How to Build a Revolve or Turntable
—
An Illustrated Guide

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Amateur Theater Division

Please note: I created this guide as a way of sharing experience. You must not take my statements as an official specification or standard. What I say about strength and safety is based on observations, not on codes, regulations or standards. If you have not made observations of your own that enable you to evaluate the statements in this guide, you should consult other sources of information before going any further. I do not guarantee your results, and I do not accept liability for any damage or injury that results from your work, whether you follow my suggestions to the letter or not. Follow the manufacturer’s instructions when using any power tool, and observe all safety precautions found in those instructions.

November, Year 6

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Building a revolve

Once in a while—even in community theater—you find a show that will benefit so much by having a revolve or turntable in the set that it really is worth spending the money and effort to build one. Some houses invest in a permanent revolve, using it for this show and locking it down for that one; others strike and store the pieces between uses. Either way, it pays to know the basics of designing, building and installing a revolve.

The ideas in this booklet are mostly due to B. Don Massey, a design professor in the Department of Theatre and Film Studies, University of Georgia, and experience gained in installing and strikes a largeish unit (shown at left, with Matt, 6, to indicate scale) for a production of George Bernard Shaw’s *The Devil’s Disciple* by Town & Gown Players, Athens, Georgia. I’ll add a few points I learned after a colleague requested a design for an even bigger unit.

(Both technicians and people on the street easily understand the word “turntable,” but in the theater it is just as often called “revolve.” I prefer the shorter term.)

I’ll begin by discussing the principles of the revolve, chiefly physics and materials of construction, and touch on safety issues that arise when a revolve is present. Then I’ll give some information on the components of the unit: running wheels, hub and disk. The next sections will provide a detailed design for a non-permanent revolve and some design considerations for a permanent one. The procedure for installing a revolve and ways of using it are worth a detailed treatment, which will wind up with some pointers on striking and storing a temporary unit.

Revolve principles

For present purposes, a revolve is a circular disk, capable of supporting the same loads as the stage floor, lying in a horizontal plane and turning around a fixed center. You can conceive of a unit that violates any point of this definition; the victim’s wheel in a knife-throwing act is not horizontal, a lightweight set piece can be revealed with a pie stand or a table mounted on a dowel rod, and so forth. I won’t take up any of those cases.

The disk has to be fairly stiff, because we don’t want set elements built on it to flex when the unit moves. We don’t look for perfect rigidity; maybe we *could* build a 16- or 18-foot circle with no give in it, but even a sound floor sags a little when loaded, so there’s no point incurring the vast expense of a perfect revolve to stand on an imperfect deck.

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If the disk is more than a handspan across, it has to have support other than at the middle. A big revolve with all its weight concentrated at the center would punch right through the deck, making us no friends in the theater.

The forces on a revolve can be broken down (resolved) into vertical or gravity forces and lateral or thrust forces. Most of the thrusts act when we turn the unit, but lateral forces arise in violent action and even when someone steps on or off. If the revolve is stationary and no one is mounting or dismounting, gravity is the only force that acts on it. It will simplify design and construction if we can use one system to handle thrust and a different system to handle weight. That won’t quite happen, but we’ll make the effort.

In building theater equipment, most of us think in terms of wood and metal. There’s a lot to be said for iron as a load-bearing material; your favorite freight elevator is chock-full of it. But think how much machinery you need to move the elevator. You may have trouble bringing in a crane to set and strike your revolve . . . or maybe you consider that routine. Me, I’ll use plywood.

So. Our revolve, whether permanent or not, will comprise a fairly rigid wooden disk, a system to bear its weight and a system to counteract lateral forces on it.

**Revolve safety**

The revolve is like a wagon: a heavy object running on wheels in a confined space. All the precautions for a wagon also apply to the revolve:

- Don’t withdraw the chocks or move the unit except when the Stage Manager says to.
- Make sure everyone knows (through rehearsal and through audible or visible signals) when the unit is moving and in which direction. Anyone who stands on the moving unit gets a “brace” warning as well.
- As a cast or crew member, either help move the revolve or stand well back out of the way. The S.M. will tell you which.
- Keep your fingers, hair, clothing and foreign objects out of the mechanism and narrow clearances around it.
- If the crew uses poles or other tools to move the revolve, don’t touch these items.
- Immediately report any malfunction to the S.M. or the revolve crew chief.

The only thing that can happen to a wagon but not a revolve is that it gets loose and runs uncontrolled over the stage. (Come to think of it, that can happen too!)
Components: Weight-bearing system (wheels)

Wheels hold up the weight of the revolve. While it’s desirable if a plain wagon moves quietly, it’s even more important for our revolve, because one of the virtues of this stage equipment unit is that it doesn’t draw attention to itself by rumbling and squeaking. So we need wheels that will operate without making noise.

But many stages have slightly irregular decks. The one I work with most often not only has soft places due to ancient rainstorms but also has craters and gouges due to use of the stage as scene shop. How do you keep the wheels from sounding as they drop into low spots and bump into high ones?

By inverting the wheels and attaching them to the deck, not the disk. Because they are stationary, you can use shims to level them (make sure they all stand in the same horizontal plane). No highs, no lows, just all one smooth surface.

Each wheel is a soft-tired industrial caster 4 or 5 inches in diameter. Home-improvement stores sell these for rolling tool cabinets and the like. You may find rubber or polyurethane tires of differing quality; buy the best you can afford. You will need dozens of them, so shop for price breaks. It’s vital to get fixed wheels, not swiveling ones. (Swivel casters will drive you crazy as they jam and chatter at crucial times. And don’t even think about smaller diameters. If the words “furniture casters” popped into your mind, I can tell you a story or two about furniture casters. Get the big, straight, rubber-tired kind.)

You will prepare each caster by attaching it to a pad, a piece of two-by lumber between 9 inches and a foot long. Use four 1-1/4 or 1-1/2 inch lag bolts to secure the caster frame to the pad, leaving wood exposed at both ends. A ratchet wrench with an extender bar will speed this job up. People who spend their week lagging wheels to pads go out on Friday night and get rowdy by watching paint dry.

Predrill each pad for four 3-inch drywall screws and set all the wheel units aside. We’ll come back to the wheels at installation time.

Components: Thrust system (hub)

The hub allows free rotation and resists sideways forces (to prevent the revolve shifting from place to place) but bears no weight. The last point may not apply if you procure a special ball-bearing hub, but remember that you don’t want to concentrate much weight at any one point. Besides, you can build a non-load-bearing hub cheaply.
The simplest hub consists of two pieces of heavy-walled pipe, sized so that one slips inside the other. The smaller pipe is mounted vertically to the deck, the bigger one to the revolve. The store that sells the pipes also sells flanges for mounting them; use one flange for the smaller pipe and one or two for the other. Even better, weld a large collar to the outer pipe. Secure each pipe so it won’t rotate in its flange (i.e., unscrew itself).

Right about now you must determine how high your revolve will float above the deck. Flip a couple of wheel units up and lay a piece of 2x4 on top. The top face of the 2x4 is where the top face of your disk will be. If you want a higher level, you can return your wheels for bigger ones, underlay plywood on the floor, or lift the wheels singly by inserting secondary pads. The height (ground clearance) of the revolve governs how long you cut the hub pipes. If the bigger pipe is too long, it will make contact with the flange of the smaller pipe, and contact means weight is carried to the deck at the center. It also means friction and noise. Allow the inner pipe to show for about an inch above its flange.

Components: Disk

Whether you build a permanent revolve or one that can be struck and stored, plan for a total (nominal) thickness of 1-1/2 inches. That’s two sheets of 3/4 inch (23/32) plywood or one of 3/4 inch (23/32) and two of 3/8 inch (11/32). Plywood labeled x inches is really x minus 1/32 inch thick; disregard the difference between the nominal and actual values.

The main reason for doubling the thickness this way is to stiffen the disk. In the case of a disk that can be dismantled, the extra plywood also gives you a place to bolt the unit together. You may get away with less thickness for a very small revolve, but in my experience single 3/4 inch plywood is certain to flex under a fairly light load.

What grade of plywood should go into your revolve? Surprisingly, the critical surface is not the top but the bottom face, which rides directly on the wheels. Every knothole on the bottom face makes a rhythmic series of bumps whenever you turn the unit. You should try to put a “B” grade face underneath, which means BB or cheaper BC plywood. A top face graded B will provide a nice even surface, but if your company routinely puts CD or CDX lids on platforms, then this grade is adequate. Be sure your crew knows which side of the plywood goes on the outside. The stampings generally appear on the bad side (the D face of CD or the C face of BC).
In a one-piece revolve or the central disk of a multipart unit, let the surface grains of successive sheets run perpendicular to each other. If one sheet has visible grain running east-west, the next sheet should have north-south grain. A disk built in segments will have most of the grain running from the center to the rim.

The thicknesses of plywood will be glued and nailed or glued and screwed together. To attach 3/8 to 3/4 plywood, use carpenter’s glue and 1-inch nails or 1-inch drywall screws.

Your storage area can probably handle a disk 4 to 6 feet in diameter without much trouble, so a unit of this size will not have to be dismantled. Anything bigger must be done in segments. The next sections will suggest how to design a large disk meant to be taken apart.

**Design approach for a segmented disk**

Here are the points to consider when designing a disk in multiple segments.

- **Materials:** 3/4 inch plywood sandwiched between two pieces of 3/8 inch (I’ll refer to the inner material as “cheese” and the top and bottom as “bread”)
- **Segment size governed by standard plywood sheet size (4 x 8 feet)**
- **Fasteners in each segment: glue and nails or glue and screws**
- **Segment-to-segment fasteners: carriage bolts (3/8 x 2-1/2 inch) with washers and nuts**
- **Hub permanently attached to a circular inner disk**
- **Each segment attached to inner disk and to the segments on either side**
- **Joints between bread segments staggered relative to joints between cheese segments**
- **Bread of inner disk encloses inner tips of cheese segments (or bread segments overhang to enclose rim of inner disk)**

Making a model can help you understand design and installation and explain them to your crew. You might use corrugated cardboard to represent 3/4 inch plywood (cheese) and lighter card stock to represent 3/8 inch (bread). Bits of dowel rod can stand in for your wheels, and the hub can be as simple as an inch of dowel rod glued vertically to a base. Pushpins can serve for carriage bolts. Build your model at dollhouse scale (1 inch = 1 foot) or smaller. Modeling enables you to make your mistakes with cheap material.
It’s also a smart idea to mock up your first revolve at full scale in the space where you will install it, as shown in the drawing on the preceding page. Drive a nail where the center will go, use a beam or chain compass to strike circles for the inner and outer disks, and define the segments with chalk lines. Lay a 4x8 sheet of plywood over the outline of a segment; make sure the segment isn’t bigger than the plywood. When you have satisfied yourself that the design works, turn part of the mockup into a marking jig for the plywood: Run strings an inch above the deck along two radii as shown in the drawing at left (sort of like stringing a guitar). Now you can slip a sheet of plywood under the strings, use your compass to mark the arcs on it, use the strings to mark the radii on it, slide the plywood out and send it to the shop for cutting. Next sheet, and so on. When you’ve sawed up all the cheese slices but one, lay everything out and check the fit, then mark and cut the last piece; do the same steps for the bread.

Don’t number the segments with chalk, which will rub off, but do number the segments.

**Design and construction: Inner disk**

In the simplest case, your inner disk will be 4 feet or less in diameter. (A later section of this booklet will show how to work out the fine details.) Cut it from three half-sheets of plywood. Bore an accurately centered hole to let the big hub pipe pass through. The photo shows the inner disk of an 18-foot revolve. You can’t see the cheese at all; the bread forms a slot (white arrow) where the cheese of each outer segment will be inserted. Note the ring of bolt holes (black arrows) for fastening the segments to the inner disk.

The flats at left and right probably indicate that this inner disk was designed with a diameter 3 or 4 inches bigger than 4 feet.

The pipe can be attached to the inner disk with a flange or welded collar on the bottom. If you prefer, you can double the flange—one on the underside and one on the top—but the upper flange may interfere with placing set units on top. Doubling the flange also means threading an extra length of pipe. All in all, a welded collar is probably better.

Best practice is to cross the grains of the bread and cheese. Glue and nail (or glue and screw) the bread to the cheese.
If your inner disk is bigger than 4 feet—as it must be for a total diameter over about 18 feet—you will have to build it up from multiple sheets.

Design and construction: Segments

Each segment—and there may be a lot of them—is built independently. Accuracy in fit-up is essential. The photo at left shows one segment from an 18-foot revolve. You can see the outer radius at the bottom, the inner radius at the top, and the overlap of bread and cheese. (I’ve added a line to mark where the bread stops.) The skidmarks indicate that you’re looking at the bottom face of this segment.

Designing the revolve may take a bit of trial and error. You want each slice of cheese to come from a single sheet (4 by 8 feet) of plywood, and similarly each slice of bread. That means the chord of a slice is up to 4 feet but not a zillionth more. A careful scale drawing is vital. To get started, figure how many 4-foot chords your big disk needs (a chord is a straight line joining two points on the circle). As a guideline without a guarantee, consult the table below. Use the angle information in creating your plan.

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<th>Diameter, ft.</th>
<th>Segments</th>
<th>Angle (*)</th>
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<td>bigger</td>
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*If all segments are identical.

Draw a circle the (scaled) size of your revolve and a concentric circle the size of your inner disk. Draw radii with the appropriate angle between them. As a check, cut out a scaled sheet of plywood and lay it over a segment; it should cover the outline completely. Now look at the drawing on the next page and note that the cheese of each segment has a tongue that sticks into part of the inner disk. From cardboard, cut the appropriate number of cheese slices. Cut two bread slices (without tongue) for each one of cheese. Lay the whole disk out on a table and make sure the pieces fit. As I said before, it’s useful to make a model that works the same way the revolve will, so glue and pin your cardboard revolve together.
Only after multiple checks of your design (by multiple people) should you begin marking up plywood and cutting the segments. Please look at the section titled “Design Approach” for a suggestion on mocking up your revolve.

As you build the segments, take care not to drill, glue, nail or screw the part of the bread that hangs over the cheese. You will need this unobstructed slot when you assemble the outer disk.

Hold out a sheet of plywood until you’ve finished all but one segment. Lay the uncut sheet in place and carefully mark it. Building this “odd” segment can make up for small errors elsewhere in the disk. Remember, number all the pieces so they go together the same way every time.

Specimen bill of materials

Here’s a rough bill of materials for an 18-foot revolve (with no guarantee of completeness):

- Plywood, 3/4 inch (23/32) CD or better grade, 16 sheets
- Plywood, 3/8 inch (11/32) BC or better, 16 sheets (for the riding surface)
- Plywood, 3/8 inch (11/32) CD or better, 15 sheets (for the top face)
- Wood glue, enough to bond 350 square feet of plywood
- Nails, 1 or 1-1/4 inch wire, 5 pounds
  OR
  Drywall screws, 1-1/4 inch, 5 pounds
- Pipe and flanges for hub
- Lumber, 2x6 – 8 feet, about 4 sticks or equivalent in scrap (for pads under the wheels)
- Wheels, at least 40
- Lag bolts, 5/16 or 3/8 by 1-1/4 or 1-1/2 inches, 4 for each wheel
How to Build a Revolve

- Drywall screws, 3 inch, 5 pounds
- Shims, both the tapered kind and the ones you make from scrap lauan
- Carriage bolts, 5/16 or 3/8 by 2-1/2 inches, about 75, with washers and nuts

Tools and supplies—how many you need depends on how many crew you have:

- Circular saw
- Jigsaw or saber saw
- Lots of blades for the jigsaw
- Glue brushes
- Hammers and other usual hand tools
- Power drills/screwdrivers and bits
- String
- Chalkline
- Soft carpenter’s pencils
- Steel measuring tapes
- Levels
- Chalk for temporarily numbering segments
- Paint and lettering brush for permanently numbering segments
- Notebook and pen

Installing the revolve

The first step in putting your revolve together the first time is to appoint the Official Remembrancer (O.R.), whose notes will later become the instructions you paint on the revolve. This is serious, because you may find the unit only works one special way, and it would be a pity if the person with the formula moved away. The O.R. should write down each step as it’s performed, including the order of adding segments, as well as mistakes that have to be corrected on the fly. This person should have no other duties, and the rest of the crew should be instructed to let the O.R. write down each step they perform before they go on to the next.

Determine where the revolve will go; mark the center (a nail or screw will do) and strike a complete chalk circle to show what space the unit will occupy. Strike other circles to define where you will install the wheels. As a rule of thumb, support the inner disk with one ring of four or five wheels; this ring should fall about 1 foot inside the rim. Add a second ring closer to the center if the inner disk is bigger than 6 feet across. Support the outer part of the disk with a ring of wheels a bit inside the rim (say 9 to 12 inches) and a ring close to the narrow end of the segments (say 12 to 15 inches from the inner ring). If the segment length is over 6 feet (rim to tip), add a ring of wheels halfway between the other two. Set wheels on the chalk circles, not more than about 3 feet apart, with all the axles pointing to the center of the revolve. It is not important to get the wheel spacing perfect.

I should admit that the number of wheels is controversial and that I come down on the conservative side. Two pages back, you saw a photo of a segment where skidmarks identified the wheel locations from a previous installation. The inner ring of wheels, for the record, was about 2 feet 4 inches out from the rim of the inner disk, and the outer ring was some 9 inches in from...
the rim of the outer disk. If your experience tells you what spacing between rings—and between the wheels in each ring—is appropriate, then follow it. If you have no experience as a guide, take the conservative approach and overbuild.

Locate the high place of your deck and screw down one wheel there to begin with; otherwise, mount one wheel on a scrap of plywood. You’ll add shims to level all the other wheels to this one. A rotating laser level may speed this part of the project up (see the tip on the last page of this booklet), but it’s certainly feasible with a carpenter’s or mason’s level. Screw down all the wheel pads with shims as needed.

Install the fixed member of your hub. Verify that the pipe is vertical and accurately centered on your mark. Carefully lower the inner disk into place and let it rest on the wheels. Use a flashlight to inspect the hub; if the outer (floating) pipe touches the flange of the inner pipe, you must remove the inner disk and saw an inch off the floating pipe. Re-install and re-check. Make sure the inner disk turns smoothly and quietly.

Install a segment so that it engages the inner disk properly. The wheels will support the weight. If you have made accurate cuts, the outside edges of the segment will point exactly to the center of the disk. Now, on the top bread of the inner disk, mark where you will drill a bolthole. Make sure this bolt does not interfere with any wheel. Drill through the bread, cheese and bread where the segment and the inner disk are engaged, and place a carriage bolt here. Drive the head down on top, put on a washer and nut underneath, and tighten a little more than hand-tight.

Mark the number of the segment next to the bolthole on the inner disk.

Bring the next segment in, making sure it fits snugly to the inner disk and to the previous segment. Drill and bolt the new segment to the inner disk. Now you have to connect the two segments. Drill through the region where segments 1 (bread) and 2 (cheese) overlap; insert bolts and tighten. Make sure these bolts don’t collide with wheels. Except in quite large units, two bolts per joint should be plenty, although more won’t hurt.

Little corrective cuts are normal. Ideally all the cheeses will fit wood-to-wood and similarly all the top and bottom breads. You can probably live with very small undercuts, which produce slots, but overcuts have to be fixed.

No one in the crew will have long enough arms to secure the last two joints with carriage bolts. A clever carpenter may be able to drive T-nuts into the bottom bread and use countersunk machine screws to hold the segments together. Otherwise, drive 2 inch drywall screws through the bread-cheese-bread stack, making sure to avoid the rings of wheels.
Have the O.R. write brief instructions for assembling the revolve. When you strike the unit, get a lettering brush and write the instructions on the bottom of the inner disk, or print them and shellac or laminate the paper there.

Congratulations: break time.

**Using the revolve**

You can divide the revolve into two, three or four parts separated by walls. The picture on page 1 shows a four-part construction. Build fixed masking to conceal the parts not in use. Be sure the screws or bolts that hold up the walls don’t interfere with any of the wheels.

Fixed diagonal braces on the walls will defeat your purpose. You can run stringers between the tops of the walls if sightlines permit, but you may have to content yourself with the stiffness you build into each wall.

The downstage edge of the circle may look ugly or just distracting. You can build a fixed apron to hide it, or you may prefer to attach a skirt to the rim of the unit.

If you need electricals on the revolve, power them with pendant cables near the pivot. It’s perfectly all right to twist the cables, as long as your crew comes and unwinds the rig every night. The lighting designer and electricians must know that fixed electricals have to be placed either outside the rim or high enough to clear the moving walls.

Two or three hands will be enough to turn the revolve. Don’t worry about abrupt starts and stops; they won’t happen.

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The drawing at left shows one way to hold the revolve in place during action. The partly closed box is attached to the deck at the rim, between wheels. Leave a little clearance between the box and the bottom of the disk. You can use a C-clamp or a wedge to secure the unit to the box, though some designers prefer to bore a hole through disk and box and drop in a steel pin. Mark the box with glow tape so crew members don’t pinch their fingers.

**Striking the revolve**

Strike is simplicity itself. Just reverse the steps above.
Storing the components

Unless you’ve built a huge revolve (over about 18 feet in diameter), the inner disk will fit into your scene shed or loft. Even in a large unit, the segments are not much bigger than your stock flats (but much heavier). Remember that each segment will stand on its outer edge; try not to scar the top surface when moving it. Be sure the unit is stored in a dry place. It will be good if the last unit into storage is the one with the instructions for installing the revolve.

Detailed design for a non-permanent revolve

The drawings on the next page, together with the others in this booklet, represent a design for a revolve with a diameter of 18 feet (radius 9 feet). You can fiddle some of the numbers; for example, the only strict requirement on the placement of bolts is that they don’t bang into the wheels underneath.

Design considerations for a permanent revolve

You can’t cut a 12-foot hole in the stage and drop a 12-foot disk into it. Because you can’t. You have to build and assemble in segments, just as for a temporary unit. There are a few special points, though.

You must go down till you come to a load-bearing surface, build and install your revolve, then construct a new flush deck around it.

Your crew can’t grip the edge of the revolve to move it. You will need to devise a method for operating the unit. The easiest may be a series of large holes near the rim. These should have metal bushings in them to prevent wear and damage to the plywood. Crew members use long vertical poles to walk the revolve around. Or you can motorize the unit.

Dirt and debris are a special problem in a permanent revolve. Take precautions to keep the subsurface clean. Including one removable segment will let you sweep under the unit and inspect the wheels for wear.

Variations and tips

You may have to modify the design heavily. Example: A colleague at a high school in California needed a D-shaped revolve instead of O-shaped. It was essential to have one flat face so that this very large unit (diameter almost 24 feet) would go behind a curtain. Placing wheels in “standard” inverted position was out of the question. His solution was to install one or two inner rings of inverted wheels, then attach the two (incomplete) outer rings to the bottom of the disk. This change added to the moving weight of the unit, and it meant extra effort to sweep the stage daily, but it met the case admirably.

In principle, a revolve up to about 8 feet in diameter can be built in one piece. Lay down and laminate your plywood, crossing grains; mount the hub; then cut the circle as you rotate the unit. Be aware, though, that the disk is enormously heavy and is likely to hurt someone when you
Synoptic design drawing for an 18-foot revolve

Bread (2 disks required)  
Cheese (1 disk required)

Segment angle: 24°

Outer disk radius: 9'0"  
Inner disk radius:  
2'0" (bread),  
1'3" (cheese)

Footprint of segment on  
a 4x8 sheet of plywood

Rings of wheels

18-20 wheels  
11-13 wheels  
6-8 wheels  
3-4 wheels  
Total: 38-45 wheels

Wheels spaced approximately  
evenly on circles with radii:  
1'3", 3'0", 5'6", 8'0"

Rings of bolts

Bolts pass through bread-cheese-bread  
overlap, on circles with radii:  
1'7-1/2", 4'0", 7'0"

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move it. Treat it as you would handle an elephant: a big crew, plenty of restraining ropes, and swearing as necessary.

The size of a plywood sheet constrains the design of the inner disk and segments. The design illustrated won’t work for a unit bigger than 18 feet in diameter. For that 24-foot California revolve, the inner disk had to grow when we reached the segment size limit. In addition, we had to reduce the diameter by 2 inches and modify the segment construction. The result worked, but the unit became extremely heavy—expensive, too. In short, a huge revolve is a somewhat different problem from an ordinary-sized one.

You can build a revolve on a raked (inclined) surface, but you will need an engineer to design it. Pipe and flanges and rubber wheels are not enough to keep the unit from sliding downhill.

One way to automate a revolve, according to theater legend, is to install a motorbike backstage. You simply kick the starter, then press the bike against the revolve near the rim. A similar arrangement with an electric motor may be quieter, especially if you mount the rig with its axle vertical.

To level the wheels with a rotating laser level, first install the wheel unit that sits on the highest point of the stage. On its lumber pad, build a tripod or equivalent and mount the level on top. Now construct a target rod of any convenient height. (Step 1) Stand the rod on the first wheel pad, use a bubble level to plumb it, and mark where the rotating beam strikes it. Go to any other location and lay a wheel unit on the deck. (Step 2) Stand the target rod plumb on the pad. If the beam hits the target, you’re done; otherwise, insert shims under the pad until it does. The new wheel is now accurately level with the first one. Repeat 40 times, more or less.

It may simplify fit-up if you mark and cut all the radii, lay out your plywood—still with its square corners—and draw all the arcs at once.