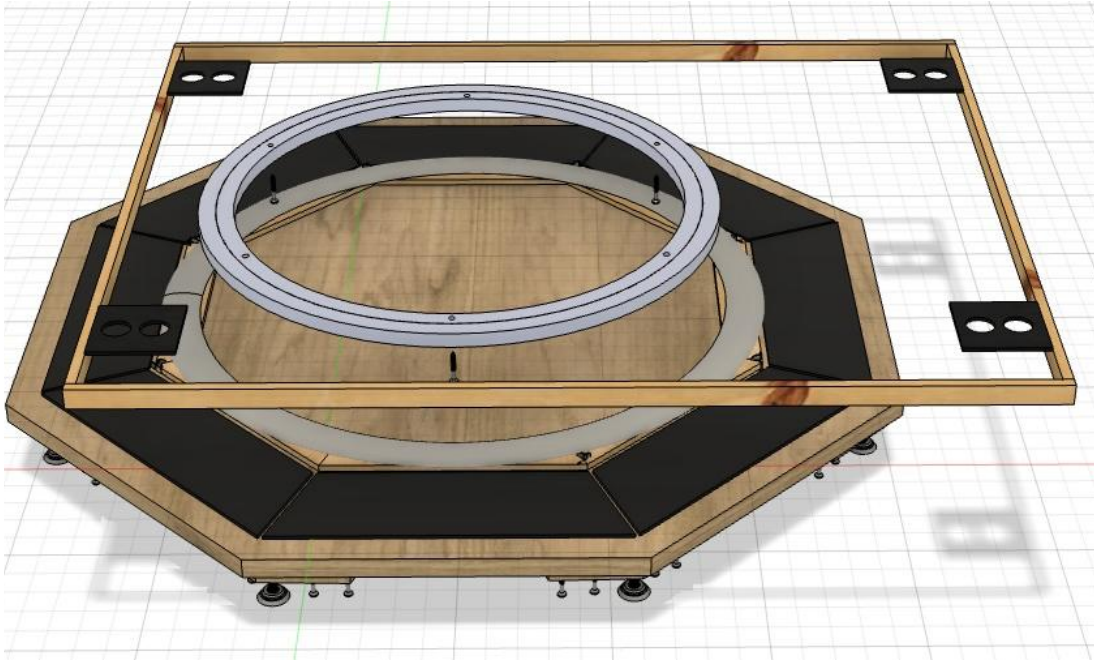
Bino-Chair Component Plans:
Rotating Base and Drive Wheel Mount
for Azimuth Control, Metric



MWL-M2500 v1

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Getting started

Welcome to these very popular components for bino-chair slewing! They evolved from an award winning prototype. They are guaranteed to be rewarding to build, especially when seeing how they smoothly rotate your chair, with stability. It's really amazing what a little wood and hardware can do! These plans are in two sections, one for the rotating base and one for the drive wheel mount on the side of the chair. The primary purpose of these plans is superior functionality and user comfort, while aesthetics is only a secondary concern.

This 1-minute video shows the rotating base and drive wheel mount being set up quickly: milkywaylounge.com/?p=549

Important short video introductions to the mechanics:
Rotating base: milkywaylounge.com/?p=734
Drive wheel mount: milkywaylounge.com/?p=682

"Must read" chair selection post: milkywaylounge.com/?p=641
A chair is needed for building and testing these components. The plans are intended to be adaptable to a range of typical chair geometries. 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.

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 bit of effort. This project is unique in many ways.

The drive wheel mount will have moderate adjustability to fit the shape and size of a range of typical chair frames. It also self-adjusts so that the wheel sits at the right height to engage properly with the ground track.

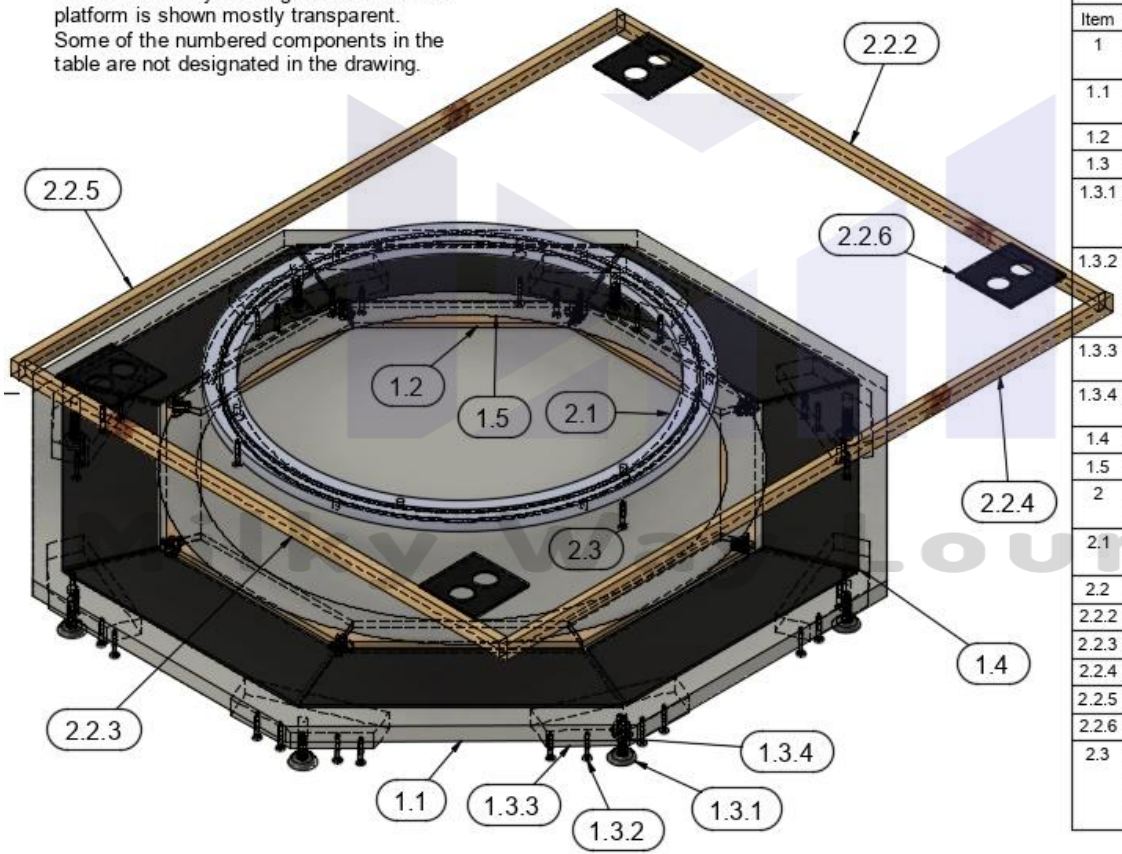
Safety is more important than anything else in this project. Never perform a construction step unless you have full confidence that it can be done safely. Workpieces must be held down or guided. Cutting equipment must be understood. Get help where unsure. Have someone available just in case.

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

Technical support: contact@milkywaylounge.com

Parts list drawing: rotating base

The turntable bearing is attached to the bottom of the chair platform, and will sit in the friction cavity of the ground board. The platform is shown mostly transparent. Some of the numbered components in the table are not designated in the drawing.



MWL 2502 Azimuth Control Rotating Base		
Item	Part Name	Material
1	Ground Board Assembly	
1.1	Ground Board	Plywood, Finish
1.2	Cavity block (8)	Pine
1.3	Foot (8)	
1.3.1	8mm Stainless Tall Leveler (8) with threaded insert (8)	Steel
1.3.2	6g x 32mm coarse thread stainless cone-head screw (32)	Steel
1.3.3	Foot Block (8)	Plywood, Finish
1.3.4	6g Stainless Tee Nut Inserts	Steel
1.4	Track segment (8)	Rubber
1.5	Ring	Carpet
2	Chair Board with Bearing	
2.1	500mm x 14mm Turntable Bearing	Aluminum
2.2	Chair Board	
2.2.2	Front Trim	Pine
2.2.3	Back Trim	Pine
2.2.4	Right Trim	Pine
2.2.5	Left Trim	Pine
2.2.6	Positioner (4)	Rubber
2.3	6g x 32mm coarse thread stainless cone-head screw (3)	Steel

Parts and materials: rotating base

Also see: Parts and materials, page 21 for the drive wheel mount.

Chair:

- **choose 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
- rated for at least 350 lbs (160 kg), regardless if user's weight is less
- standard width ~76cm, even if advertised as XL or Oversized
- appropriate brands: Portal, Timber Ridge, Cabela's Big Outdoorsman Lounger, Ever Advanced (Amazon, etc)

Plywood:

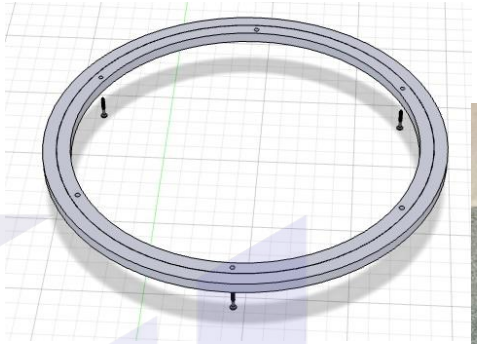
- ground board size: 840mm square (minimum 800mm square)
- chair board size: ~690mm x 840mm
- ground board: **18-19mm, exterior AC or BC, either exterior grade or uses exterior waterproof glues, resists warping,** at least 7 layers, appearance is a less important factor
- chair board: 18-19mm, ideally the same as above, or a second choice is hardwood plywood (interior grade) for the chair board
- avoid under 18mm, avoid treated, avoid most interior grade
- acceptable: AC interior grade that uses waterproof glues
- example: plymaster exterior AC (pic at right) or search through exterior project panels for those flat and not delaminating
- the supplier can make a couple of cuts for easy transport
- store flat and dry, seal well when done
- the top of the line is marine grade

EXTERIOR AC HOOP PINE
PLYWOOD 2400X1200X19MM

Parts and materials (continued): rotating base

Turntable bearing:

- **diameter ~500mm, 14mm width, rating over 350 lb (160 kg)**
- larger than 500mm may not fit; smaller than 450mm may not be available in 14mm, and may not add as much stability
- recommended: “Dailydanny”, 20” (500mm), 14mm width, 450 lb (200 kg) rating (Amazon, etc)
- good: “Tambee”, commercial, 20” (500mm), 14mm width, 450 lb (200 kg) rating (Amazon, etc)
- acceptable: “Tambee”, commercial, 18” (450mm), 14mm, 380 lb (173 kg) rating, would need to adjust friction cavity size (Amazon)



Rubber:

- for chair positioners: 3mm 300x300mm sheet, any (Amazon, eBay)
- for track: two 23x61 “Multy Home” or “Step Guard” rubber grid tread covers, but suggest an extra for practice, (building suppliers, eBay)

Levelers:

- **5/16” (M8) stainless** leveler bolts with tee-nut inserts, 8-pack (Amazon: ex: “Anwenk or Lenshade”) jam nuts not required

Wood screws: (building suppliers)

- 35: M3.5 or 6g ~35mm coarse thread countersunk flat-head screws, stainless, very coarse thread like timber screws, not 0.60p
- 16: M3.5 or 6g ~20mm coarse thread countersunk flat-head, any

Other supplies:

- 10mm edging for plywood: from 300cm hardwood or softwood strips, matched thickness, or rip from other stock (building supplier)
- carpet: ex: cut carpet tile sections (building supplier or flooring dealer), get 2 or 3 thicknesses ~8-11mm, not visible when done
- super glue, used for rubber: (eBay for low cost larger quantities)
- contact cement or rubber cement
- wood-metal epoxy
- exterior paintable caulk
- exterior finish: semi-gloss/satin, spray or brush, ex: spar urethane
- exterior paint: semi-gloss/satin, color will show on board edges

Tools and supplies

Recommended power tools: drill, table saw, crosscut saw, circular saw, drill press, small belt sander. A router is recommended for those experienced with woodworking. Without a drill press, there are methods to keep a power drill perpendicular to the work surface (Advice page), 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. A jigsaw can be handy.

Other tools and supplies: sharp plywood cutting blades, hand tools, tape measure, clamps, stapler, square, straightedge, rubber hammer, paint brush, masking tape, duct tape, black sharpie, isopropyl alcohol or acetone, bulls eye mini bubble level.

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

Practice: Use new or scrap materials to practice many of these steps. This will likely save time and produce better results. Also: measure twice, cut once.

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

Construction overview: rotating base

Short mechanical introduction video: milkywaylounge.com/?p=734

Chair size: The included dimensions should work for a moderate range of typical zero gravity chair sizes. Adjust for your chair size; see the directions. With some chair styles the chair frame can be wider than the chair platform and extend out from the sides of the platform.

Plywood: Plywood is used for the ground board, the chair board and the eight foot blocks. All plywood can become distorted over time, but careful selection and treatment can minimise this. It's best to use ~19mm flat exterior grade AC or BC, especially for the ground board. Your store can make one or two cuts, which helps for transport and storage. Try to store it flat and dry.

Plywood edges should be sealed, mainly to help reduce warping. Exterior finish or exterior caulk and paint can be applied to the edges. Trim can be added to some plywood edges.

On a finished bino-chair, a uniform flat surface helps the drive wheel run evenly along the ground board's track all the way around.

Foot blocks and levelers: Each foot block will have a leveler bolt that will thread through metal inserts and part way into a recess in the ground board. The foot blocks help create a level standoff from the ground in an uneven location like a lawn.

Chair positioners: Your chair may have four small plastic feet inset on the front and back base frames, or four plastic glides surrounding the corners of the base frame. The locations of these will determine the locations of four positioner pads to be placed on the platform. There is no need to clamp the chair frame to the platform, unless you feel that the chair might get bumped out of these positioners.

Turntable bearing: aka. lazy susan, slew bearing, R2D2 bearing. The inner ring of this large diameter bearing will be attached to the bottom of the chair platform. The outer ring, which is offset slightly lower than the inner ring, will sit in the cavity in the centre of the ground board. The bearing will be closer to the left side and the rear of the platform, as seen from the top.

Friction ring: This large ring centreed in the ground board acts as both an enclosure for the turntable bearing and a method to add slewing friction. It's made of a layer of wood and carpet that becomes squeezed between the ground board and the chair platform. The amount of friction is set by the thickness of the wood and carpet combination. The goal is to test it later with your finished bino-chair for just the right amount of friction. It's not visible when the bino-chair is in use.

Ground track: This can be made by cutting eight pieces from rubber non-slip stair tread covers. It can take considerable iteration to trim the segments until they meet cleanly and symmetrically.

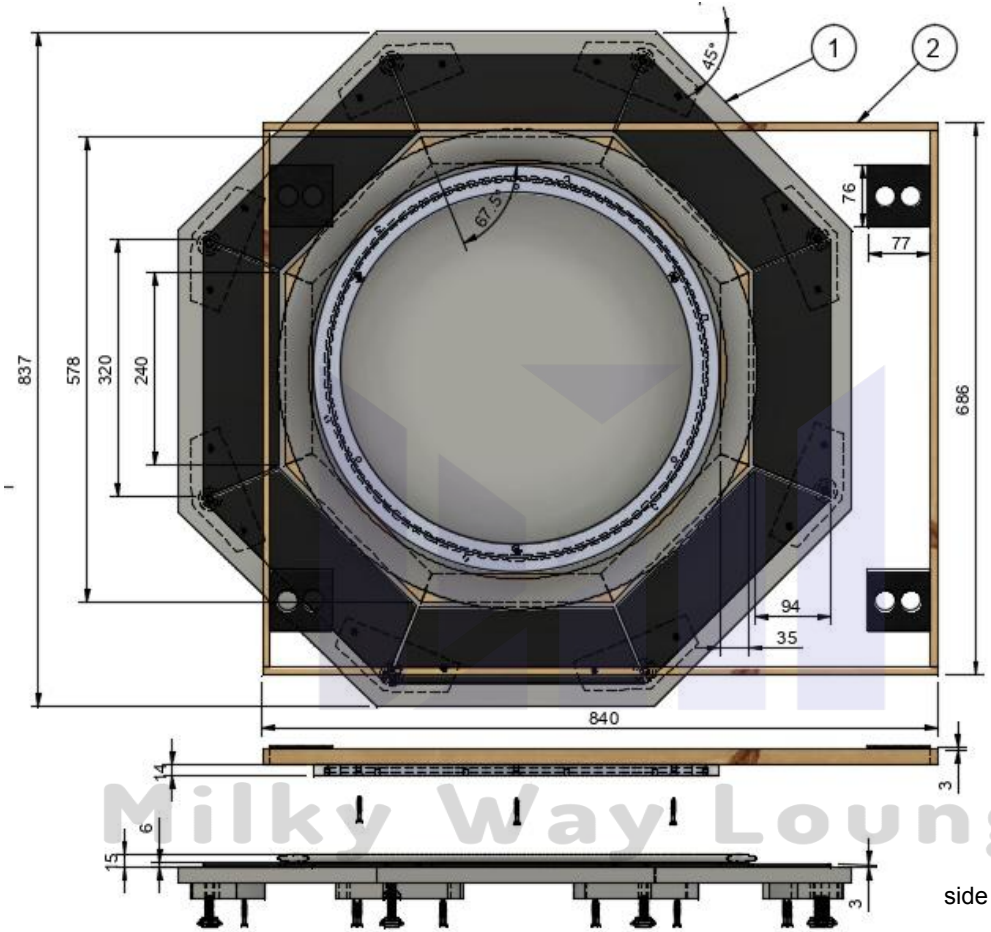
Wood finishing: Finishing all exposed plywood helps reduce warpage. This is especially true for humid and dewy conditions.

Gluing of rubber pieces: This is for track segments and chair positioners. The track segments can take considerable time to cut, trim and glue into position.

Friction ring installation: When your bino-chair is nearing completion, test for the correct amount of friction, then install the pre-built friction ring.

Alternatives: The ground board, track and friction ring could all be designed circular instead of octagonal. In these plans the drive wheel mount is designed to fit on the left side of the chair. To fit it on the right side instead, simple changes can be made (pages 15 and 26). However, most zero gravity chairs have a tray table on the right.

Projected views and dimensions: rotating base



MWL2502 Azimuth Control Rotating Base	
Item	Part Name
1	Ground Board Assembly
2	Chair Board Assembly with Turntable Bearing

These dimensions, in millimeters, approximate what is needed to match a standard zero gravity chair size; adjust accordingly (see instructions). The center of rotation is closer to the left side (top of diagram) and to the rear of the chair platform. The chair positioners should be tailored to the position and style of your chair's feet. The trapezoidal cavity blocks (~24cm long) and track segments (~32cm long) are cut at a 67.5° angle. See individual instructions for more detail on dimensions. The plywood thickness shown is 18mm.

side view of chair board assembly

side view of ground board assembly

Chair size and chair feet: rotating base

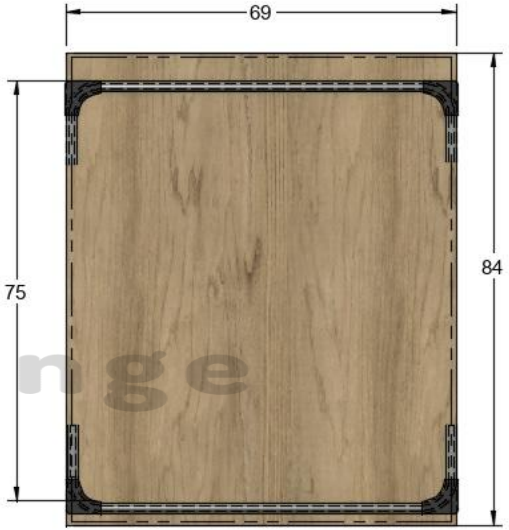
Chair size: Take horizontal measurements at the base of your chair frame, both front-to-rear and left-to-right.

If your chair frame is much longer front-to-rear than the typical 75cm chair, then the chair platform obviously needs to be that much longer than the nominal 84cm length. Regarding the width, let's also consider the type of feet on the chair. The feet could be small projections, or they could be large glides (see at right).

Chair feet: If your chair has small plastic projections, the chair platform need not be as wide as the chair frame. If your chair has plastic glides surrounding the frame corners, the platform should be about the same width as the chair frame, which is typically 69cm. We'll see later that there are suitable locations for the rubber chair positioners for both these types of chair feet.

If your chair frame is much wider than 69cm, and if your chair has glides rather than feet, then the platform would need to be that much wider. Avoid using a chair that's much wider than this, unless you're willing to magnify the entire rotating base described in these plans. If it's a little wider than typical, then it should be fine.

Positioners for projection feet



Positioners for glider feet

Cutting out the chair board, ground board, and foot blocks: rotating base

Adjust these dimensions if using a chair that has a non-typical size (see previous instructions). Preferably use the plywood previously recommended, a table saw and a circular saw, with sharp plywood cutting blades. Check that the blades are set for very perpendicular cuts.

Chair board: If you're planning to add trim to the edges of the chair board, like in these plans, then cut an 82 x 67cm chair board with a table saw. Don't sand the edges prior to adding trim later. If not planning to add 10mm trim, then cut a 69 x 84cm chair platform.

Ground board: Cut a ~84cm square (minimum 80cm square) from preferably 18-19mm exterior AC or BC plywood for the ground board, preferably with a table saw. Cut off the four corners with a circular saw to create the octagon. Use a belt sander for the rough cut edges of the octagon, but don't use it on the chair board edges. Clamp down a straightedge guide for circular saw cuts. Check for same lengths on all sides.

Foot blocks: Draw and cut out the eight ~7 x ~15cm foot blocks from the four corners of the ground board, as shown. Sand the edges.

Drilling and installing the foot blocks and levelers: rotating base

Practice the following with two scrap pieces of plywood, one piece representing the foot block and one piece representing the ground board, then repeat it for the actual foot blocks:

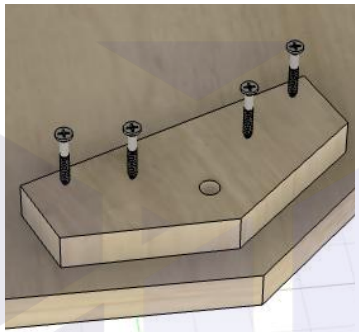
Drill a hole in the "foot block" for the body of the insert, as shown. A drill press is best. The hole diameter depends on the insert body diameter, but should be close-fitting. Don't install the leveler yet. Attach the "foot block", using four M3.5 or 6g ~35mm coarse thread stainless countersunk screws, to the "ground board", as shown, using countersinking and shallow pre-drilling.

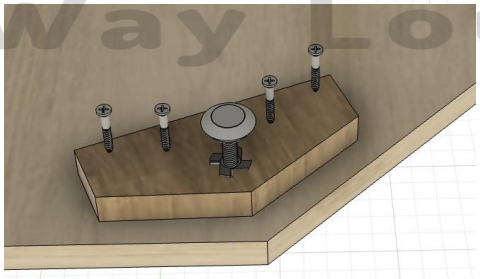
Most levelers have threaded inserts. To make room for the leveler bolt, continue drilling the insert hole halfway into the "ground board" (use masking tape on the unused part of the drill bit to mark the length of the exposed part of the bit).

Being careful not to damage the insert, hammer it in so that any t-nut prongs have sunk in, perhaps a rubber hammer.

Test by turning the leveler bolt all the way in. Optionally, pry up the insert, apply a little epoxy, being careful not to get any on the internal threads, then hammer the insert back in. Turn the leveler bolt in again.

After finishing installing all foot blocks and levelers, the bottom of the ground board should look like that shown at the far right.





Chair platform edges: rotating base

This is a fairly easy way to improve the chair platform edges if not just finishing them with urethane or paint. Trim can be added to the rough cut edges of the chair board. Measure the thickness of the chair board. Procure lengths of trim that are the same thickness. Or they can be ripped from softwood or hardwood to 10mm wide, squarely and cleanly. Cut to length squarely, starting a little long, then cutting back. The nominal lengths will be 84cm for the two side pieces and 67cm for the other two pieces.

On a flat work surface covered with newspaper, test that the joining surfaces will meet cleanly. First install the two short pieces at exactly the same width as the chair board. Use exterior glue liberally. Masking tape or brad nails will hold the pieces in place while the glue dries. Use a lot of uniform pressure. Pre-drill any hardwood trim if using brads. The two long pieces can be installed even while the glue is drying for the short pieces. Check for good surfaces prior to installing the two long pieces of trim.

Use a nail punch lightly on the brads to push the brads slightly below the surface. Progressively sand the final edges.

Chair positioners: rotating base

Your chair may have small plastic feet about 50cm apart on the front frame and on the rear frame. Let's call these "projection" feet. The Portal zero gravity chair is like this. These feet will determine the locations of the positioner pads on the platform. Cut 3mm thick rubber or wood into ~76x76mm squares, with a 25mm hole in each and tape them into position for now. If you choose to have larger positioners with a pattern of holes in each, this would allow the chair position to be varied slightly, which may have some benefits that we'll see later. This diagram shows positioners that have two holes each. The chair could sit one position or the other.

Positioners for projection feet

Positioners for glider feet

If your chair has no small plastic feet which would sit inside positioner holes, it probably has plastic "glider" feet surrounding the frame corners. Chair brands like this are Timber Ridge and Cabela's. In this case design 3mm thick rubber or wood L-shaped positioners to hold your chair frame position. For unusual chair feet, other kinds of positioners made of rubber or wood can be devised, or contact technical support.

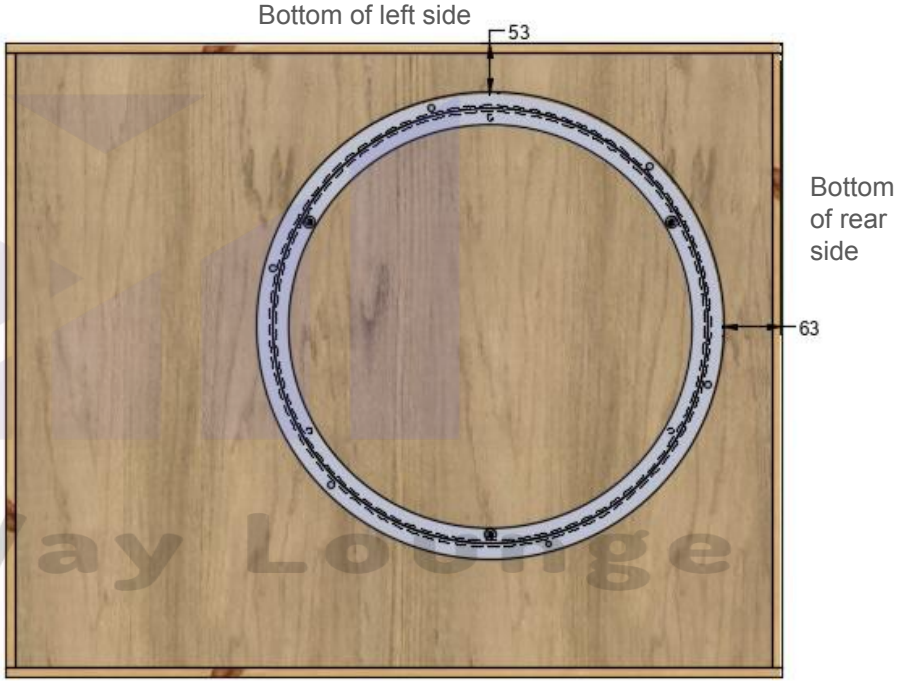
Turntable bearing: rotating base

Remove any standoffs from the outer ring of the bearing. Mount the bearing closer to the left side and rear side of the bottom of the platform, as seen from the top. For a 500mm bearing on a standard sized platform, this leaves 5cm on the left side and 6.5cm on the rear side, as shown.

Attach the inner ring to the bottom of the chair platform with three M3.5 or 6g ~32mm very coarse thread countersunk flat head timber screws. You may want to pre-drill very narrow tight-fitting holes. The heads of the screws should bury into the countersunk holes of the inner ring. Don't over-tighten the screws, so that the plywood holes avoid getting stripped. Your bearing may have more than three countersunk holes through the inner ring.

A 500mm bearing is recommended; adjust if using a 450mm bearing. Adjust if using a different sized platform. One goal later on will be to position the drive wheel on the track on the left side of the chair. See the other set of plans also.

An alternative: To allow the drive wheel mount to fit on the right side of the chair instead of the left, a simple change can be made: the turntable bearing would be installed 5cm from the bottom right side of the platform instead of the left side. Another small change would be made to the drive wheel mount also.



a 500mm bearing mounted under a 69 x 84cm platform.

Friction ring: rotating base

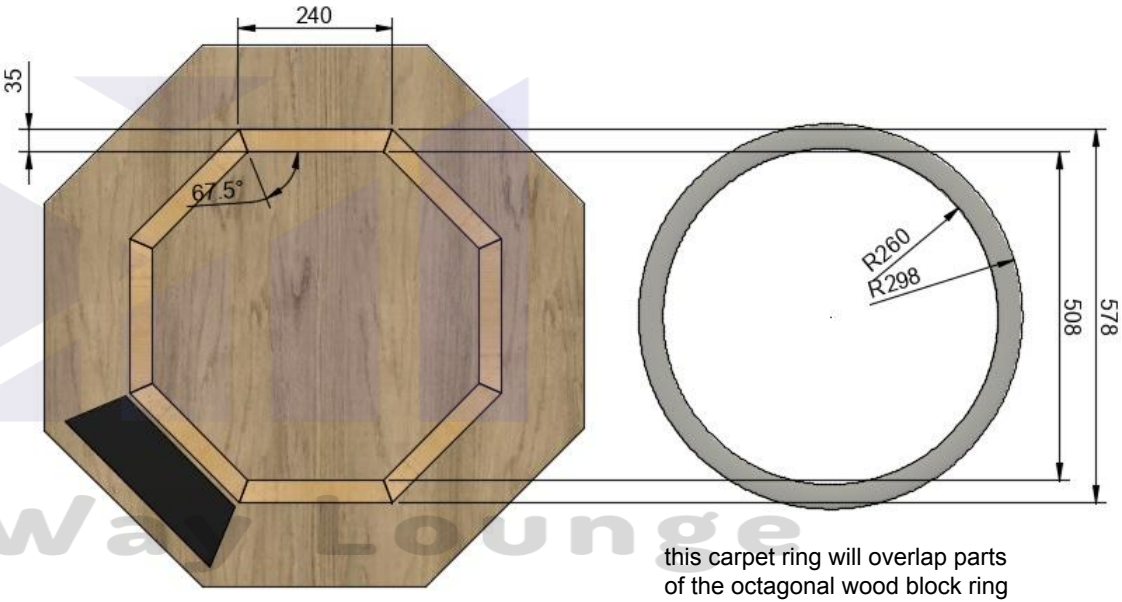
Adjust this friction ring size if using something other than a 500mm bearing. Cut the eight 35mm wide trapezoidal blocks at a 67.5° angle from ~6mm softwood or plywood, starting slightly longer than needed. Reduce their lengths until they closely circle the turntable bearing. For symmetry, the blocks should end up all about the same length, ~24cm. This octagonal wood shape should line up later with the eight rubber track segments, which in turn should line up with the eight edges of the ground board. A very good alternative is to cut an octagonal ring from 6mm plywood with a jigsaw.

A ~10mm thick carpet ring will lie on top of portions of these blocks. A carpet tile with rubber backing works well. There are various thicknesses of carpet tiles to choose from. Turn the carpet over and draw a ~37mm wide ring with a ~51cm inside diameter and ~58cm outside diameter, as shown. Cut from the back with a sharp utility or carpet knife. The ring can be cut in sections, and there can be gaps in the ring.

The goal is to generate the correct amount of friction by iterating with either the wood block thickness or the carpet thickness. Test by placing the completed friction ring on the finished chair platform with the bearing. Place the chair on the platform, sit on it and try rotating. You can feel and hear the right amount of friction.

When done, set aside the components of the friction ring, or keep them in place with duct tape. Final testing for the correct amount of friction should be done later. At that time the wood and carpet pieces will get screwed and stapled down.

The friction ring is not visible when the bino-chair is in use.



a typical 504mm bearing would sit in this 508mm cavity. One track segment is shown in position for reference.

this carpet ring will overlap parts of the octagonal wood block ring

Cutting and trimming track segments: rotating base

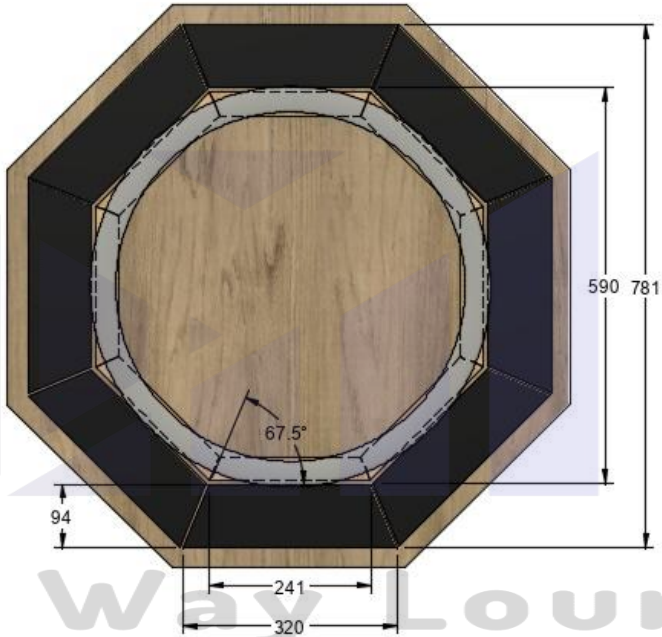
This entire step can be a little tricky and may require practicing with an extra stair tread.

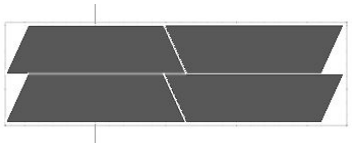
Cutting track segments from stair treads: Four track segments can be cut from each 23 x 61cm rubber non-slip stair tread cover. On the back sides, draw the four trapezoidal track segments slightly longer than needed, as in the cut diagram. Draw each trapezoid about 10 x 33cm and use 67.5°. While cutting, use duct tape or staples to hold the stair tread steady upside down on the work surface. A straight edge must also be held steady to guide each cut. Cut from the back with a sharp utility knife. Never have fingers in front of the blade.

Trimming: For symmetry, attempt to trim each track segment to the same length. Arrange the pieces on the ground board near the locations of the friction ring blocks. There will be considerable iteration as you trim and sand the segments on all four sides until they meet symmetrically, and until they look straight.

All edges can be straightened and the corners can be rounded. Each segment may end up about 9.5 x 32cm. The end result is worth the extra time spent.

Number the back of each segment with masking tape and also number its location.





Four segments can be cut from each stair tread. Disregard that the rubber grid pattern may cover only part of the surface of the stair tread.

The rubber edges can be belt sanded, for example: unplug the sander, tape the ON/OFF trigger into the ON position, clamp the sander down on its side on a workbench, then plug it in. Secure the segment on top of a board while sanding.

Wood finishing, rubber gluing, friction ring installation: rotating base

Wood finishing: Progressively sand, then clean the wood. Use ventilation. Then use multiple thin coats of exterior finish or similar for exposed top surfaces, sanding lightly with each coat. Spraying works well. It's not essential to spray the areas where rubber will be glued in later. For any exposed plywood edges, one idea is to press exterior paintable caulk along the entire edge, dry, sand, then use multiple thin coats of exterior paint. Dry and lightly smooth before each thin coat of paint. Two or three thin coats of exterior paint also work well for bottom surfaces and for the plywood foot blocks.

Rubber gluing: Before gluing rubber, it's best to clean any debris then wipe with isopropyl alcohol or acetone. Position the pre-numbered segments and lightly staple them in a few times in the area along their centre lines, not near the edges. Check that they are still in the correct positions. Use good ventilation. Working in sections, keep selected rubber edges propped up (with say popsicle sticks or pencils) and apply contact cement to the underside and to the exposed wood. After tacky, press the edges down and apply pressure. A rubber hammer can be used. Repeat for all edges. Remove the staples. If any edges are not tightly adhering, slip in some super glue and add pressure. Use a black sharpie to color any wood that shows through the seams.

A similar method can be used for the four chair positioner pads. First check for correct placement by sitting in your chair on top of the platform. Super glue works a little better than contact cement for any pads that have holes. Staples could also be added.

Friction ring installation: When your bino-chair is nearing completion, tape in your friction ring components, and test again for the correct amount of friction. When satisfied, use pre-drilling and 16 short countersunk flat head screws to attach the wood blocks to the ground board. The carpet pieces can be attached to the wood blocks with deeply buried staples. Glue can be used, but this makes any future alteration difficult.

Assembly and testing: rotating base

Quick assembly: It works out well to lay down a rubber mat or a small folded tarp first. This provides a good surface for the levelers to sit on and also keeps away a lot of moisture. A rubber mat can even be cut into an octagonal shape.

The foot blocks on the ground board help to create a fairly level standoff from uneven ground in a location like a lawn. At first, use a mini-bulls-eye-level when adjusting the levelers, but in general a level is not needed. The bino-chair need not be perfectly level because of the resistance added with the friction ring.

Then just set the chair platform's turntable bearing in place and set the chair on the positioner pads. If the chair positioners have two holes each, the chair could sit in one position or the other. One chair position may balance the chair better on the platform. And later, when the drive wheel is installed, one chair position may make the drive wheel more tangential to the centre of rotation.

Sit in the chair and spin it by pushing on the ground, or later, by using the drive wheel.

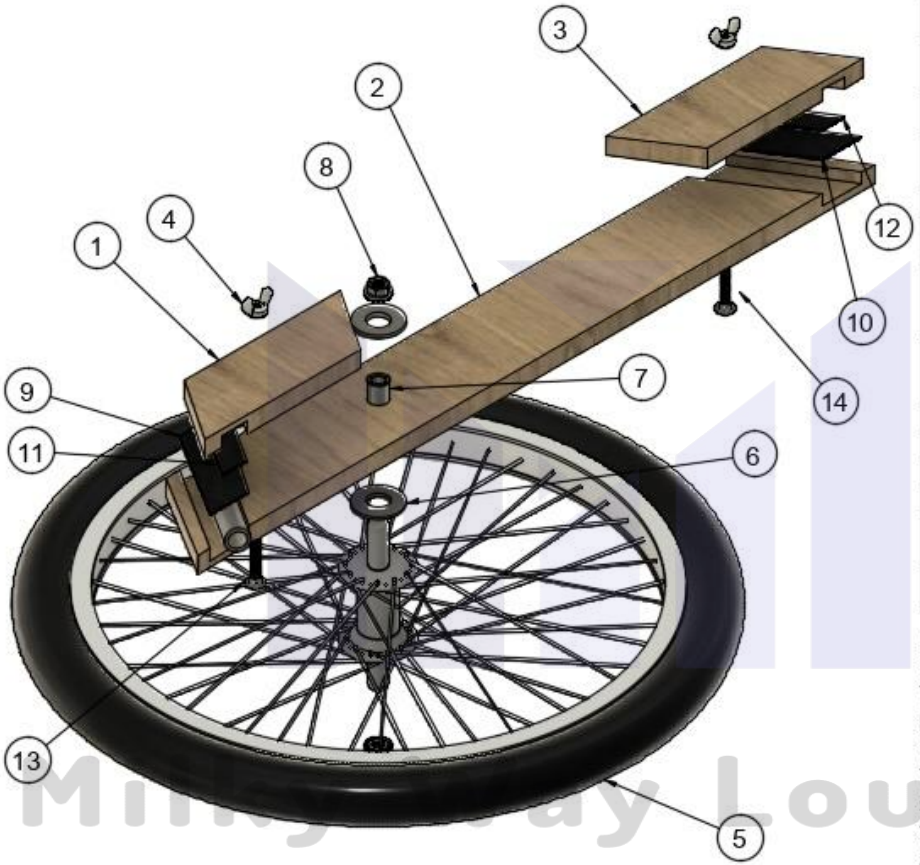
Initial testing: Slewing should be easy and smooth. There should be no drifting and almost no bounce back from the selected viewing direction. Adjust the friction if necessary. And this should be true regardless of how far the chair is tilted back. The friction will probably be slightly audible.

Testing later with the wheel mount installed: First coarse adjust the drive wheel height in order to engage with the track properly as it rotates the chair (instructions on page 28). Then with every re-assembly of the bino-chair, the drive wheel should automatically self-adjust to the correct height. When the bino-chair is not completely level, or when your hand is released, there should be no drifting. Also the rotating base should not wobble.

Ultimately on a completely finished chair, using two hands, one hand should be able to easily control azimuth while the other controls elevation.

Technical support and contact:
contact@milkywaylounge.com

Parts list drawing: drive wheel mount



MWL M2501 Azimuth Drive Mount Parts List		
Item	Part Name	Description
1	Rear-clamp ~19cm long	~60mm x 16-19mm hardwood
2	Crossbar ~66cm long	80-85mm x 16-19mm hardwood
3	Front-clamp ~19cm long	~60mm x 16-19mm hardwood
4	Nylon Wing Nuts (two)	M6 x 1.0p
5	BMX Wheel v1	
6	Stainless Fender Washers (two)	ID: 10mm OD: 25 to 35mm
7	Bike Axle Sleeve Bearing Cylinder ~16mm long	ID: ~10mm OD: ~16mm, to fit wheel axle
8	Stainless Serrated Flange Locknuts (two)	~9.5mm, to fit wheel axle
9	Rear-crossbar-pad	1.2 - 2mm rubber
10	Front-crossbar-pad	1.2 - 2mm rubber
11	Rear-clamp-pad	1.2 - 2mm rubber
12	Front-clamp-pad	1.2 - 2mm rubber
13	Stainless Cup Head Bolt (rear)	M6 x 1.0p, 45 to 50mm
14	Stainless Cup Head Bolt (front)	M6 x 1.0p, 45 to 50mm

A 20" BMX rear multi-geared freewheel wheel with solid bolt-on axle works well. The gear cluster is removed. All axle hardware is typically included with the wheel, except for the fender washers. The clamps are designed to fit a standard 3/4" (19mm) chair frame at typical frame angles. Adjust accordingly.

Parts and materials: drive wheel mount

Also see: Parts and materials, page 5 for the rotating base.

Wheel:

- Locate early; recommended is a 20” rear multi-geared freewheel with a solid bolt-on axle (bike repair/supply shops, eBay’s wonderlakebicycle #153369041366 appears correct). BMX entry-level is good. Any multi-gear cluster will be removed, and the sleeve bearing cylinder under the gear cluster will remain. The axle should extend out more on the gear side. A single gear bike axle may not extend out as much as a multi-gear cluster. Not quick-release, not thru-axle. The sleeve bearing cylinder and nuts described below are typically included with a wheel. A nominal 20” wheel is usually smaller, ~48cm in diameter.
- A 20” wheel typically has an ISO 406 mm or 16” rim (pic at right). The axle extends out slightly more on one side**.** Some nominal 20” wheels have a larger ISO 451 mm rim; this slightly larger rim should also work.
- Pneumatic multi-surface-tread tyre: typically called 20” x 1.75”
- Tube: typically called 1.75”
- Sleeve bearing cylinder, stainless: ID ~10mm, OD ~16mm, length ~16mm
- At least one stainless flange nut is needed to hold the wheel on the crossbar. The thread is typically 9.5mm or possibly ⅜”. A second nut can be added to jam the first nut, if there’s room.
- A larger wheel than this may not work since the wheel mount may need to be positioned too high near obstructions in the chair’s framing. Also, there may not be a comfortable gap under the armrest when turning the wheel during bino-chair operation.
-

Hardwood:

- any straight 80-85mm x 16-19mm: consider hardwood flooring remnants, which are strong and pre-finished on one side. The lengths are one ~70cm and two ~19cm (one ~110cm board is ideal).

Other small parts and materials:

(may be cheaper from building suppliers, but can be found online)

- cup head bolts (2): M6x1, 45 to 50mm, stainless
- nylon wing nuts (2): M6x1, multi-pack, will need more of these for bino-chair Elevation Plans
- fender washers (2): stainless, ID 10mm or ⅜”, OD 25-35mm (if the sleeve bearing cylinder is slightly longer than width of the crossbar, then instead use fender washers that have ID 16mm)
- rubber: 1.2 to 2.0mm thin sheet ~200x300mm (Amazon, eBay); if using ~3mm rubber, then use full 19mm hardwood and deeper channels (see directions)
- exterior semi-gloss or satin wood finish, spray or brush, ex: spar urethane spray

Construction overview: drive wheel mount

Short mechanical introduction video: milkywaylounge.com/?p=682.

Description: This drive wheel mount is normally clamped to the left side of the chair. This is where the wheel will engage with the rubber ground track on the rotating base. The two clamping blocks can swivel in order to adjust to the frame angles, etc. Wingnuts are turned onto cup head bolts to tighten the clamps and grasp the chair frame. The wide dado channels on the mount's crossbar can help accommodate chairs and wheels that are slightly different than nominal, such as a larger or smaller chair frame, a more or less angled chair frame, or a larger or smaller wheel.

Versatility: Again, the clamping mechanism is adjustable, in order to function with a moderate range of typical chair frame sizes, frame angles and wheel sizes. Measure your chair's front-to-back frame size horizontally at the base. It may be slightly larger or smaller than the typical 76cm. Also the angled frames extending up from the base may be more or less angled than the nominal 58° in the plans. Design changes to the mount would likely be needed for significantly different chair styles. Each clamping block has two clamp axle hole options to allow for re-positioning of the clamps with respect to the crossbar, which turns out to add a lot of versatility.

The coarse setting for the mount: For first-time attachment to your chair, a coarse adjustment is made to compensate for the chair frame's overall geometry and for the coarse height of the wheel from the ground track. The coarse setting should not need to be changed later. See the "Assembly" page for instructions on coarse setting for the mount.

Self-adjustment of the mount: Let's assume that the mount will be re-attached to the chair for each use. It should self-adjust to the chair frame and to the required height off of the ground track, simply by pushing it into place while tightening the two wingnuts.

Rubber pads: These help grip the chair frame and prevent marring.

Wheel axle hole: The axle hole in the wheel mount is closer to the rear of the mount, because the centre of rotation of a bino-chair is closer to the rear of the chair, and the drive wheel should be tangential to the rotation. The axle needs to extend far enough through the crossbar. There should be enough room on the axle to include the fender washers and at least one flange nut.

Alternative: In these plans the mount is designed to fit on the left side of the chair. To fit it on the right side instead, simple changes can be made (pages 15 and 26). This would not normally be done because most zero gravity chairs have a tray table on the right side. Typical use of a bino-chair means using one hand for azimuth control and the other for elevation control, but both azimuth and elevation can be controlled with just one hand if necessary.

Another alternative: Regarding mounting onto a chair frame, instead of using the square channels that are described in these plans, rounded grooves could be made. Experienced woodworkers would use a router for this.

Early checks for the chair and wheel: drive wheel mount

Chair:

Choose a chair early. For now, let's assume that you're getting a standard zero gravity chair. Take a horizontal measurement at the base of your chair, from the front frame to the rear frame. If that's close to 76cm then you have a standard sized chair, and the dimensions here will not likely need to be adjusted. There is also some adjustability for chair frame size, because of the way the clamps can work.

If you ordered a standard zero gravity chair and it has not arrived yet, then as you begin a trial run mount, assume that the dimensions in these plans will not need to be altered.

Wheel:

The tube and tyre can be installed on the wheel early. Remove any gear cluster and clean the axle. Check that the sleeve bearing cylinder fits snugly. The axle should extend out a bit more on one side, where there was a gear cluster. This end of the axle will be the one extending through the crossbar.

Mount: cutting out the blocks: drive wheel mount

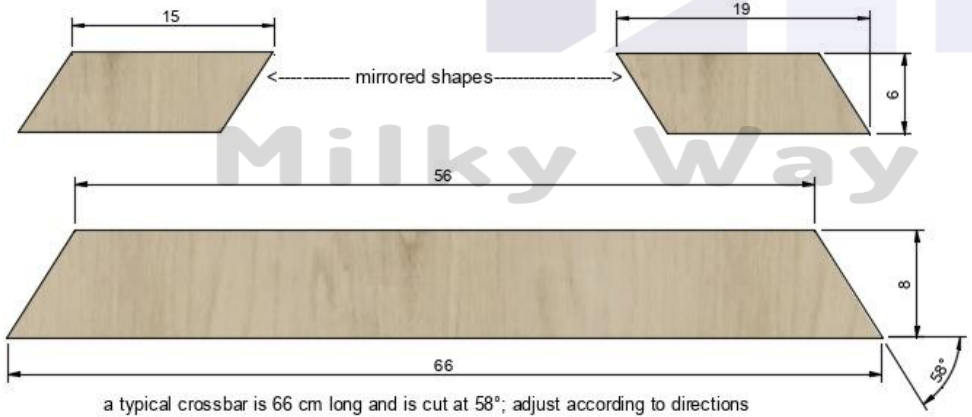
Trial run: Produce better results by doing a trial run. Some of these instructions are very methodical and can be misleading, so that could be even more incentive to practice first. It is challenging to custom fit.

Prep: Any straight 16mm to 19mm hardwood can be used, but hardwood flooring works well. The grooved undersides of 19mm flooring can be removed with a table saw, but it need not be removed, and won't be easily visible. If the bike axle doesn't extend quite far enough through, then 16mm thick wood could help. Again, there should be enough room on the axle to include the fender washers and at least one flange nut.

Rip: Using a table saw, rip an 8 to 8.5cm crossbar and two ~6cm clamp blocks.

Check angles: The nominal angle for the edges of the blocks is 58° in these plans. However, the actual angle of the chair frame base should be used if it's more than a couple of degrees off from 58°. With the chair on a work surface, hold the crossbar board up against the outside of the left side of the chair frame, with any pre-finished side facing you. The board should also be at the nominal height, which is 17cm from the bottom of the crossbar to the work surface. Use duct tape to hold it firmly level. At the back of the board, slide a pencil along the frames, to trace four complete lines on the board, one on each side of each frame. Keep the pencil perpendicular. Measure to get average angles. Use angles that are within ~2° of this, for your cuts.

Crossbar length: Measure the distance along the bottom between the outermost traced lines. This is typically ~64cm. It's best to use this traced distance measured, plus 2 or 3cm, which would then be typically ~66cm for the overall crossbar length (also see next page).



a typical crossbar is 66 cm long and is cut at 58°; adjust according to directions

Crosscut: Use a crosscut saw or a guided circular saw, to cut the trapezoidal crossbar. The length may be different than 66cm, and the angle may be different than 58°. Crosscut the clamp blocks at this angle. Sand all edges.

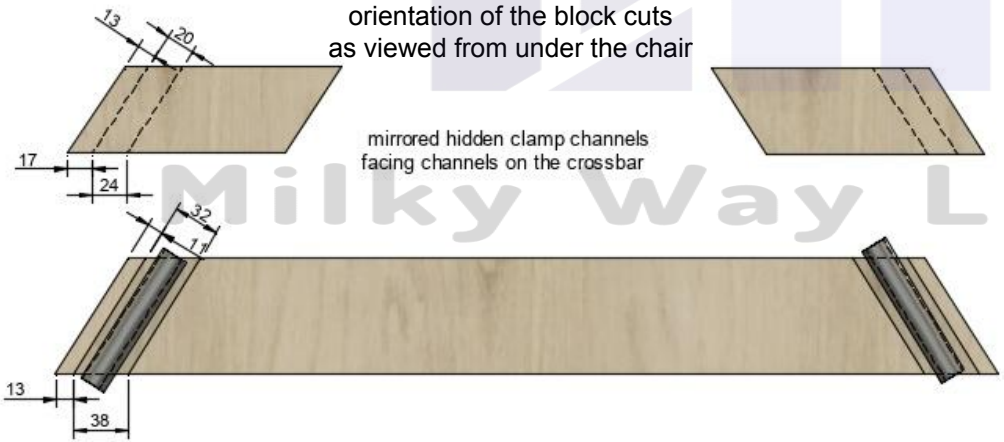
When using tongue and groove 85mm hardwood flooring, the tongue can be stripped away with the table saw. Remove the entire tongue, but not any more than the tongue. The groove can face downward on a bino-chair, so as not to be visible. Normally one face is prefinished so that should end up being the more visible face on the bino-chair. This all implies that **the clamp blocks should be cut as mirror images of each other, as shown.** For all three blocks, the faces that have not been prefinished, will be the ones that get the channels (next page).

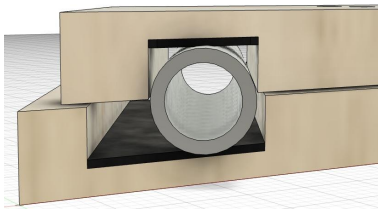
Cutting the channels: drive wheel mount

Overview: Preferably continue with practice boards for this step. There are various methods to cut channels in the blocks. A router can cut dado channels or rounded grooves (see Advice page). Here we imitate dados by doing repeated passes with a table saw. If using flooring, the channels should be made on the faces that are not prefinished.

Width and depth: For a ¾" (19mm) chair frame, the width of the channels on the two clamping blocks should be slightly more than this. The width of the channels on the crossbar should be ~32mm. Since each of the four channels has a ~1.5mm thin rubber pad, the channel depth should be slightly less than ~11mm (pic at right). With 3mm rubber, use full 19mm hardwood and slightly deeper inset channels.

Cutting: Use a mitre gauge and hold the workpiece tightly, preferably moving the rip fence with every pass (pic at right). Set the angle to keep the end of the block flat against the rip fence. Since it's hard to see where the cuts are being made, this could take a little practice. Refer to the drawing below and start a little shallow.





Rubber lined dado channels clasping a chair frame. As the clamp starts to close, the rubber is compressed.

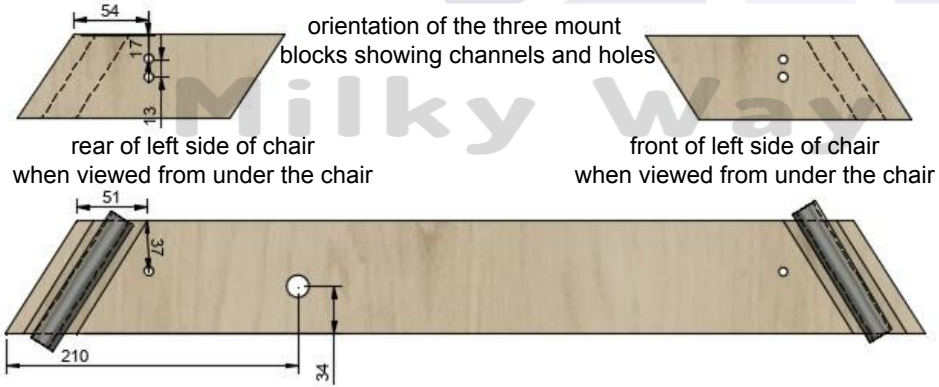
Channels can be cut without removing the blade guard, by re-orienting the equipment and making partial cuts from each side of the wood.

Chisel: Chisel and smooth the channels. Later, pieces of the rubber material can be taped in place for testing that the chair frame is being grasped properly (next page).

Hole positions, rubber pads, checking: drive wheel mount

Overview: The wheel axle hole in the crossbar is closer to the rear of the mount, because the centre of rotation of a bino-chair is closer to the rear of the chair, and the drive wheel should be roughly tangential to the rotation. If not using a typical zero gravity chair, the wheel's position may be different. Continue to use a practice workpiece until you have a mount that holds the wheel on the chair frame in the correct position.

Wheel axle position: Hold the crossbar up against the outside of the left side of the chair frame. Looking from under the chair, the frame should appear along the middle of the crossbar's channels (pic below). Use duct tape to hold the crossbar centred there; it need not be completely level. A nominal 20" bike wheel is actually ~48cm in diameter (radius: 24cm). So the axle hole in the crossbar should be ~24cm from a ground track. But the ground track will be ~3cm beneath the surface that the chair is sitting on. So the axle hole should be ~21cm up from the work surface. Mark that height on the crossbar. In the plans below, it was marked at 34mm from the bottom of the crossbar, which is typical. Remove the taped up crossbar.



Drill: Drill the axle hole at the marked height, preferably with a drill press. Drill the two 6mm holes in the crossbar, as shown. Chisel out a little square area around each of the small holes for the square collars of the cup head bolts to sit into. Drill the two 6mm holes in each of the clamping blocks, as shown.

Rubber: Rubber adds grip and also prevents marring of the chair frame. Cut four pieces of ~1.5mm rubber with a scissors or a utility blade, and fit into the channels. Clean with isopropyl alcohol. Use contact cement or super glue with pressure.

Checking: Without the wheel attached to the crossbar, attach the mount to the chair using the cup head bolts and wing nuts. Test the various clamp block positions with the four clamp hole options, and see how they would shift the position of a drive wheel if it was attached. Refer to the coarse settings section on the "Assembly" page.

Wheel: Put the chair on the edge of a workbench. Attach the wheel and check if it can be set into a position where it extends ~3cm below the work surface.

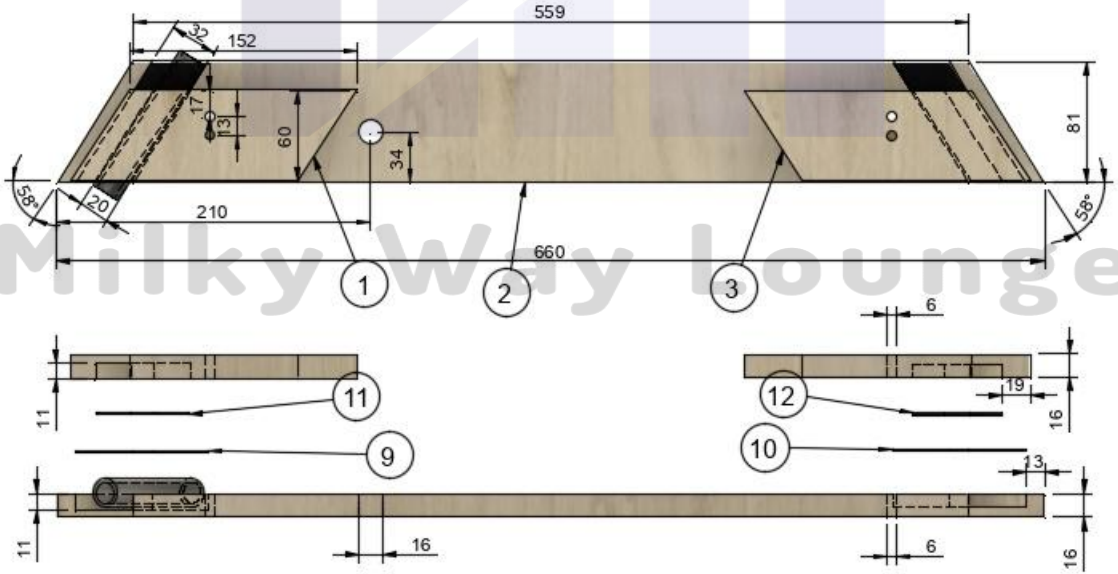
Good to go: If everything looks correct with this trial run, build the entire mount for keeps, or fully test the trial run with a finished bino-chair.

Alternative: To instead fit this mount on the right side of the chair, a simple change can be made: drill an axle hole ~21cm from the other end of the crossbar. To complete this switch, another small change would be made to the rotating base as well.

Projected views and dimensions: drive wheel mount

MW2501 Azimuth Control Crossbar And Clamp Dimensions		
Item	Part Name	Description
1	Rear-clamp ~19cm long	~60mm x 16-19mm hardwood
2	Crossbar ~66cm long	80-85mm x 16-19mm hardwood
3	Front-clamp ~19cm long	~60mm x 16-19mm hardwood
9	Rear-crossbar-pad	1.2 - 2mm rubber
10	Front-crossbar-pad	1.2 - 2mm rubber
11	Rear-clamp-pad	1.2 - 2mm rubber
12	Front-clamp-pad	1.2 - 2mm rubber

These dimensions are chosen to work for a moderate range of typical zero gravity chair sizes and shapes. Customize for other wheel and chair sizes and shapes, especially for non zero gravity chairs. The clamps are designed to work with standard 3/4" (19mm) chair framing and a range of typical frame angles. The cut angles of all blocks shown here are all 58°. Adjust accordingly. When using a wheel much smaller or larger than 20", the length of the crossbar and/or the height of the axle hole in the crossbar will change accordingly. The lateral position of the axle hole is approximate and is intended to position the drive wheel tangential to the center of rotation. The clamp blocks are shown in their lower positions. 11mm channel depth is used to grasp the chair frame when 2mm rubber pads are used.



Assembly, adjustment and final testing: drive wheel mount

Assembly: It is recommended to assemble and adjust your trial run mount first. If not done already, install the tube and tyre on the wheel, and fill the tyre partially. Install the wheel on the crossbar. If a rotating base has not yet been built, create a chair platform that's ~3cm higher than the surface that the wheel touches. Holding the crossbar against the outside of the chair frame, attach the clamp blocks loosely in either position for now.

Coarse adjustment for initial set up: Each clamp block has two hole options to choose from.

- if the wheel is too high use one or both of the lower clamp block holes to lower the crossbar
- if the wheel is too low, use one or both of the higher clamp block holes to raise the crossbar
- the rear clamp block has a greater effect on the wheel height than the front clamp block because it's closer to the wheel axle

The crossbar need not be level. Once the correct wheel height has been found, mark the clamp holes that are being used, for easy set up next time. Also note if it's not level.

If a larger wheel height change is needed, an alternate axle hole can be drilled through the crossbar, or the crossbar channels can be widened in the direction needed.

Subsequent viewing sessions: Here, coarse adjustment should not be needed. Simply hold the wheel in place while tightening the wing nuts. If using a rotating base, the partially filled pneumatic tyre should be pushed down a little to sink into the ground track, as the clamps are tightened.

Wood finishing: Progressively sand, then clean the wood. Cover any rubber with masking tape. Using ventilation, apply multiple thin coats of exterior finish, sanding lightly with each coat. Spraying works well.

Final testing: Slewing should be easy and smooth. There should be no drifting and almost no bounce back from the selected viewing direction. This should be true regardless of what the elevation setting is. Adjust the friction if necessary. When the bino-chair is not completely level, or when your hand is released, all of the above should still be true. Also, there should be no wobbling, except for the limitations of the zero gravity chair itself. (when tilting back a chair with heavy binoculars, use a chair-front counterweight).

Yes, there is more than meets the eye when building a fully functional bino-chair! If interested, here are the full usage specs for the completed bino-chair: milkywaylounge.com/?p=390

Congratulations on your build!

Technical support and contact: contact@milkywaylounge.com

Addendum: woodworking advice, and use of a router

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. At no time should any part of your body ever be in front 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. Any hardwood must be pre-drilled with the correct hole size before inserting a fine-thread screw.

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.

Using a router table to create rounded channels:

- with a router, one option is to use a 7/8” or 22mm round-nose bit
- use a mitre gauge and a router fence
- starting very shallow, do successive passes, holding the workpiece tightly against the mitre gauge and the fence, especially since routing across the grain
- continue until the channel is slightly less than 11mm deep
- check for the correct depth by taping in curled rubber linings on two facing blocks surrounding the chair frame; it should grab the frame
- the width of the channel on the clamping block can end up at 22mm or slightly more; the crossbar channel width should be ~35mm
- cut, curl and glue in ~1.5mm rubber to line these rounded channels
- workaround without a 22mm bit: use a 19mm bit and do staggering to create a 22mm or slightly wider channel that is slightly less than 11mm deep. After this, optionally increase the face radius to 11mm using a cylindrical sanding drum sleeve.