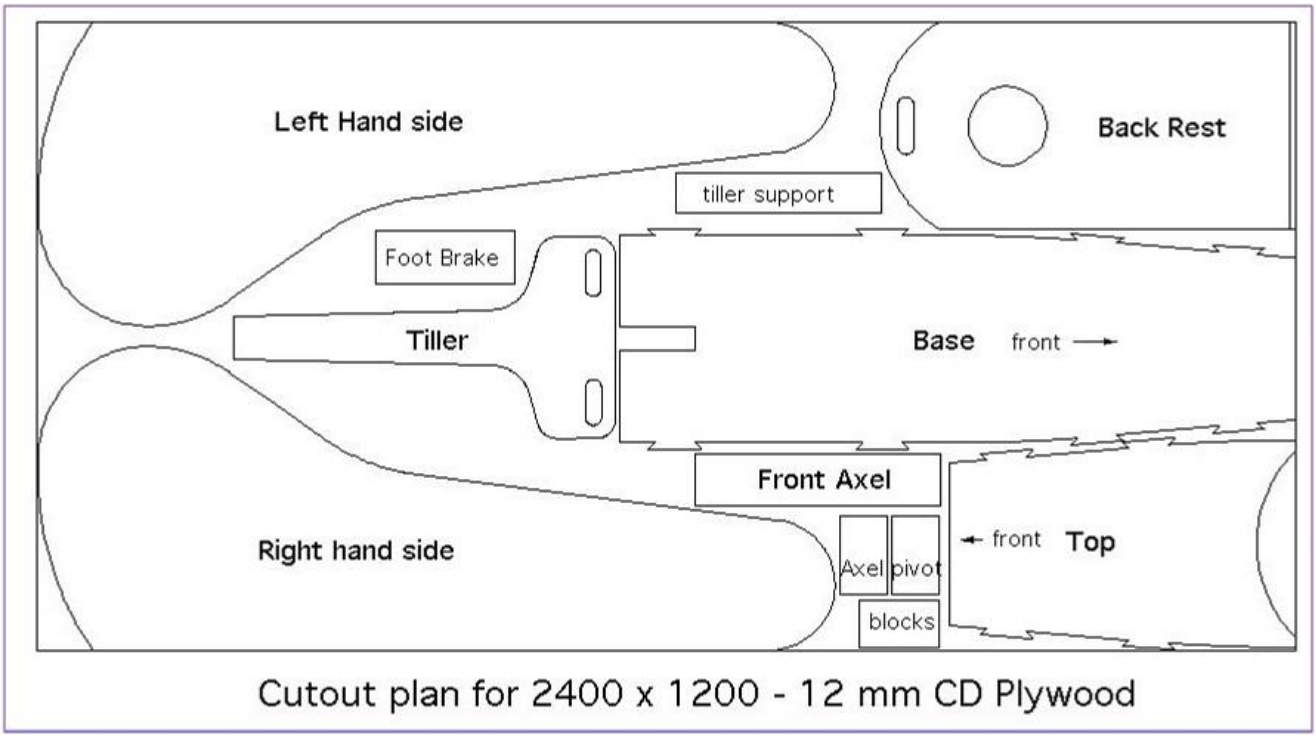
The components
ready to assemble

BUILD SESSION ONE

What you need ....

- 1 sheet 12 mm CD Ply (from Bunnings , Placemakers or M10 (about $75)
- Some 4x2 pine or an old hardwood pallet from your local trucking company
- 4 wheelchair dolly wheels or similar 150 to 300 mm max (the 300 mm max wheel diameter is a class rule)
- a few screws, nuts and bolts a bit of old tire and some rubber and cord (more on that in Build 2 and 3)

The components as they cut from a single sheet of 12 mm Ply



Cutout plan for 2400 x 1200 - 12 mm CD Plywood

STEP 1: get your plywood and place GOOD SIDE UP on some trestles or boxes so it is stable, level and at a good height to work on and layout the plywood parts as below

The 2 Sides are laid out so the bottoms are formed by the edge of the ply sheet.

The Top is laid out on a centre line drawn 205 mm from the bottom edge of the sheet.

The Base and Tiller are laid out on a centre line that is drawn 595 mm from the bottom edge of the sheet.

The Back Rest lays out with it's top edge formed by the top edge of the sheet.

The rest of the pieces layout in the spaces left as shown above and to the dimension in the two Cut sheet as per the PDF drawings below.

So now you can go ahead and mark out and check twice and then cut out all your plywood components.

You will notice little wedge shaped pieces of ply on the base and top .... these you need to cut very carefully at 45o .... later you will make and cut slots in the sides for these to fit into like a jigsaw puzzle - these are important as they will really hold your trolley together well - so take your time to get these right.

More next week when we cut up the 4x2 and put the basic trolley together
(Note : we also have some templates of the cut outs if you want to borrow .... email us and can give you any advice you need).

Return to the website to obtain a full copy of the design drawings.

BUILD SESSION TWO

Now you have all your plywood cut out as below ?

Cutting out the top curve

You will notice little wedge shaped pieces of ply on the base and top "dovetails" .... these you need to cut very carefully at 45 degrees .... later you will make and cut slots in the sides for these to fit into like a jigsaw puzzle - these are important as they will really hold your trolley together well - so take your time to get these right.

You should mark them out with a 35 degree try square and cut with your jigsaw as below.

If you cut them with a knife as below the jig saw will sort of follow the line - don't try to cut out the corresponding holes in the sides till later.

Here are all the basic pieces cut out of the one sheet

To mark out where to "doves" should cut on the sides for the "tails" ... fix (ie screw) the base to the side of your bench and then lay the corresponding side on it lined up so that front of the base is a 110 mm back from the very front of the side.

Now you can carefully mark where each "tail" intersects with the side ready to cut out ... note you have to be careful here as the base (and later the top) has a curve in it so you have to kind of "rotate" the side around this curve marking as you go ..... need more than 2 hands here! If you just mark it "straight" then the back cutout will not be in the right place as you bend the sides into place.

Once you have the side cutouts marked for the base .... repeat for the top ... starting it at the same point 110 mm back from the front. This one is easier as there are just 2 cutouts and they are on the straight section so easier to mark.

Once both sides top and bottom are marked out you need to cut them the correct depth and width ... you can do with your jigsaw or you can do them with a table saw with a smallish blade by winding the blade up into the ply (only do this method if you have good table saw skills!).... set the guide so that the saw cut is the right width for 12 mm ply and test on a scrap of ply as to where the blade has to cut up to to reach each side of the long side of the doves ... underside of the plywood shown below which is the outside of the trolley.

Once you have established how far the saw has to be raised up and where the center point of the dove has to be in relation to a mark on you guide you can set up and cut all the doves out.

Now you can cut the 45 degrees of the doves with a back saw and cut out any remaining bits not cut on the table saw or with the jig saw.

Now that all your doves are cut you can "marry" them to the corresponding side of the base and fit in place ... dry fit to start as you may have to recut the doves a bit to fit into the corresponding tails ...

Once happy with it you can glue and screw it together (I use Gorilla Glue as it tends to fill any gaps you may have but you can use white glue if you want)
Use #6 1-14 Pozi screws or similar (as #8 tend to be a bit big and split the ply)…. you can screw in from the sides and also up from the underside in each tail to pull it all together nicely.

Once both sides are screwed to the base you need to install the back rest which will make sure it is all square. This is laid out as per the dimensions on the sides layout detail - 385 mm from the back at the base and 100 mm at the top.

The back gets glued and screwed behind this line.

Now you can dry fit the top in place but DO NOT screw in place permanently. You now have the basics of your trolley.

Now screw and glue together your axle pivot blocks.

Once all three are together you need to nail and glue some ABS plastic or similar on top (I used offcuts from the Vent Shop here in Nelson who make ABS plumbing pieces but you could use the lid of a 10 lt plastic paint can). Glue with Gorilla glue and hold in place with for 30 mm brads. This plastic provides a smooth slippery surface for the axle to pivot on.

The axle pivot block is then screwed and glued in the front of the base ... it is centered (the 150 mm dimension goes across the base) and over hangs the front of the base by 10 mm - screw from underneath through the base .

Now you need to make up the axle and cutout the sides for it.

Below is a made up one
470 mm long x 100 mm wide - 12 mm ply
The block in the middle is where the tiller will mount.
The black blocks are foam and ABS plastic that run in the slots in the sides and form a bit of a shock absorber for the axle.

You will need some 12 mm high density foam rubber (from Para Rubber). Cut this into 40 mm wide strips and the same length as the width of the axle ply. Also cut 2 strips of ABS plastic the same size.

Mark in 45 mm from the end of the axle, glue and nail the rubber with ABS on top .... hold in place with 30 mm pins making sure that you don't drive the nails home (you will remove them when glue has cured).

Tack the nails into the plastic before you drive them through the rubber and into the ply.

Once the blocks glue has cured then you can remove the pins by twisting and pulling with a pair of pliers ... (don't pull out with a claw hammer as the plastic will come off). Then you can place the axle on pivot block in the front of the trolley and you can mark where the heights of the side slot that the axle will pass through. Transcribe these marks to the outside and then mark it out 25 mm infront of the "110 mm line" and 140 mm long.

Cut out the square with your jigsaw ... you can then slide the axle through from side to side.

More next week when we cut up the 4x2s install the wheels and put the final trolley together ready for Resene's Paint day

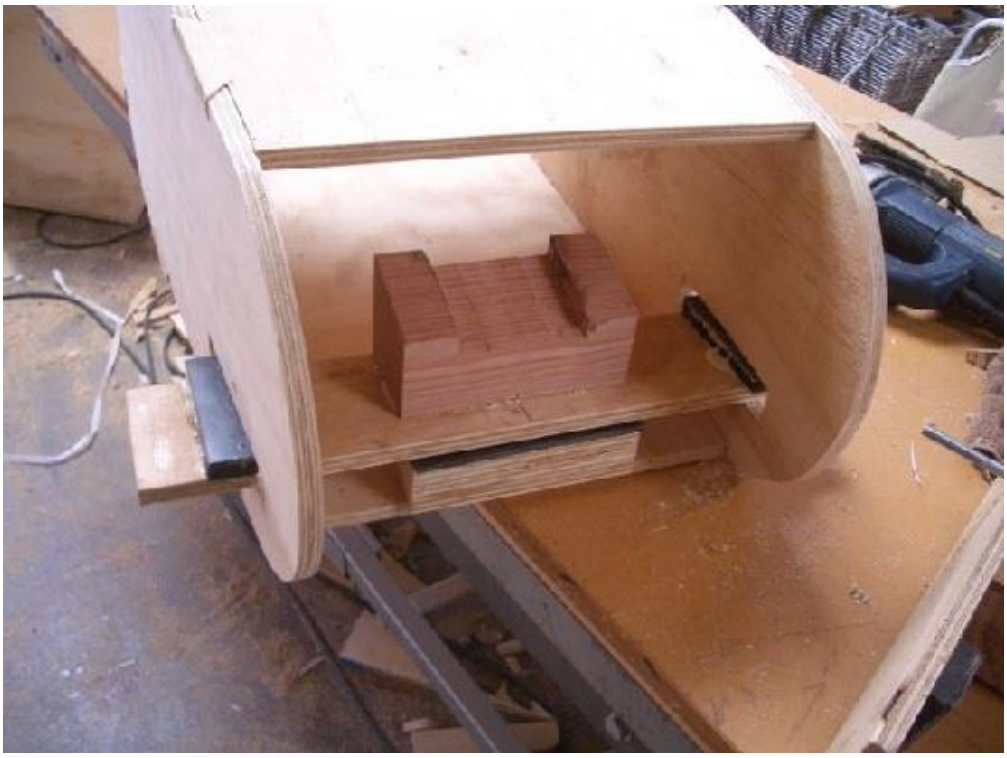
BUILD SESSION THREE

Now it is time to finish off your trolley ready to race ..

Time to drill out the hand hold in the back rest - using a hole saw then jigsaw out the opening and sand smooth.

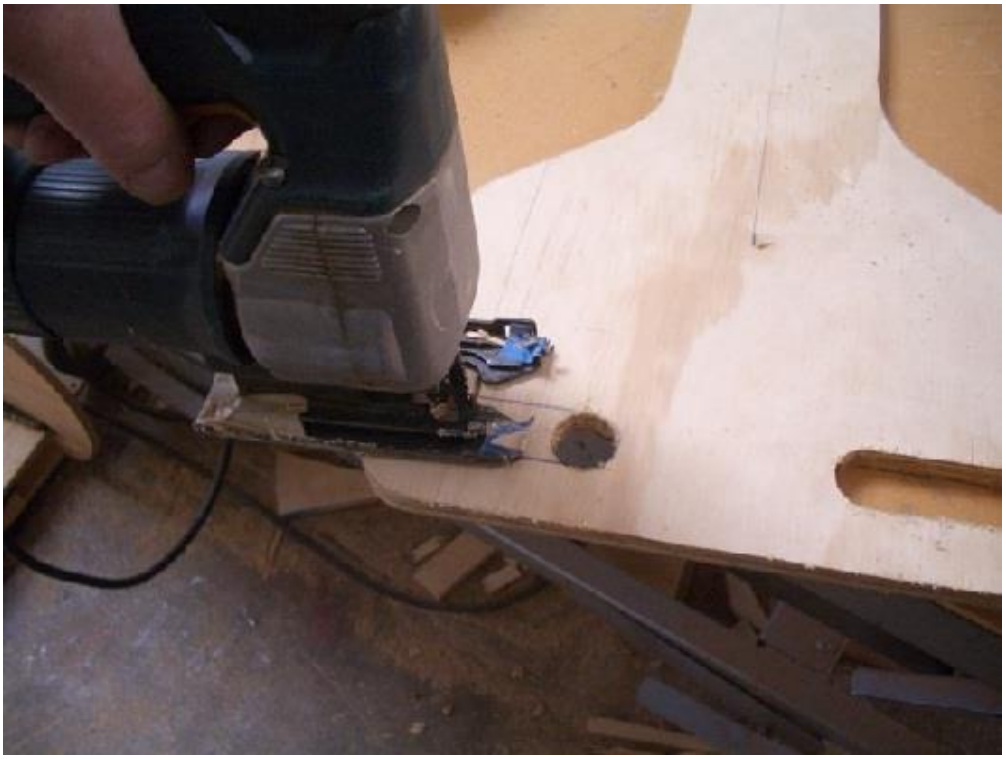
Once you have the front axle all made up with tiller block you slip it back into the trolley one end at a time and put a screw through where the pivot bolt will go - as close to the tiller block as a washer will allow (you can cut into the bottom of the block a bit to allow the washer to

slip under). The axle should line up parallel with the front edge of the base and be exactly centered across the trolley and the screw goes in the centre.



Drill out the ends of the hand holds in the tiller.

Then cut them out with your jigsaw and sand the edges smooth.



Now install the tiller - Remove the top and install the tiller into the slot in the top of the tiller block - make sure the axle is at right angle to the trolley body when the tiller handle is centered between the side of the trolley - fasten by screwing in place as shown.

Install the tiller support under the tiller around the area where the tiller expands
Install this a little higher so that holds the tiller up a little higher that its normal resting place (this stops the kid from ripping the steering out in an excited moment of racing).

Now remove the screw and drill your axle pivot through the axle ply and into the pivot block using the hole made by the screw - use a 8 mm HT bolt here with washer top and bottom and a Nylock nut .... tighten till tiller and steering feels nice - make the hole as tight as you can and wind the bolt in ..... if it too loose you will have sloppy steering which will only get worse ...

Now is a good time to sand your trolley down making all the dovetails are smooth and flush and edges sanded and rounded off a bit - last thing we want is a splinter in your kid 1/2 way down the hill ... very distracting to driving !!

Next it is time to install some wheels.....so cut some 100 x 50 and install against the inside back edge of the trolley on each side as shown below.

Glue and screw the 4x2's in place. Then measure 100mm back from the back edge of the trolley side and square up and across the bottom.

Measure your wheel's radius and subtract 50 to 60 mm (this allows for 50 to 60 mm of ground clearance for your trolley).

Measure up the difference and mark where you wheel will mount (eg for a 200 mm dia wheel will be 100-60 = 40 mm if you are using the max wheel size of 300 mm you would be 150 -

60 = 90mm up which means you would need to use 150 x50 timber inside the back wall of the trolley so that the axle bolt goes through this block).

The diameter of the bolt you use depends on the bearing size of your wheels BUT you will need to use high tensile bolts to hold your wheels on. Blacks have lots.

Drill a 1/2 sized hold from each side.

unless you have a drill press you should drill from both sides s that the hole is nice and square or get someone to sight your drilling.

Then drill a hole just under size of your bolt .... install a large flat washer, as shown, on your bolt and thread into the hole.

Holding the wash tight down on the bolt, drill two small holes in the washer top and bottom, countersink the holes then glue with Gorilla glue and screw the washer in place.

This is important to install as it gives your axle bolts something solid to bear on when the load comes on them.

Repeat on the other side and leave 24 hours to dry.

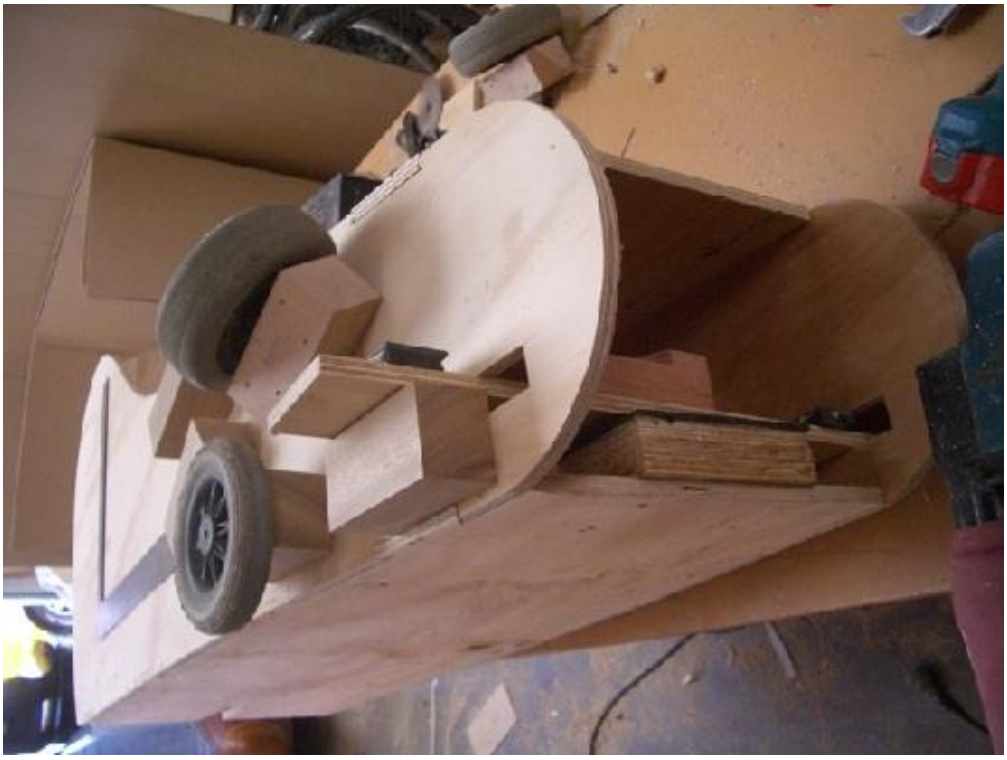
Once dry install your wheels with a small washer on each side , making sure it does not touch the outside of the bearing.

Now do up the NYLOCK nut on the inside so it is just tight (very important to use lock nuts everywhere as plain nuts will rattle loose 1/2 way down Collingwood St !!

Now you are ready to install the front wheels on the front axle plywood.
Cut 2 blocks of hardwood for these ... approx size 50 mm thick x 60 mm deep by 110 mm long. These are then mounted on the axle as below - make sure they are nice and square with the axle.

Clamp and pre-drill one hole and install a #8 1 1/2" long screws (square head are the best to drive in).

Measure the clearance of the block and your front wheel size to work out where the hole should be giving you 50 to 60 mm of ground clearance.



Install the brake pedal as shown (check where the best position is for your driver)it has 3 holes driledl in down the side next to the side and use an old door or gate hinge.

The three holes are so you can thread the brake rope through the bottom one then back through the middle one and back through the top one and then tie it off to a screw in the back of the brake pedal - the only rope to use here is 5 mm Dyneema from Burnsco ... it is totally non stretch and works great.

Now you need to set up your brake as show below.

You have two bits of wood the same as the rear axle supports screwed either side of the slot in the base. Then between them goes the brake which is a 4x2 with a curve on each end

...the bottom has an old bit of car tyre glued and screw on it.The top has a grove for the rope.

You will need to put your trolley on a flat surface to work out where to pivot and place the brake ... you want a bit of ground clearance when it is held in the off position by the bungy cord but you don't want it too high .... when you apply the brake full on you should be able to lift the trolley rear wheels off the ground.

Now install a 2x2 cross bar almost level with the top of the brake when fully on.

Your Dyneema rope then gets stapled on the back side of the brake and goes through a hole drilled in the brake, then up over the grove and through a wee pulley (also from Burnsco) and across the right hand side where you install the second pulley.

You then drill a hole through the back rest level with this back cross bar and feed the rope through it and up to your brake pedal.

Now install a second cross bar on the rear of the back rest, just under the head hole... now your bungy goes from here over the two groves in the first cross bar and gets stapled to the back bottom corner of the brake.

You will need to have the pedal almost vertical with the rope - just tight against the bungy.

Now you need to make on the underside of the top where this point is and you install the brake stop on the underside of the top.

Now you can reinstall the top for the last time ... making sure the brake pedal rests tight up against the stop.

Now you are DONE ... and it is time for a test push and here is what a bunch of them look like before paint

and here is what they look like after letting the kids loose at Resene Paint Day

HAPPY RACING
any questions ... just email us

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