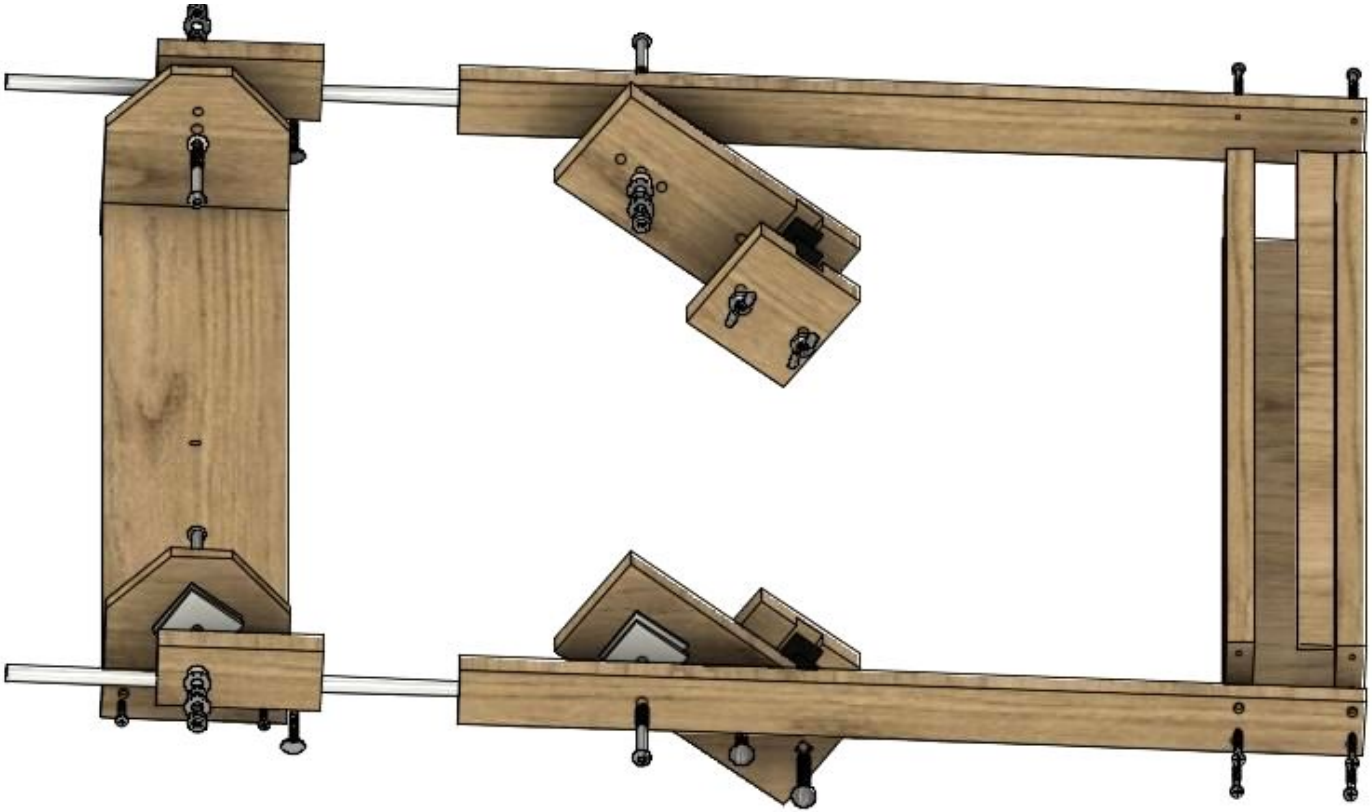
Bino-Chair Component Plans:
Teeter-Cradle for Elevation Control, Metric



MWL-M2503 v1

Table of Contents

Getting started

Welcome to this teeter-cradle, the main component for bino-chair elevation control. It has evolved from an award winning prototype. Building it will be especially rewarding when you see how well viewing is enhanced. The primary purpose of these plans is superior functionality and user comfort, while aesthetics is only a secondary concern.

A video showing this elevation control in action is on the front page of the main site: milkywaylounge.com **This "must see" video introduces the teeter-cradle mechanics:** milkywaylounge.com/?p=837

As always, please expect a little trial and error as you build, because you're fitting to your chair's geometry. You will surely see that the results are well worth the extra effort that you put in. These plans are intended to be somewhat adaptable to fit a moderate range of typical chair sizes. These plans fit a teeter-cradle to a standard zero gravity chair frame. Adjust otherwise.

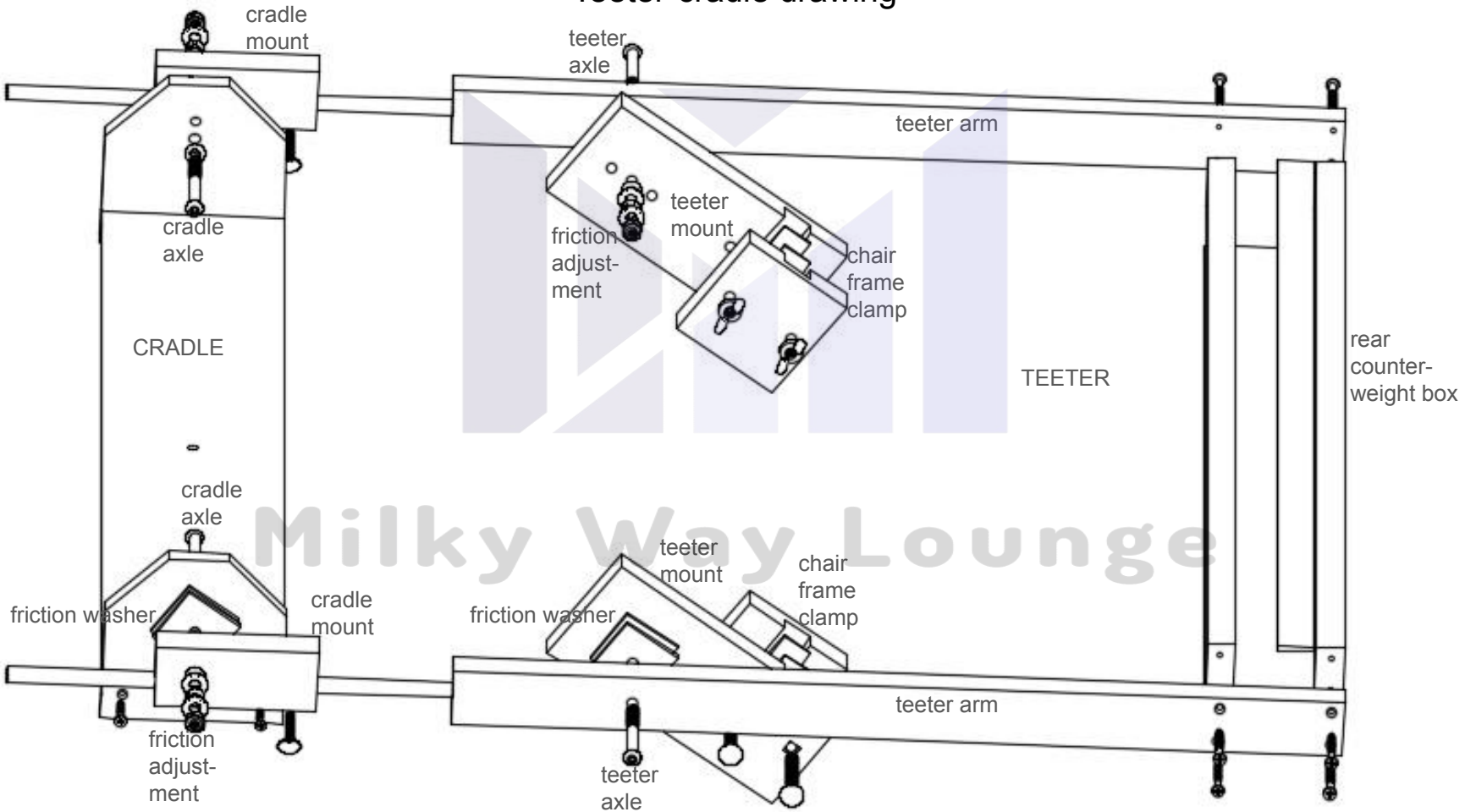
If you have not selected a chair yet, here is an important post: milkywaylounge.com/?p=641 A chair is needed for building and testing this teeter-cradle. Some customization can be employed for very different chair styles and sizes. However, one can save time and uncertainty and achieve better results by using a standard zero gravity chair. Without one, functionality will be limited, and some design aspects would need to be altered. Using an old chair that you happen to have lying around is unlikely to work out satisfactorily, and may be unsafe.

Safety is more important than anything else in this project. Never perform a construction step unless you have full confidence that it can be done safely. Workpieces must be held down or guided. Cutting equipment must be understood. Get help where unsure. Have someone available just in case.

These plans contain only relevant information, so it's advisable not to skip sections. Please publish your reviews under the main site's Reviews tab, or send an email with constructive criticism. Have fun building!

Technical support and contact: contact@milkywaylounge.com

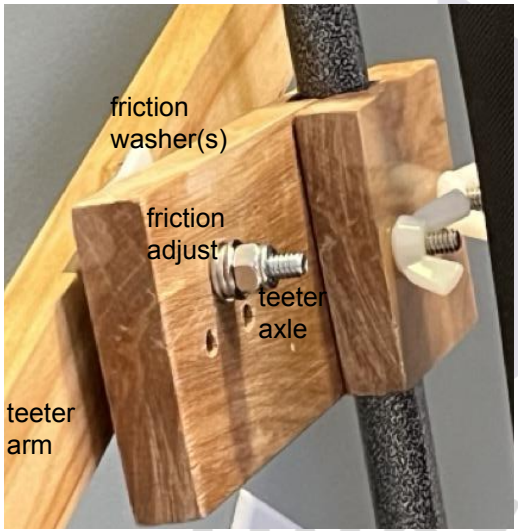
Teeter-cradle drawing



Overview of the elevation control

Teeter: This seesaw is mounted on the chair's backrest with the teeter mount blocks. When the backrest is tilted, the teeter follows along.

Teeter mount: A pair of wide blocks, is clamped to each side of the backrest (one pair pictured below). Round or square channels are cut into the blocks so that the chair frame can be clamped with bolts and wingnuts. It holds the teeter axle, connected to the teeter arm.



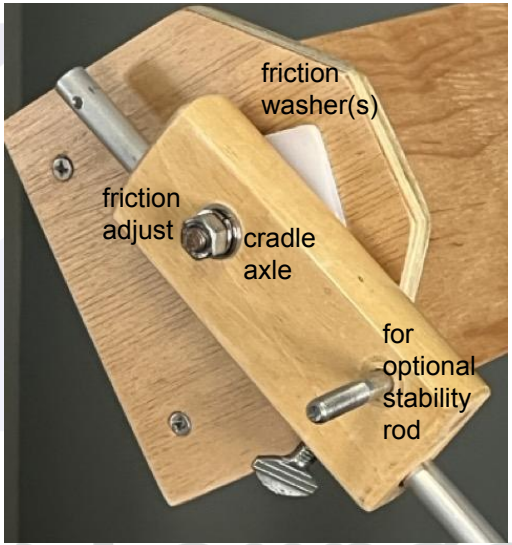
Teeter mount: one side

Axle friction: The axle's swivel friction is set by partially tightening the axle nut. On this axle a split-lock washer keeps some compression on large friction washer(s). To retain that setting, either use a nyloc nut or a pair of hex nuts with a retaining washer in between them.

Cradle: The swiveling cradle is mounted on the end of the teeter using a cradle mount block on each side.

Cradle Mount: The blocks hold the cradle axle and can slide forward and back on the aluminium tubes (one block in the foreground below).

Cradle mount: one side



Chair-front counterweight: to offset the weight of the loaded teeter-cradle. It makes it easier to tilt the chair back and forth.

Stability rods: to reduce view drifting and "heartbeat". This option is detailed in a section at the end of these plans.

Parts and materials

See also: parts and materials list for the optional stability rods.

Chair:

- choose a chair early; a standard zero gravity chair is recommended. Important: www.milkywaylounge.com/?p=641
- the frame is typically 19mm (¾") and the upper parts of the sides of the backrest frame must have no fabric attached (pic at right)
- rated for at least 350 lbs (160kg), regardless if user's weight is less
- standard width ~76cm, regardless if advertised as XL or Oversized
- appropriate brands: Portal, Timber Ridge, Cabela's Big Outdoorsman Lounger, Ever Advanced (Amazon, etc)
- for a wider chair or a different style, adjust the wooden parts requirements below.

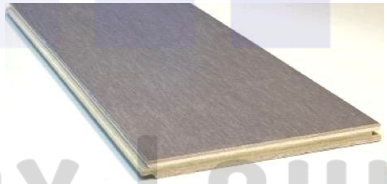
19mm x 80mm hardwood flooring

Hardwood:

- 180cm of hardwood 16-19mm thick, ~80mm wide, straight
  ex: hardwood flooring (see pic) is strong and pre-finished on one side. Can be cut to the required ~67cm, 56cm, 28cm, 28cm and ripped to ~38mm. Underside grooving can optionally be removed with a table saw, for a final thickness of 16mm to 17mm
  birch, maple, poplar or similar is strong and not too heavy
- 23cm hardwood 22-25mm thick ~41mm wide (suggest an extra piece)

Lightweight quality ply material, for cradle:

- 10-13mm thick, ~12cm x ~92cm (the longest piece is ~67cm)
  ex: a multi-ply flooring plank (see pic) is strong, stable, prefinished
  avoid vinyl laminate flooring, heavy materials, and flexible materials



11mm light multi-ply flooring plank

Heavy board(s), as ~2.2 kg counterweight to fit the chair front:

- ~19mm hardwood, ~70cm x ~15cm ex: a heavy stairway riser may be smooth and prefinished (see pic); add more heavy material, to make a total of ~2.2 kg.

19mm heavy stairway riser

More parts, materials, tools and supplies

Aluminium tubes: ex: www.amazon.com/gp/product/B0DHCD95TD
- two 12” (300mm), OD: ⅜” (9.5mm) with use of ~10mm drill bit
  alternative OD: 10mm with use of a larger drill bit
  the 6063 alloy should work, but 6061 is stronger
- recommended drill bit: 10mm or 13/32” long fluted bradpoint

UHMW for friction washers: (rigid, durable, good friction)
can start with this alternative: 8 to 16: M6 nylon fender washers
- ⅛” (3mm) buyplastic.com/uhmw-polyethylene-plastic-sheet/
  two 5-¾” (145mm) square white sheets
  white is unprocessed and may have better friction properties than black; UHMW fender washers are hard to find; teflon is less durable, less workable, and may have too little stiction

Hardware: from building suppliers or online, use ¼”-20 or M6x1
if starting with non-stainless; consider replacing later with stainless
if starting with fully threaded; consider replacing with part threaded
- 6: cup head bolts M6x1, ~50mm
- 4: hex head or button head bolts M6x1, 55-60mm
  ideal: button head, hex drive, partially threaded
- 8: nuts M6x1, later replace with 4 nyloc nuts
- 8: split-lock washers M6, 8: M6 washers
- 6: nylon wingnuts M6x1
- 8: 2-3mm M6 nylon washers, OD: 13-16mm
- 3: M5x0.80p wing screws, threaded length 15-20mm
- optional: 2 M6 nylon flange bearings, length 6-10mm
  4: acorn nuts M6x1

Wood screws:
- 8: hardwood screws: ~35mm M4x0.70p countersunk
- 2: wood screws: any ~30mm M4x0.70p
- 4: wood screws: ~25mm M3.5x0.60p countersunk

Rubber: for square channels use ~1.5mm (1/16”) small sheet, high durometer rubber amazon.com/dp/B0D4Q12FT7/ For round channels, instead of rubber, use tacky glue or similar.

Miscellaneous:
- Thin material: ~3mm x ~80mm x ~67cm ex: plywood/pressboard
- Trim molding: ~3mm x ~25mm x ~67cm
- Mat material: ~15cm x ~66cm ex: foam mat, carpet square
- Set of ankle weights: ex: with five 400g or 1 lb sandbags

Wood Finishing: exterior semi-gloss/satin wood finish, spray/brush, ex: spar urethane spray

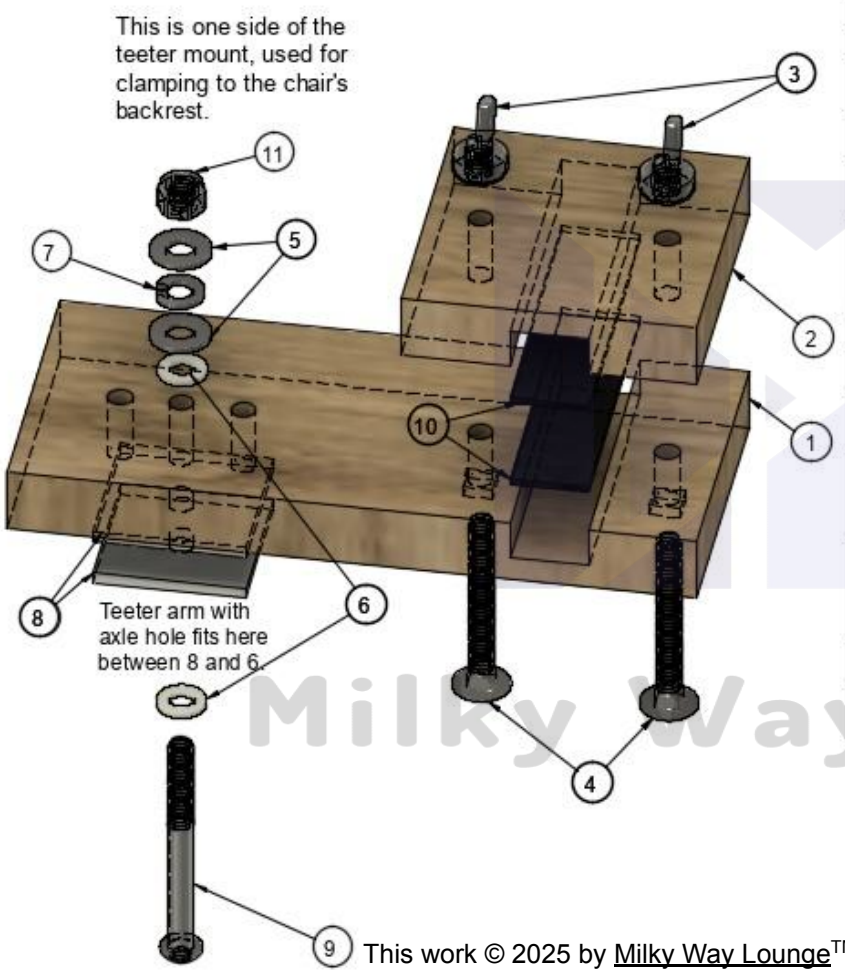
Recommended power tools: drill, table saw, crosscut saw or circular saw, drill press, small belt sander. A router is recommended for those experienced with woodworking. There are methods to keep a power drill perpendicular to a workpiece, however once you get a drill press you will never look back. A table saw can do a much better job than a circular saw, and is generally safer to use.

Other tools and supplies: sharp wood cutting blades, hand tools, tape measure, utility knife, scissors, paint brush, masking tape, duct tape, black sharpie, contact cement, small chisel, assorted sandpaper grits, small wood screws, small wrenches to fit hex nuts, countersink bit, optional: tacky glue or similar.

Safety: ear protection, safety glasses, dust mask, gloves, and ventilation for wood finishing.

Novice builders: For those with limited experience with woodworking, there are some guidelines on the Advice page at the end.

Teeter mount: parts drawing (one side)



MWL2503 M1 METRIC TEETER MOUNT PARTS LIST			
ITEM	QTY	PART NAME	DESCRIPTION
1	1	LONG TEETER MOUNT BLOCK	HARDWOOD
2	1	SHORT TEETER MOUNT BLOCK	HARDWOOD
3	2	NYLON WING NUTS (2)	M6X1
4	2	SQUARE-NECK CUP HEAD BOLTS (2)	M6X1 ~50MM
5	2	WASHER	M6 STEEL
6	2	NYLON WASHER	M6, 2-3MM THICK
7	1	SPLIT-RING WASHER	M6 STEEL
8	2	UHMW CUSTOM WASHER(S)	3MM, CUT/DRILLED 38MM SQUARES
9	1	BUTTON HEAD HEX DRIVE BOLT PARTIALLY THREADED	M6X1, 55-60 MM
10	2	CUSTOM PAD	1.5MM HARD RUBBER
11	1	NYLOC LOCKNUT	M6X1

double this parts list to include both teeter mounts;
instead of a nyloc, it is preferable to start with two hex nuts and a retaining washer between them

Teeter mount: cutting blocks and channels

Prepare: Use 16-19mm hardwood. If using flooring, consider removing the grooved underside of a long straight board with a table saw. Remove the minimum so that the thickness ends up 16-17mm. Belt sand for uniform thickness, and smooth the edges. Make two teeter mounts, as described.

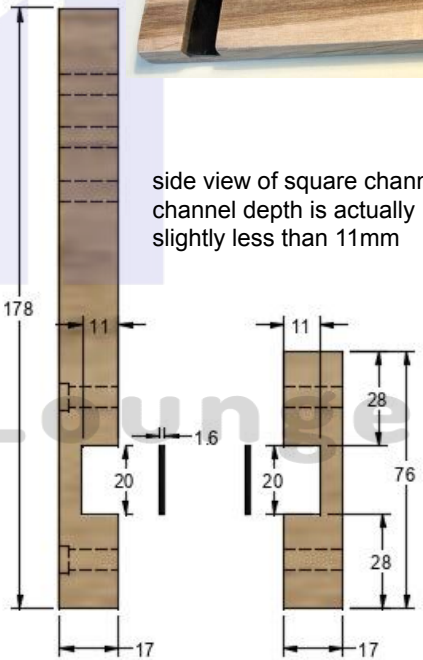
Cut out and mark two lengths: Rip to ~75mm with a table saw. Crosscut two pieces to 26cm each. Check that the pieces are very square. Sand the ends and edges. These two blocks will later be cut into 7.6cm and 18cm pieces, but for now these 26cm blocks are easier to handle when cutting the channels. The channels must be cut across the wood grain direction. These 19mm wide channels will be centred 4cm from each end, as shown, and the cut line is also shown for cutting later into the 7.6cm and 18cm lengths.

For tall users: If taller than 188cm then see the Advice page for a recommended change to the teeter mount.

Cut channels: Assuming a 19mm chair frame, here are three ways to cut channels. Also refer to how they will be tested, on the next page.

With a table saw or with a router, cut 19mm wide square channels slightly less than 11mm deep with repeated passes or with a dado blade. The backs of these channels will later hold ~1.5mm rubber pads (shown above to the right).

Alternative: With a router cut round channels with a 19mm round-nose bit. Starting shallow, do successive passes, holding the workpiece tightly against the mitre gauge and the fence, especially since routing across the grain.These should be slightly less than 9.5mm deep. Round channels will not use rubber pads.



side view of square channels; channel depth is actually slightly less than 11mm

Teeter mount: drilling blocks, testing, use of pads

Test channel depth: Sand all edges and corners. Smooth the backs of the channels with a chisel and sandpaper. Surround the frame with two channels. The channels should be slightly shallow, so that when clamping, they can grasp the frame. Tape rubber pads into square channels. The clamps should close most of the way. If not, make the channels slightly deeper. If a channel is too deep, try doubling up one rubber pad. The final test will come below after clamping with the bolts and wingnuts.

Cut each 26cm piece into 7.6cm and 18cm pieces, where marked.

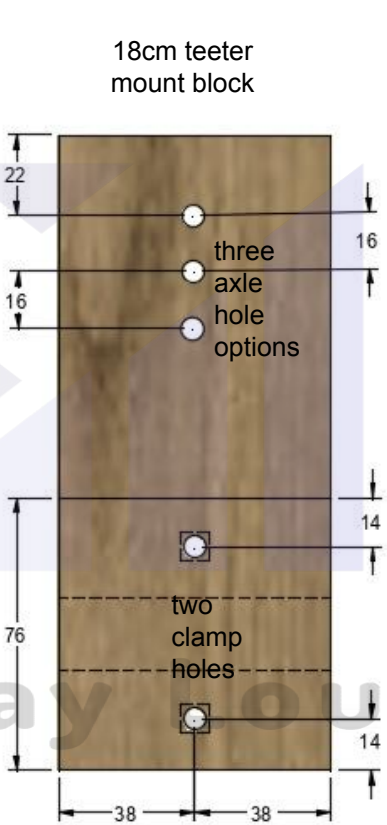
Drill clamp holes: 6mm holes should be drilled using a guided perpendicular method. A 7.6cm piece should be clamped or taped tightly to a 18cm piece, while the channels are exactly opposite each other (as shown). Drill one hole, then insert an M6 bolt in the first hole while drilling the second hole. Mark all four blocks and their orientations, so that later the blocks and holes will always be mated correctly.

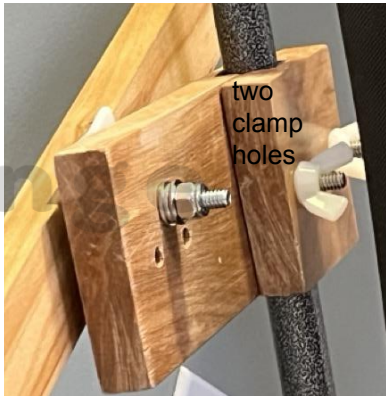
For the two clamp holes on each 18cm piece, chisel just enough room for the square collars of the cup head bolts to fit snug. Alternative: any 45-50mm bolt with low profile heads can be glued into the 18cm pieces.

Final channel test: Tape rubber pads into square channels, and test that both bolts can be inserted while clamping a chair frame (as shown). The clamps should close most of the way when tightened with nylon wingnuts. If not, make the channels slightly deeper. Again, if a channel is too deep, try doubling up one rubber pad.

Drill axle holes: Drill three 6mm teeter axle holes, for options, as shown.

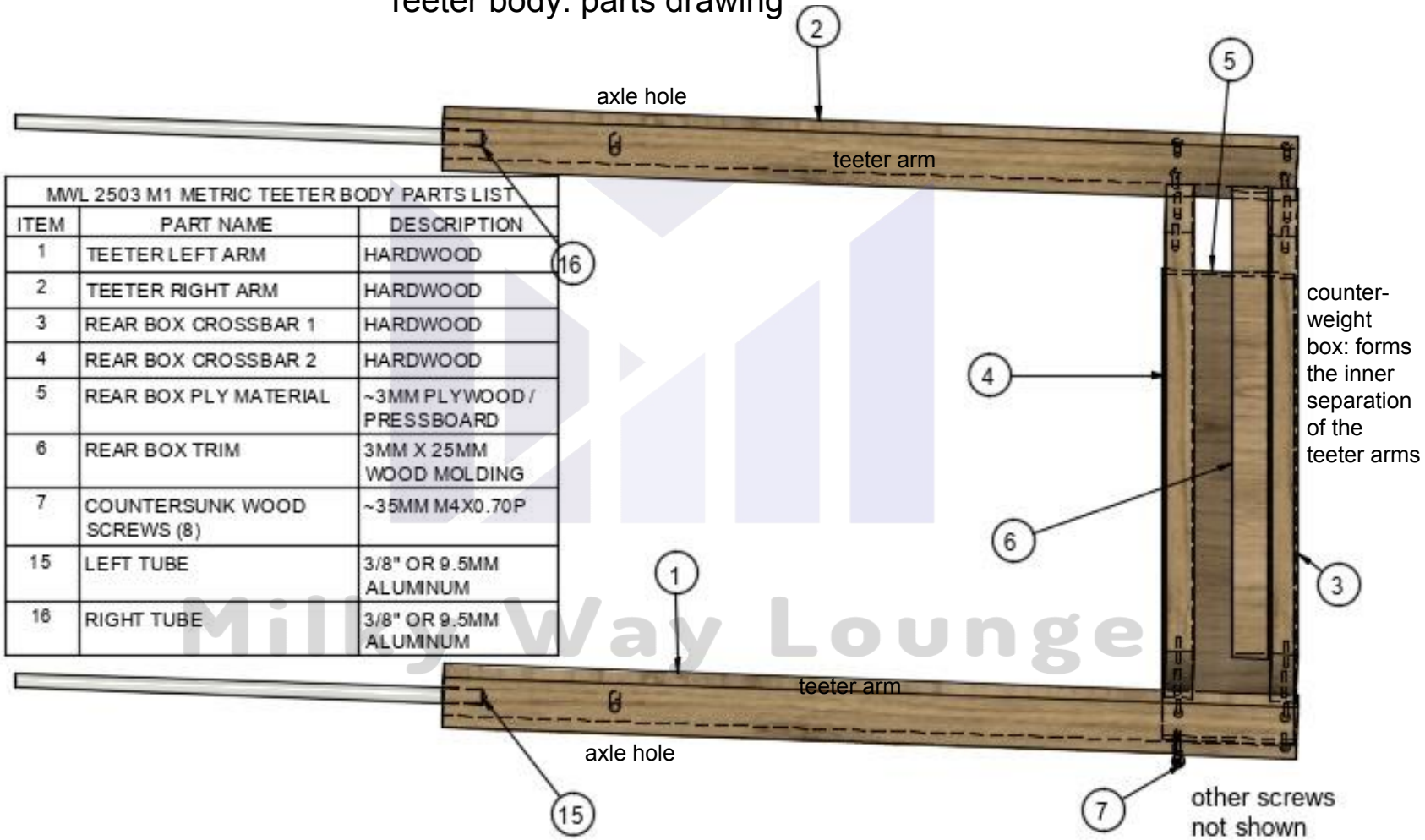
Pads for channels: Smooth and clean the channels and the rubber. For square channels glue in the pads with contact cement or super glue. For round channels apply tacky glue or similar to be completely dried before using.





Teeter body: parts drawing

MWL 2503 M1 METRIC TEETER BODY PARTS LIST		
ITEM	PART NAME	DESCRIPTION
1	TEETER LEFT ARM	HARDWOOD
2	TEETER RIGHT ARM	HARDWOOD
3	REAR BOX CROSSBAR 1	HARDWOOD
4	REAR BOX CROSSBAR 2	HARDWOOD
5	REAR BOX PLY MATERIAL	~3MM PLYWOOD / PRESSBOARD
6	REAR BOX TRIM	3MM X 25MM WOOD MOLDING
7	COUNTERSUNK WOOD SCREWS (8)	~35MM M4X0.70P
15	LEFT TUBE	3/8" OR 9.5MM ALUMINUM
16	RIGHT TUBE	3/8" OR 9.5MM ALUMINUM



Teeter pieces: cutting and drilling

Measure: Clamp the teeter mounts to the backrest and measure across from outsides of the two 18cm blocks. Add 1cm to account for one or two of the large friction washers on each side. This measurement becomes the “teeter arm inner separation”.

Cut teeter pieces: Use 16-19mm straight hardwood. Rip two 4cm wide pieces from a 122cm length. For the teeter arms, cut 56cm off of each 122cm piece. The remaining two pieces will be used to make the rear counterweight box. Cut these two pieces at the “teeter arm inner separation” from above, starting 3mm longer. Sand and smooth the faces, ends and edges.

Drill tube holes: Practicing this step is very helpful. On the front end of each 56cm piece, drill 2.5cm deep tube holes that are slightly wider than the tubes. Use a 10mm or 13/32” bit for ⅜” or 9.5mm tubes. Long fluted bradpoint bits are good**.** The workpiece may not fit under a drill press. Use a method to guide the bit perpendicularly. One method is to refer to the pic at the far right. At the corner of a workbench, clamp three items: the workpiece, a 3mm wood spacer under the bit and a small guide block. Keep the bit parallel with the guide block and with the table top. Alternately view from above and from the side, and slowly drill 6mm at a time. Finish a ~2.5cm deep perpendicular hole.

Check tube holes: Insert a tube and check for alignment. Later the tube will be epoxied in, and can held closer to alignment while the glue is drying. If alignment is very poor, start over, or the other end of the 56cm length could swapped for the front end.

Drill axle holes: At 13cm from the front of each 56cm piece, drill a 6mm axle hole in the centre, keeping very perpendicular.

Cut square washers: With a table saw, cut four to eight ~38mm UHMW squares. Drill a 6mm hole in the centre of each. Carefully sand all burring with 100 grit. This process need not be exact, but the washers should have no burring. Nylon fender washers are an alternative, but their friction is higher. Teflon is not as durable and the friction may be too low. One or two washers will be used on each axle of the teeter.

Drilling tube holes with the bit parallel to the guide block and to the table top

Teeter rear counterweight box, teeter assembly

Rear counterweight box: This design holds up to five 450g ankle weight sandbags, or similar. It will counterbalance heavier binoculars, due to leverage and due to the weight of the box itself. The top of the container is partly open for accessing the sandbags, but secures them at any teeter angle. All wood parts should be smooth, to avoid tearing the sandbags. Plan on orienting outward any prefinished hardwood faces.

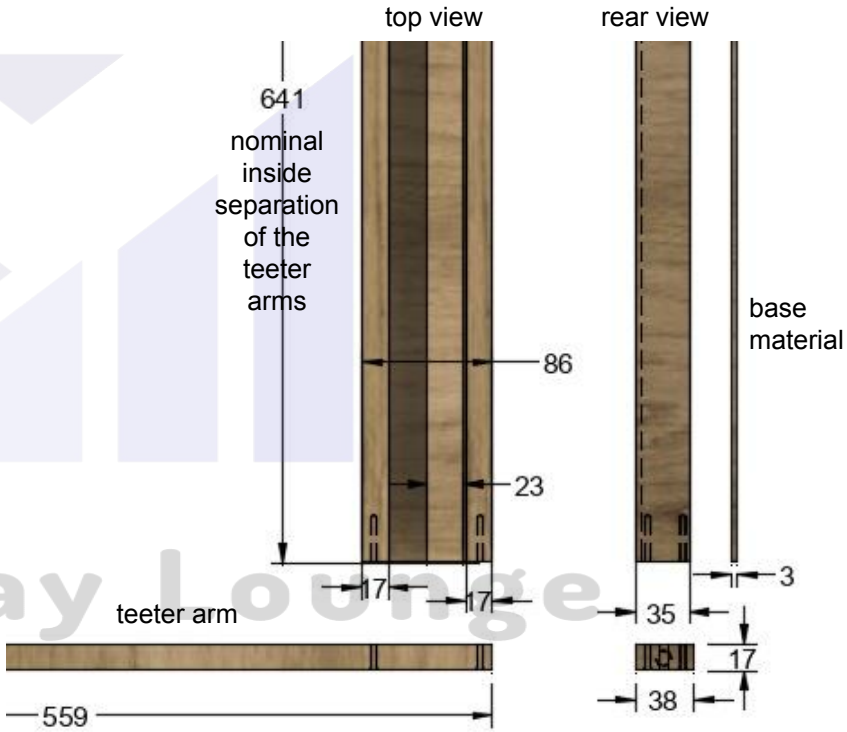
Construction: (see drawing, where 18mm hardwood has been used)

- the height of the two cross pieces is reduced by 3mm to fit the 3mm base material (alternative: use rabbet grooves)
- using pre-drilling, and countersinking, screw together the four main pieces: the two 56cm arm pieces and the two cross pieces. Use ~4cm countersunk hardwood screws.
- cut the ~3mm x ~9cm base to the same length, and attach underneath with small wood screws; this bottom area will not be very visible.
- cut ~3mm x 2.5cm smooth trim of the same length, and epoxy it to the top of the rear cross piece, as shown
- test that any ankle-weight sandbags fit snugly

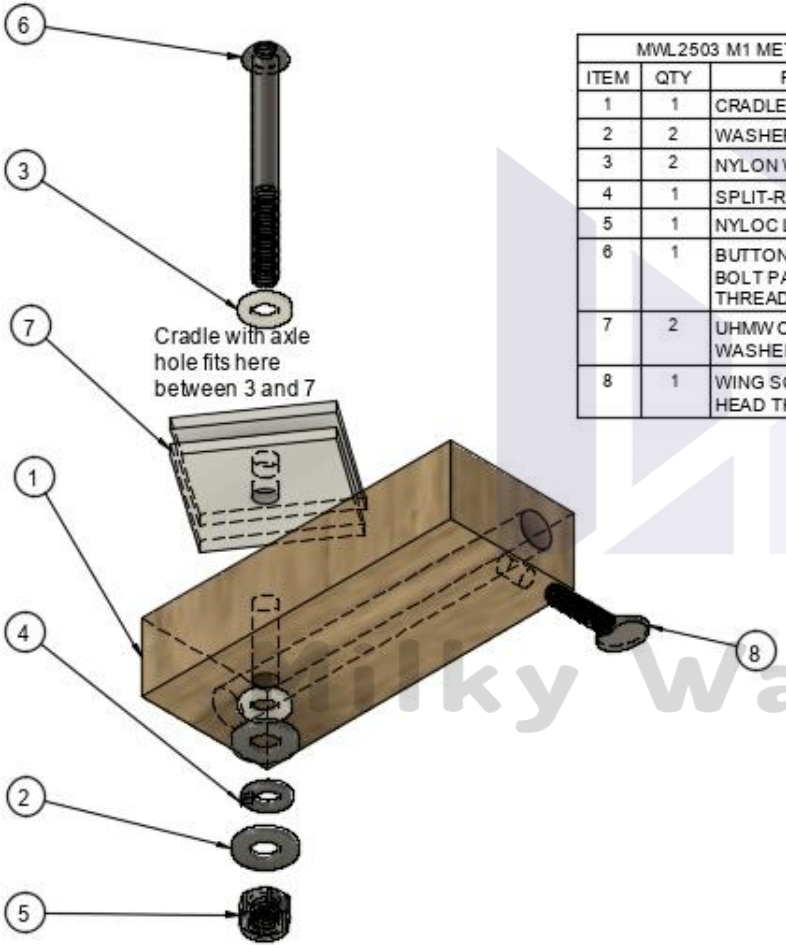
Test: Install the teeter mount blocks on the chair. Attach the teeter to the mount blocks, for now using only minimal hardware on each side (a bolt, one or two UHMW or multiple nylon fender washers, and a nut). The width of the teeter at the front should be about the same as at the rear. The arms and tubes should be close to parallel. One way to adjust this is to add or remove UHMW washers on the teeter axles. Or the counterweight box cross pieces can all be cut slightly shorter.

Glue in the tubes: After testing, epoxy the tubes into the teeter arms, using a method to hold the tubes parallel to the arms as the glue dries.

a section of the counterweight box:



Cradle mount: parts and dimensions (one side)

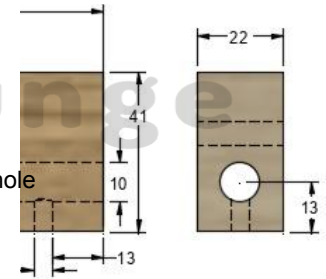


MWL2503 M1 METRIC CRADLE MOUNT PARTS LIST			
ITEM	QTY	PART NAME	DESCRIPTION
1	1	CRADLE BLOCK	HARDWOOD
2	2	WASHER	M6 STEEL
3	2	NYLON WASHER	M6, 2-3MM THICK
4	1	SPLIT-RING WASHER	M6 STEEL
5	1	NYLOC LOCKNUT	M6X1
6	1	BUTTON HEAD HEX DRIVE BOLT PARTIALLY THREADED	M6X1, 55-60 MM
7	2	UHMW CUSTOM WASHER(S)	3MM, CUT/DRILLED 38MM SQUARES
8	1	WING SCREW OR SPADE HEAD THUMB SCREW	M5X0.80P 15-20MM

double this parts list to include both cradle mounts

side view

end view



Cradle mount blocks: cutting and drilling

Cut out the blocks: Rip ~22mm thick hardwood to ~40mm width with a table saw. Cut two 10cm blocks, or work with a long piece that can be cut later. Having another piece for drilling practice is helpful.

Preparation for drilling: Mark the tube hole position (as shown on the last page). Indent the workpiece at the mark. If drilling for ⅜" or 9.5mm tubes, a long 13/32" or 10mm fluted bradpoint bit is good. Drilling could easily require some iteration. Perpendicular drill bit guiding must be used (see advice page). If a couple of inches has been drilled with a guided method, then that hole can be used to guide a power drill the rest of the way through. A drill press method is described here.

Drilling tube holes: Turn the drill press platform 90° and fully tighten. Check if plumb. Lightly clamp the piece to the platform and hold a plumb level against it (the first pic). Use spacers under the clamps to prevent marring the wood. Position the block and the platform until the mark on the block is under the drill bit, and when plumb in both axes, fully tighten the platform position and tightly clamp the block. Check for plumb again in both directions. Making sure the bit doesn't wander, drill as far down as the bit will travel. Use successive penetrations to clear the shavings. To make the hole deeper, with the bit spinning, crank the platform up and repeat lowering the bit all the way. If necessary finish the hole with a power drill. Check that the tubes will slide freely through the blocks.

Drill the other holes: Drill a very perpendicular 6mm axle hole in each block (as shown on the last page). Drill holes for wing screws, and adjust the hole size so that they can turn fairly easily. Sand the unfinished faces, and smooth the edges and corners. Apply thin coats of exterior wood finish. Install the wing screws.

example: the workpiece is plumbed, and starts low, then the platform is cranked up into the spinning bit (a long scrap workpiece is shown)

Cradle: construction and assembly

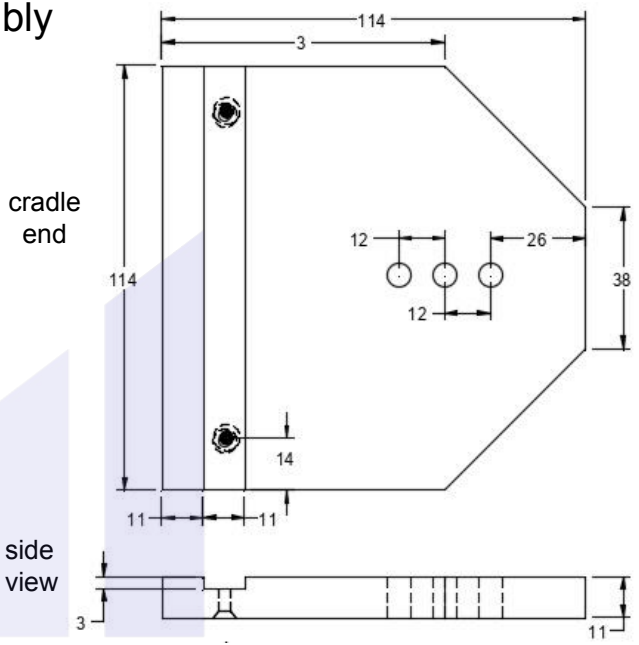
Preparation: Lay the teeter body on a work surface. Check that the teeter arms and tubes are parallel in each axis. Slip the cradle mount blocks on the tubes. With the tubes held parallel, measure the inside distance between the cradle blocks. Subtract 6mm to account for a large friction washer on each end. This is the “target cradle length”. The drawing and the picture show cradle parts made from a 11mm multi-ply flooring plank.

Cut: Rip a quality 10-13mm multi-ply plank to 12cm with a table saw. The length of the main cradle board should be ~12mm less than the “target cradle length”. You may want to start slightly longer than this. Cut two more pieces 12cm long. Check that all three pieces are very square. Cut the diagonals on the two end pieces. Sand all faces, ends and edges.

Cut channels: Cut two 3mm deep, very snug-fitting channels with a table saw or router, being careful not to make the channels too wide. Test the channel width. Ideally some force should be needed to push the ends of the main board into the channels. Sand the ends and the channel edges to help them fit. If the channels are too wide, shims and epoxy can be used later when gluing.

Drill: Drill three 6mm axle hole options perpendicularly in each cradle end piece, as shown. If using nylon flange bearings then the hole size needs to match the OD of the bearings. If you know your adapter mounting hole size, drill three tight-fitting holes ~2.5cm apart in the middle of the main board, as shown.

Test, glue and finish: Screw the cradle together without glue to check it will fit well when mounted squarely on parallel teeter tubes. If the cradle is too short, add one or two extra UHMW squares. When ready, use the screws and exterior wood glue, and hold the cradle parts very square as the glue dries. Progressively sand and clean. Use several coats of semi-gloss or satin exterior wood finish, by spray or brush, ex: spar urethane spray, sanding lightly between coats.



Chair-front counterweight: cutting and channels

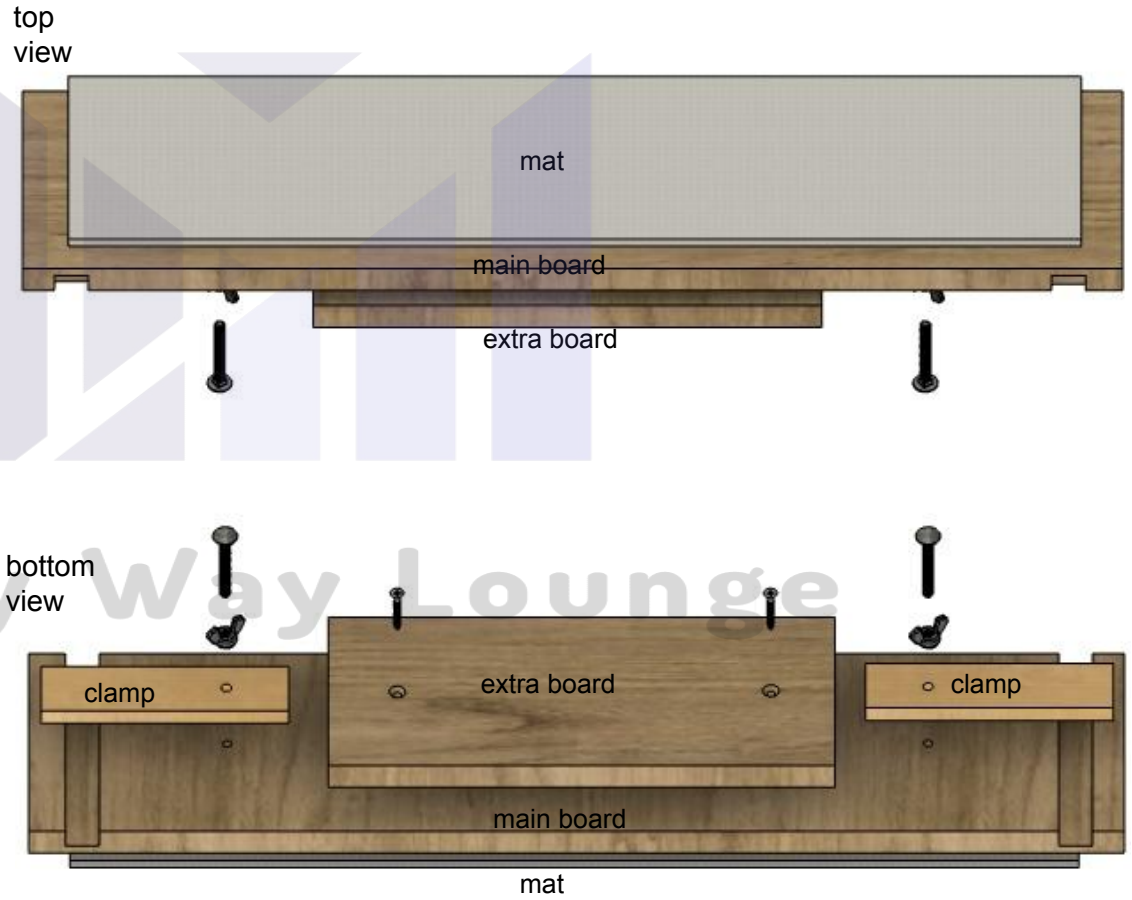
Overview: ~2.2kg at the chair front will help offset the weight of the loaded teeter-cradle, with the extra leverage. The weight need not be exact. Extra weight can be fastened underneath the main board later. It will be padded to double nicely as a comfortable leg rest. It is not used for non-reclining chairs.

Measure the left-to-right centre-frame to centre-frame width at the front of your chair**.** Add ~9cm. This is the “planned board length”. Measure the length of the chair’s straight frame that extends beyond the fabric, not including any curved part of the frame. Subtract 13mm. This is the “planned board width”.

Cut: Rip a ~19mm heavy hardwood board to the “planned board width” and cut to the “planned board length”. Sand and smooth.

Cut channels: Refer to the dimensions drawing on the next page. Cut ~13mm deep channels that are slightly wider than 19mm and that are positioned to fit the chair frame. Use a router or a table saw with repeated passes or with a dado blade. If the table saw blade guard is in the way, then cut from both sides of the board. Alternative: with a router cut round channels with a ¾” or 19mm round-nose bit. Use repeated passes until the depth is ~13mm.

This entire bottom area is not very visible.



Chair-front counterweight: clamps and testing

Clamps: With ~13mm hardwood or plywood, rip two 4cm pieces, each 15cm long. Drill loose fitting holes in the blocks, where shown. Drill tight fitting holes in the bottom of the heavy board. Use any ~50mm bolts, and put a wingnut on each bolt (see below). Usage: partially tighten or loosen the wingnuts, while the bolts remain tightly in the board.

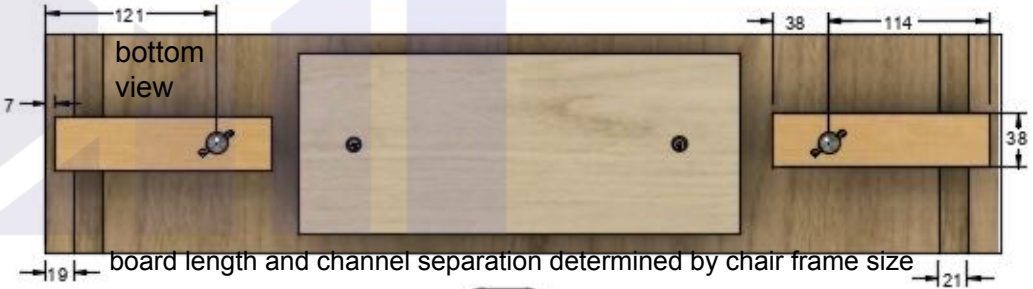
Glue mat: Use contact cement to glue foam mat or carpet square material that is slightly smaller than the board.

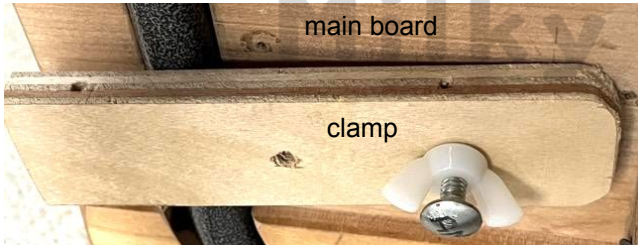
Weigh: If the combined weight is low, material of any kind can be fastened under the middle of the board to make a total of ~2.2kg. An extra board is fastened here.

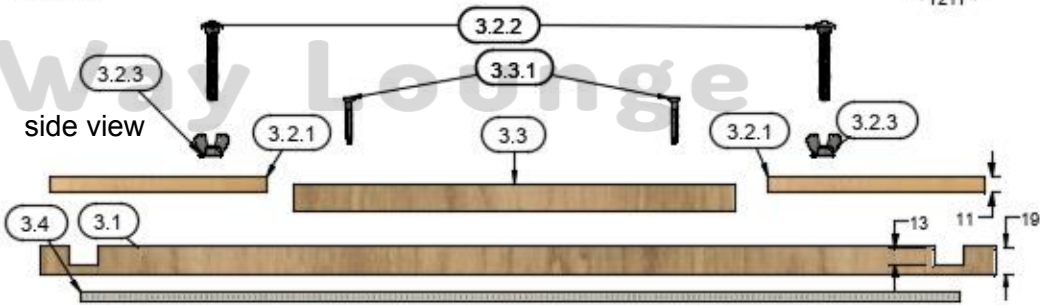
Test: Clamp the assembly on your chair and check that its position doesn't shift.

Finishing: Progressively sand. Apply multiple coats of exterior semi-gloss or satin wood finish, by spray or brush, ex: spar urethane spray. Dry and lightly sand between coats.

MWL 2503 M1 METRIC CHAIR-FRONT COUNTERWEIGHT PARTS LIST		
ITEM	PART NAME	DESCRIPTION
3	CHAIR FRONT COUNTERWEIGHT	
3.1	BOARD	~19MM HEAVY HARDWOOD, SIZED TO FIT CHAIR FRAME
3.2	CLAMP (2)	
3.2.1	CLAMP BLOCK (2)	~13MM HARDWOOD OR PLYWOOD
3.2.2	SQUARE-NECK CUP HEAD BOLT (2)	M6X1 ~50MM
3.2.3	NYLON WING NUTS (2)	M6X1
3.3	EXTRA BOARD	HEAVY HARDWOOD: SIZED FOR WEIGHT
3.3.1	WOOD SCREWS (2)	ANY M4X0.7P ~30MM
3.4	MAT	SOFT MAT OR CARPET



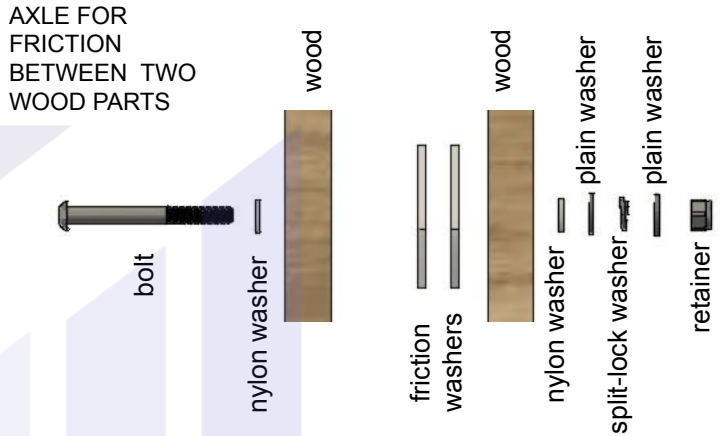




Teeter-cradle: setup and coarse settings

Axle friction: The drawing shows an axle that has friction washers between two wood parts. It can rotate to a new position. The final position will remain steady if there is moderate “stiction” (stiction is stationary friction, where an object resists beginning to slide). **Key point:** by partially tightening the retainer nut, the split-lock washer is compressed between two plain washers, which maintains moderate compression on the large friction washers.

A nyloc nut is shown as a retainer. Nylocs are not meant for a lot of reuse, but they can be replaced if worn out. It is better to use two hex nuts instead of a nyloc. This acts as a “retainer” if another lock-washer is tightly squeezed between the two hex nuts. **Another key point:** Partially tighten the first nut by holding the bolt, then fully tighten the “3-part retainer” with two wrenches, without holding the bolt.



First time setup and coarse settings:

1. Install the cradle mounts on the cradle, using the middle axle holes on the ends of the cradle. If later using binoculars that are very large or have a high centre of mass on your binocular adapter, then use higher cradle axle holes. The cradle bolts face outward. The wing screws will end up closer to the chair, underneath. Use very light axle friction for the testing here.
2. Attach your bino adapter to the middle cradle board hole. It must be secure. Perhaps use a wing screw with a washer under the cradle.
3. Mount the teeter on the middle axle holes of the teeter mounts. The teeter bolts face inward. The mount blocks face inward. Moderately tighten these axles.
4. Clamp the teeter assembly onto the backrest, without the cradle. The rotating base is optional.
5. Slide the cradle assembly halfway onto the teeter’s tubes and tighten the wing screws. If the tubes are not parallel, or the cradle assembly size is different than the tube separation, adjust the number of large friction washers in the cradle and teeter mounts.
6. Attach the chair-front counterweight.
7. Add ~1.4 to 1.8kg to the rear box, depending on the binocular weight.
8. Attach your binoculars to the adapter. Slide the cradle mounts so that the binoculars are at normal viewing depth. Adjust the counterweight again.
9. With the cradle axle friction set low, rotate the loaded cradle. If the binoculars tend to swivel towards the chair, try moving them forward on the adapter, or mount the adapter forward on the cradle. Then re-adjust the cradle mount position on the tubes. If the binoculars tend to go upside down, then lower the cradle by using higher cradle axle holes. Then adjust the cradle axles for moderate friction, following the procedure at the top of this page. When done, ideally the loaded cradle stays in whichever position it is put.

Teeter-cradle usage

Coarse settings (continued):
10. Adjust the teeter axles for moderate friction. Slide the cradle mounts in so the binoculars are at normal viewing depth. Tighten the wing screws. The loaded teeter should be easy to swivel, but should stay put when set in any position. The teeter will also become more stable when adding stability rods, which are built using the separate set of plans.
11. Add thickness to the neck cushion, perhaps by wedging some foam under an existing neck cushion. Push the teeter up and sit in the chair as far back as possible. Pull the teeter down, and then slide the binoculars in close to your eyes. Tighten the wing screws.
12. With the oculars fairly close to your eyes, tilt the teeter up part way. If the oculars get closer to your eyes, the teeter mount should be raised on the backrest. And vice-versa.
13. The optimal depth setting for the teeter axle from the backrest should correspond to neck cushion thickness and head size. For example, a big person using a very thick neck cushion may want to use a teeter axle hole that's further from the backrest. This may be more noticeable when viewing up high.

Viewing control during a session:
If the coarse settings have been made, very little adjustment is needed during any subsequent viewing session.

With one hand on the cradle, swivel both the cradle and the teeter at the same time, keeping a comfortable eye-to-ocular distance. Releasing your hand should not affect the view. See this in the site video: milkywaylounge.com

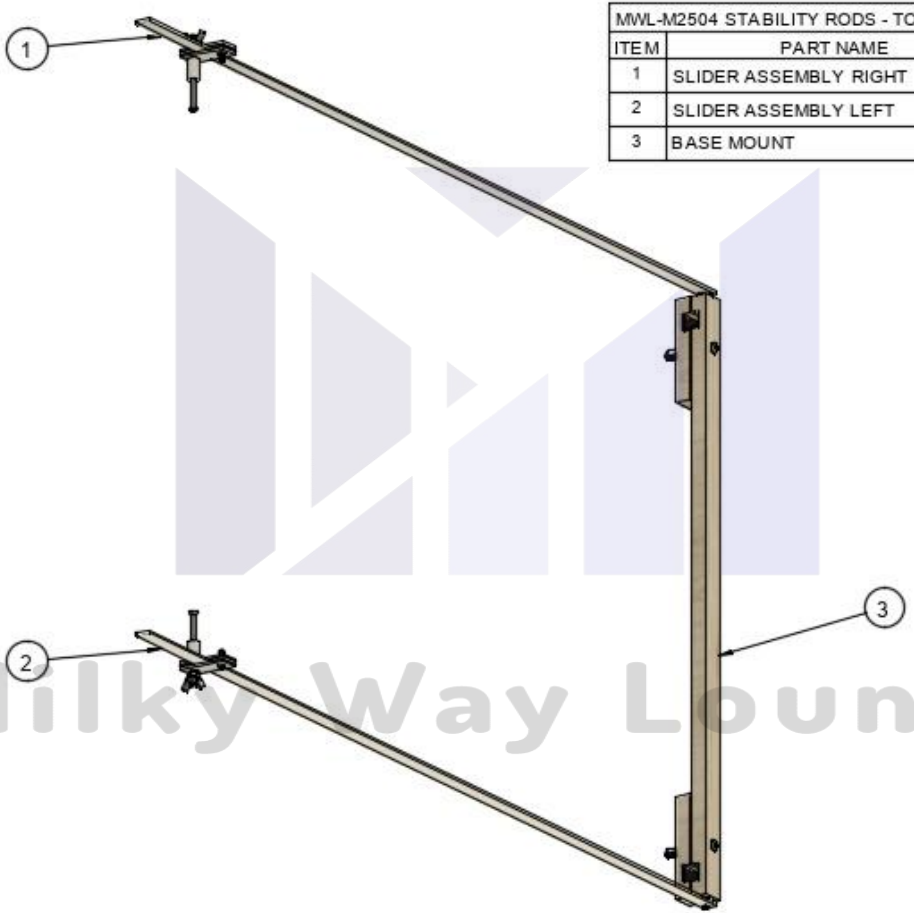
After the viewing session: The chair can be collapsed with the entire teeter-cradle assembly installed. However it is recommended to remove the binoculars and the front and rear counterweights.

Handle grip: a cylindrical camera handle grip, or a selfie stick, can be attached to the bottom of the cradle for easier handling of the teeter-cradle. Attach at about 20cm to the side of the binocular adapter.

Warnings:
- always use the chair-front counterweight
- always use the wing screws to prevent the cradle from sliding either off the tubes, or towards you

Stability rods (an option)

MWL-M2504 STABILITY RODS - TOP LEVEL	
ITEM	PART NAME
1	SLIDER ASSEMBLY RIGHT
2	SLIDER ASSEMBLY LEFT
3	BASE MOUNT



Stability rods: overview

Introduction: These stability rod plans are an optional add-on to the teeter-cradle plans for elevation control. The main site video shows the stability rods in action: milkywaylounge.com They reduce drifting and vibration of the teeter. They are connected with an axle to each of the cradle mounts, and to the base of the chair. These plans are for a standard zero gravity chair; modify for other chair styles.

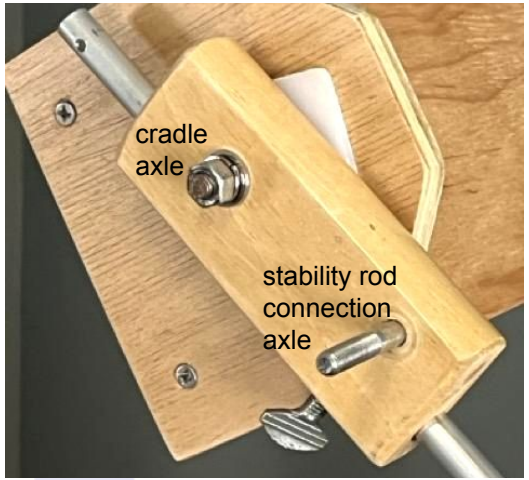
Viewing elevation stability: Any viewing elevation setting should be as stable as possible. There is already considerable stability due to the intentional stiction of the large washers of the teeter and cradle axles. Remaining instability can be caused by:
- a large leverage mismatch if the binocular weight has been shifted on a binocular adapter, or by large shifting of the cradle on the teeter tubes
- drifting and settling, usually due to body movement
- vibration due to an effect called “heartbeat”

Operation: The stability rods support part of the front weight of the teeter, by adding a connection down to the base of the chair. This triangularizes the support, and creates a connection to a stable location.

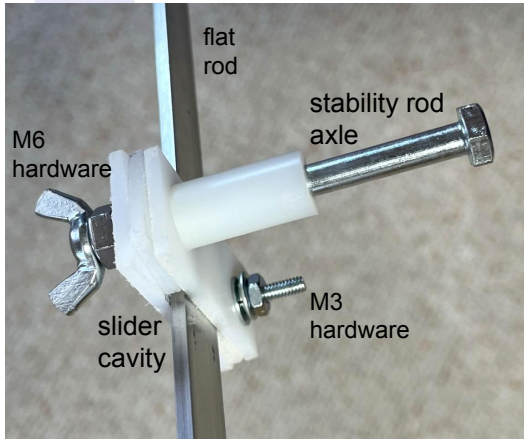
An axle on each cradle mount will connect to one of the slider assemblies (see pics). When the chair tilts back or when the teeter moves, the stability rods follow along. The connection allows for sliding and swiveling of the rods. There is moderate adjustable friction between the rods and the slider cavity. Coarse adjustment of the friction can be done before a viewing session.

“Heartbeat” is user-dependent body pulse entering the chair and finding its way up through the teeter and cradle and into the binocular view. It is more noticeable with bright objects at high magnification, and less so for extended objects at moderate magnification. It is also related to the sturdiness of the chair and to the chair padding. These stability rods reduce heartbeat to about half amplitude.

cradle mount



slider assembly



Stability rods: parts and materials

The aluminium flat bars and the UHMW sheet must be the same actual thickness; both should be 3mm or both should be ⅛".

Aluminium flat bars:

- 2: 3mm x 20mm x 1.2m flat bars, mill finish, uncoated (16mm will also work) see www.metalmate.com.au products 5202 or 5103, also 5112; ex: Bunnings, Bowens, etc; can choose ⅛" to match a ⅛" UHMW sheet

UHMW sheet:

- www.ebay.com.au/itm/293684914820 (3mm white sheet, untested)
  buyplastic.com/uhmw-polyethylene-plastic-sheet/ (⅛", 5-¾" white square, tested)
  amazon.com/MECCANIXITY-Sheets-Molecular-Polyethylene-Plastic/ (untested)
  can choose ⅛" to match ⅛" flat bars

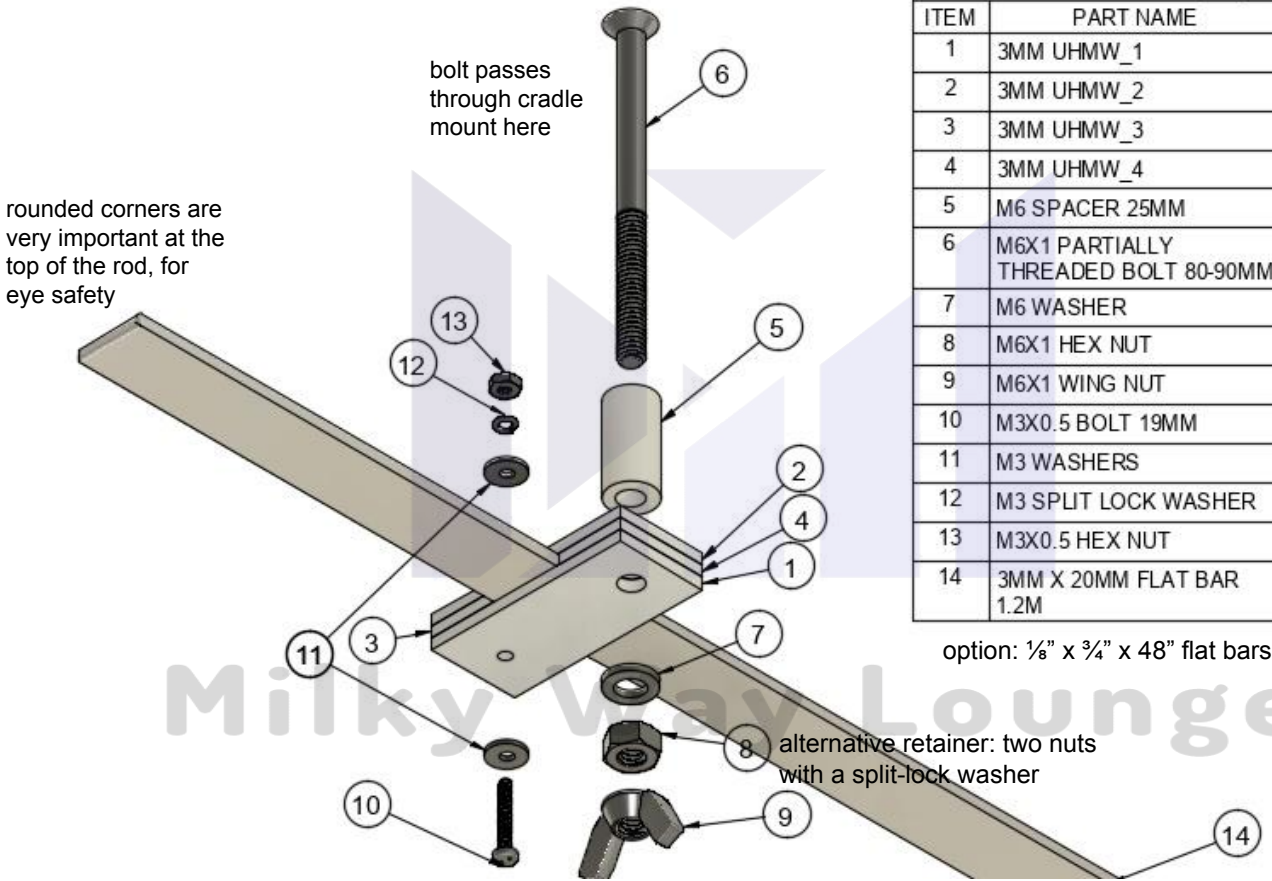
Hardware: from building suppliers or online
if starting with non-stainless, consider replacing later with stainless

- 2: bolts M6x1, 80-90mm (for slider axles, see pic)
  countersunk flat head is preferred, but pan head can work
  partially threaded is preferred
- 2: pan head or hex head bolts M6x1, ~65mm (for base mount)
- fully or partially threaded
- 2: nylon wingnuts M6x1
- 2: steel wingnuts M6x1 (optional)
- 4: nuts M6x1 2: washers M6 2: split-lock washers M6
- 2: nylon spacer cylinders M6, ~25mm long
- 2: bolts/machine screws M3 ~19mm
- 2: nuts M3 6: washers M3 2: split-lock-washers M3
- 2: M4 bolts/machine screws ~25mm (to attach base of rods, see pic)
- nylon washer choices (to position the base of the rods)

Rubber: for square channels use ~1.5mm (1/16"), small sheet, high durometer rubber amazon.com/dp/B0D4Q12FT7/ For round channels, instead use tacky glue or similar.

Hardwood: ~19mm x 25mm x 110cm (the longest piece is 75 to 80cm)

Stability rods: sliders - parts drawing (one side)



SLIDER ASSEMBLY (TOP) PARTS LIST		
ITEM	PART NAME	MATERIAL
1	3MM UHMW_1	UHMW, WHITE
2	3MM UHMW_2	UHMW, WHITE
3	3MM UHMW_3	UHMW, WHITE
4	3MM UHMW_4	UHMW, WHITE
5	M6 SPACER 25MM	NYLON 6
6	M6X1 PARTIALLY THREADED BOLT 80-90MM	STEEL
7	M6 WASHER	STEEL
8	M6X1 HEX NUT	STEEL
9	M6X1 WING NUT	STEEL
10	M3X0.5 BOLT 19MM	STEEL
11	M3 WASHERS	STEEL
12	M3 SPLIT LOCK WASHER	STEEL
13	M3X0.5 HEX NUT	STEEL
14	3MM X 20MM FLAT BAR 1.2M	ALUMINUM

option: ⅛” x ¾” x 48” flat bars with ⅛” UHMW

Stability rods: sliders - construction and testing

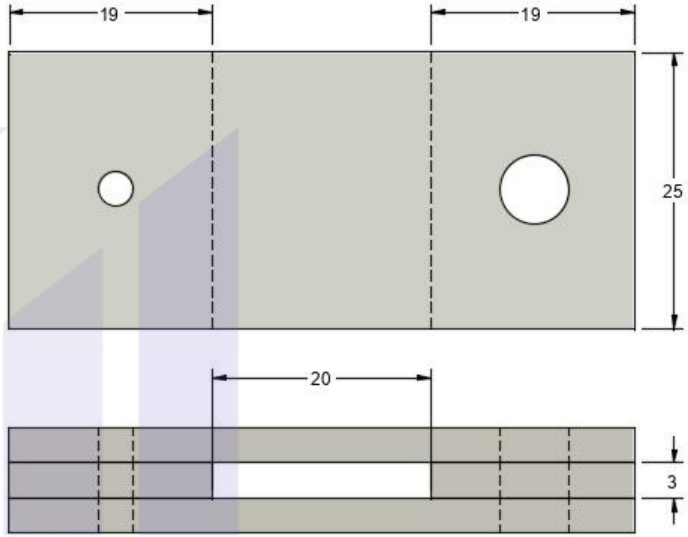
Prepare the rods: Mark the best end of each aluminium rod as the top end. Smooth and clean any defects or debris from the top 40cm of each aluminium rod with fine steel wool or similar. The top corners must be rounded to avoid eye injury; it is highly recommended to do that before construction. A hole will be drilled into each bottom end later.

Cutting UHMW: Assume here that the flat rods are 20mm wide. Use a table saw to cut a UHMW sheet into four 25 x 58mm and four 25 x 19mm pieces. The rip fence might trap the small cut-off pieces, so it could be positioned on the other side of the workpiece. Smooth all edges with fine grit sandpaper.

UHMW sandwiches: The following drilling need not be precise. Tape four pieces together tightly in the arrangement shown, adding another 19mm piece temporarily in the centre as a space-holder for the aluminium rod. Drill a 6mm hole in the centre of one end, through the three taped pieces. Preferably with an M6 bolt inserted, drill an M3 hole in the centre of the other end, through three pieces.

Remove some tape and check that the rod will fit fairly snugly in the cavity. Gaps of about 1mm are ok on either side of the rod. If the cavity is too large or small, try rotating a 19mm piece, or sand back an edge. Smooth any burring on the edges and on the holes.

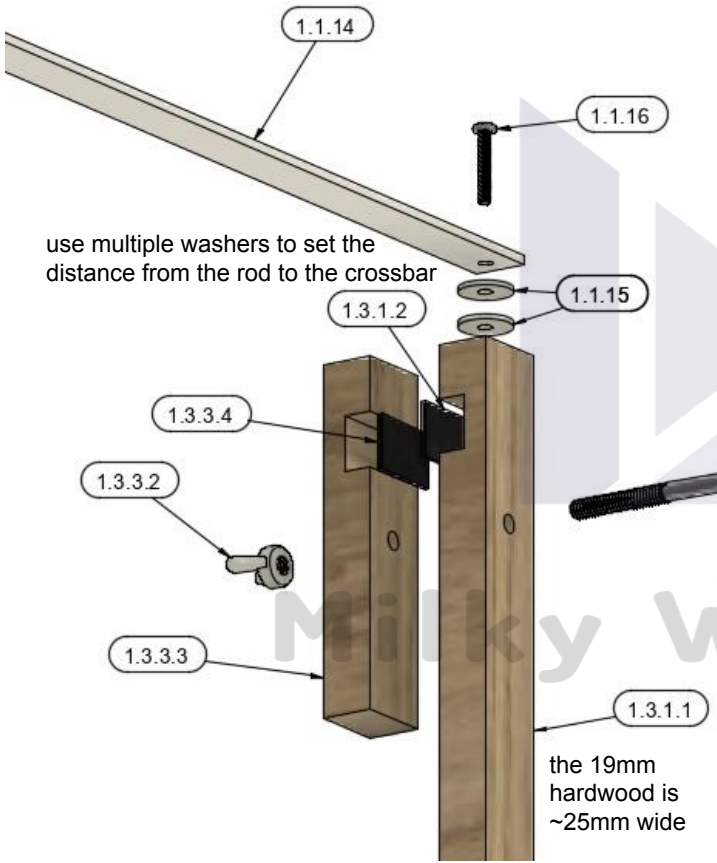
Testing: Later, these sliders will be mounted on the cradle mount blocks. For now, a small block with a 6mm hole can be used for testing. Refer to the parts diagram on the previous page to assemble the 6mm axle together with the small block. Then install the M3 hardware, ideally pointing in the other direction. Insert the rod and partially tighten the nuts to create moderate friction. By holding the M6 nut with a wrench, the wing nut can be jammed tightly against the hex nut to retain the hex nut setting. Or use a M6 split-lock washer between two nuts. Likewise, adjust the M3 retaining hardware. Again the goal here is to allow coarse friction/stiction adjustment before a viewing session, with a means to retain that friction setting.



adjust if using ⅛” x ¾” flat bars and ⅛” UHMW

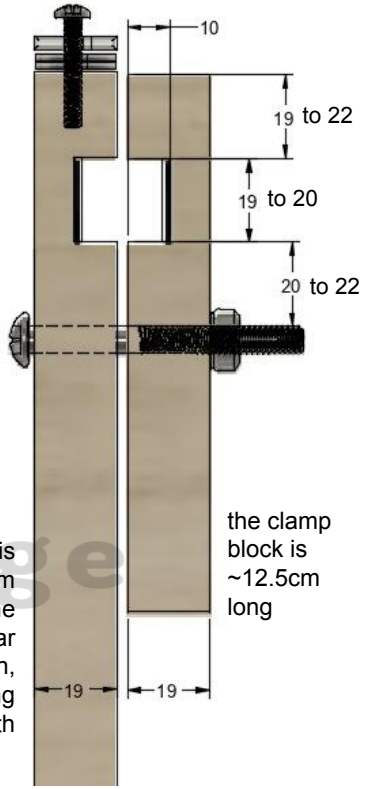
Stability rods: base mount - parts and dimensions (one side)

BASE MOUNT PARTS LIST (ONE SIDE)		
ITEM	PART NAME	DESCRIPTION
1	STABILITY ROD ASSEMBLY	
1.1	SLIDER ASSEMBLY RIGHT	
1.1.14	3MM X 20MM FLAT BAR 1.2M	ALUMINUM
1.1.15	M3.5 TO M4 WASHERS	NYLON
1.1.16	M3.5 TO M4 BOLT ~25MM	STEEL
1.3	BASE MOUNT	
1.3.1	BASE CROSSBAR	
1.3.1.1	CROSSBAR	HARDWOOD
1.3.1.2	1.5MM PAD	RUBBER
1.3.3	RIGHT MOUNT	
1.3.3.1	M6X1 BOLT ~60MM	STEEL
1.3.3.2	M6X1 WING NUT	NYLON
1.3.3.3	CLAMP BLOCK	HARDWOOD
1.3.3.4	1.5MM PAD	RUBBER



pan head or hex head bolt, partially or fully threaded

M4 ~25mm bolt/machine-screw with washers to position the rod



the clamp block is ~12.5cm long

the crossbar is typically 55 to 60mm longer than the centre-to-centre rear chair frame width, and almost as long as the armrest width

Stability rods: base mount - construction and testing

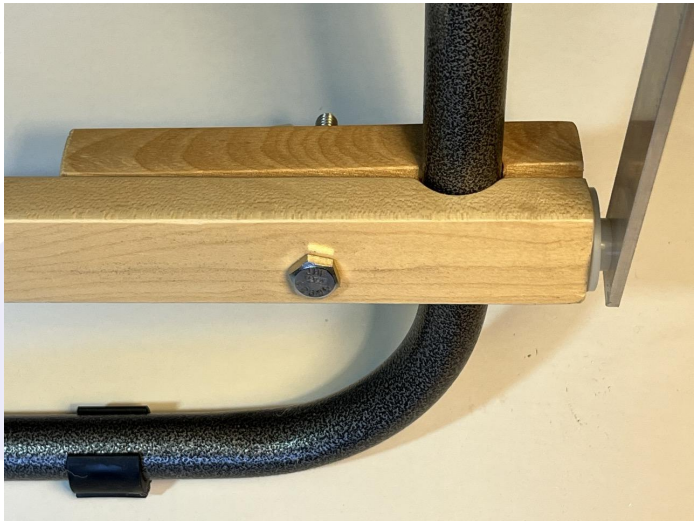
Wood: Measure the rear chair frame width, centre-to-centre, and add 33cm. Rip this length of 19mm hardwood to ~25mm width. Cut a crossbar that is 6cm longer than this “rear chair frame width”, which should be almost as long as the armrest width. Also cut off two 12.5cm pieces for the clamps.

Channels: Review the earlier guidelines in the teeter-cradle plans, for cutting channels. Hold up the crossbar against the rear frame and mark the locations for the channels. For square channels, cut two channels ~10mm deep in the crossbar, that are centred at the chair frame width, each being slightly over 19mm wide. There should be 19-22mm remaining on the ends. Cut matching channels on the 12.5cm blocks, as shown. Square channels will hold ~1.5mm rubber pads later. Check the fit and widen the channels if necessary.

Alternatively use a router to cut round channels, like in the photo. Refer to the advice page in the teeter-cradle plans. Round channels should be ~9mm deep. They will use tacky glue instead of rubber pads.

Clamps: Tape the clamp blocks to the crossbar with the channels aligned, and drill the 6mm holes, as shown. Slightly widen the holes to make the bolts very loose fitting for better clamping action. Assemble the clamps with the M6 hardware and test the fit to your chair. See the orientation in the photo. As the wing nut (hidden in the photo) is tightened, the clamp block should tilt as it grabs the chair frame.

Connections to the rods: Remove the crossbar from the chair. At the centre of each end of the crossbar, drill a very snug fitting perpendicular hole for an M4 ~25mm pan-head bolt or machine-screw. At ~12mm from the end of each rod, drill a large enough hole, preferably with a metal bit, as shown on the previous page. Test connecting the rods to the crossbar. Various washers are also shown in the photo, which will be used later to position the rods.



Wood finishing: Progressively sand. Apply multiple coats of exterior semi-gloss or satin wood finish, by spray or brush, ex: spar urethane spray. Dry and lightly sand between coats.

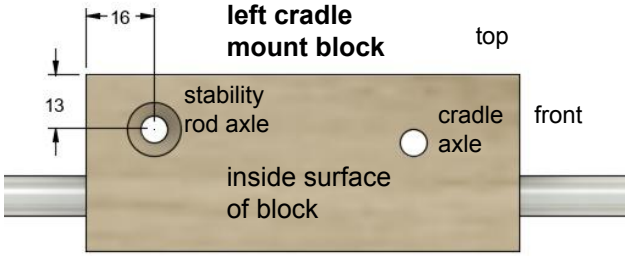
Rubber pads: For square channels, cut the four pads, clean the surfaces, and use super glue or contact cement.

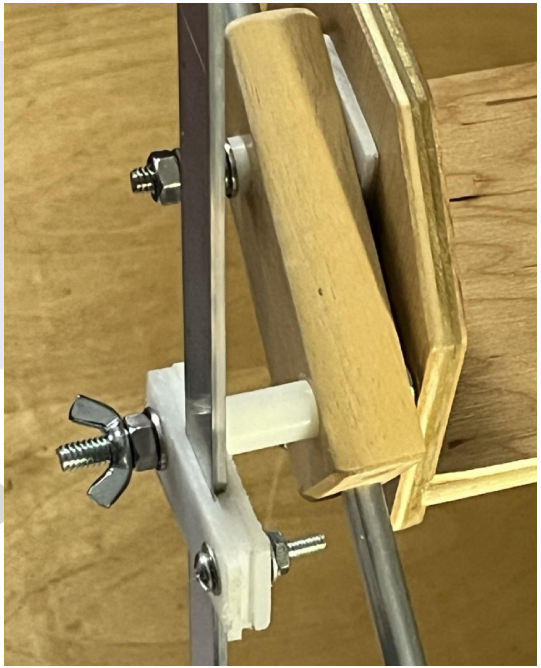
Stability rods: attaching to the cradle; final assembly

Drill the cradle blocks: A method to drill perpendicular holes must be used. Remove the cradle mount blocks. A countersunk 6mm hole should be drilled on the inside surface in the upper rear area of each cradle mount block, as shown. An alternative way to countersink is to first drill a shallow wide hole, then drill the 6mm hole in the centre of the wide hole. Test with the bolts.

Assembly:

1. Install the teeter, cradle and drive wheel on your chair. Attach the sliders to the cradle mounts, without the aluminium rods. Clamp the base mount onto the chair, about 10cm from the bottom.
2. Start on the side of the chair that has no drive wheel. Orient the slider so that the small M3 hardware is closer to the chair. Insert the top of the flat rod into the bottom of the slider.
3. Bolt the bottom of the rod to the crossbar using at least one washer. Adjust the number of washers or spacers at the base so that the rod doesn't rub against the armrest.
4. Repeat on the drive wheel side, where the rod will run between the wheel and the armrest. Adjust the number of washers. Alternative kinds of spacers can be used instead of washers. If the end of the crossbar projects out slightly too far, then trim it. If necessary, spacers can also be added on the axle at the top of the rod.
5. Adjust the slider friction to get some weight support, but allow fairly easy teeter movement.
6. For standard zero gravity chairs, after removing the drive wheel, the chair should still be collapsible with the stability rods installed!





Congratulations on your build! You now have full access to the night sky in comfort. Full usage specs for the bino-chair: milkywaylounge.com/?p=390
Contact and technical assistance: contact@milkywaylounge.com
Please publish your reviews under the main site's Reviews tab or send an email with constructive criticism. Thank you.

Woodworking and other advice

Tool use: Workpieces must be held down, preferably clamped. Cutting tools often tend to latch onto a workpiece and then can either throw the workpiece, including your hand, or throw the tool itself. Cutting equipment must be understood. Cutting tools must almost always be guided to ensure a proper cut. Dull tools can be dangerous to use. Get help where unsure. Have someone available nearby just in case. No part of your body should be in front of an insecure cutting tool or in front of a utility knife.

Working with wood: It can be unsafe to work with warped wood. Pay attention to wood grain direction, when sanding and finishing. Use progressively finer sandpaper. Clean the surface and the worktop before finishing. Wood needs to be sealed with exterior wood finish to prevent degrading and warping, especially when exposed to outdoor conditions. This is especially true for the end-grain in the edges. Using ventilation, apply multiple thin coats of exterior finish, sanding lightly with each coat. Spraying works well.

Perpendicular drilling methods:
Drill press, portable drill guide, drill block, square, jig blocks
www.youtube.com/watch?v=TwAOfYY9nKw

Drill bits: A “bradpoint” bit will wander less than a “twist” bit as the hole is being started. Avoid spade bits for precision drilling.

Drilling hardwood: Make an indentation in the workpiece for positioning the bit. Hardwood must be pre-drilled with the correct hole size before inserting a screw; the screw should be fine-thread.

For those over 188cm tall:
1. The chair’s backrest may be short for a tall user. So the 18cm rectangular teeter mount blocks should be replaced with longer trapezoidal-shaped blocks that extend forward and upward at ~30° from horizontal. This will bring the teeter axle height up to neck height. The hole options for the teeter axles should also be further out from the backrest since the user’s neck may be resting on a cushion that is on the upper rail of the chair. Feel free to contact technical support.
2. The chair-front counterweight should be increased to ~2.7kg.