

Chapter seven

The Dobsonian

At A Glance
Advantages: <ul style="list-style-type: none">• Well supported, stable mount.• Easy for the home woodworker, machinist, or “guy with a few tools”.• Cheapest mount for any given aperture.
Disadvantages: <ul style="list-style-type: none">• No tracking without add-ons: platform or motor controls.• If using motor control systems, accuracy in construction gets “considerably” more important.• Sensitive dependence on balance in the tube. May restrict use of accessories.

I. Overview

Judging by what you see at star parties, the Dobsonian mount has got to be the hottest thing in telescope making since the mirror grinding kit. Invented by John Dobson of the San Francisco Sidewalk Astronomers, this alt-azimuth mount was created to get large mirrors into user-friendly mounts so that lots of other people could use them. Dobson is a self-described “carney barker” for the stars; he and his group bring telescopes to public parks and gathering places so that the general public can see the wonders of the sky. It's a noble cause. Because of this mission, John designed the mount for large aperture, short focal length Newtonians. It isn't surprising that they are still used most often for this.

But let's back up for a minute. The alt-azimuth mount is the oldest type of mount in existence. What makes the Dobsonian so special? To begin with, every alt-azimuth mount has the advantage that weight of the tube presses straight down onto the bearing surfaces. Equatorials have at least one axis that is tilted. The Dobsonian combines this advantage with the use of materials that are widely available and that allow the use of friction to control the movement of the mount. It is this total reliance on friction for motion control that is the hallmark of the Dobsonian mount. John is also widely known as a fan of plywood for telescope construction. Plywood is a good material for a few reasons: it doesn't have a dominant grain pattern like other woods, so it is equally strong in any direction, it resists warping, and it damps vibration well. Just as important, plywood is available at every lumber dealer in America, and cheap.

Figure 1 is a Dobsonian mounted reflector, like the ones we've seen before with a twist I'll get to in a few minutes.

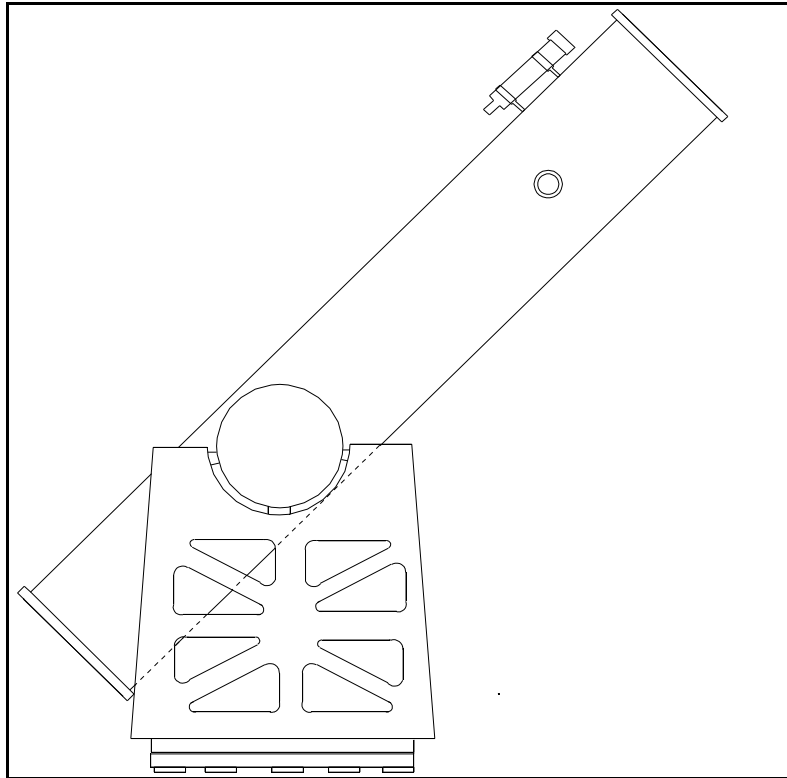


Figure 1- A Dobsonian mount.

Everything that we need to know to design a serviceable Dobsonian was presented in the material on mechanical design, so let's go over a method of approaching the design. From what I have seen and read, builders have had both good and bad results designing their Dobs, and it's my belief that the mixed results come from overlooking how critical friction control is to this mount.

Since the Dob is a "low tech" mount, let's use a Sonotube cardboard OTA. Sonotube, and other brands of concrete form tubing, is often available from building supply companies at rather economical prices. We need to know:

CG	21.3" (from bottom)
Total Wt.	34.3 lbs.
Outside Diameter	12.125"

Here, I have used 60 inches of 12 inch ID Sonotube, and reinforced the ends with 3/4 inch thick by 3/4 inch wide plywood rings. This is commonly done, and serves to keep the tube round at the ends. It doesn't reinforce the tube in the sense of increasing the area moment of inertia, but instead helps keep the tube from buckling.

We need some method of attaching the altitude bearings to the tube: let's make a box from 3/4" plywood that can be clamped onto the tube. The inside dimensions will be 12.125 x 12.110. The tube bending to close this .015 gap will clamp it tightly. The pieces can be any width; assume 12". That means we have two pieces that are 12.125 x 12 x .75, and two that are 12.110 x 12 x .75. The total is 463.2 cubic inches of plywood; at 0.026 lbs/in³ that's 12 pounds of wood. Add two bearings that are 8 in. diameter and 3/4 inch thick at another 1.96 pounds, and you have a total weight of 48.3 pounds being supported by the mount.

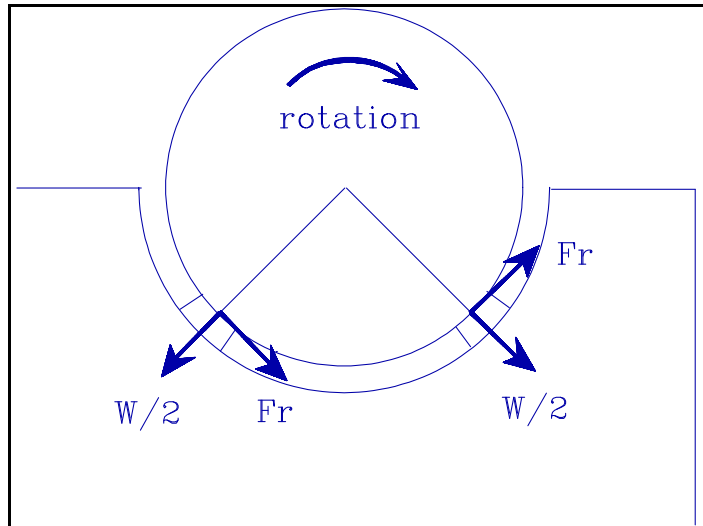


Figure 2 – Bearing Friction Vectors

A common approach to the elevation bearings is to use four Teflon pads, two per side spaced 90 degrees from each other (45 degrees from the vertical) as shown in figure 2. Because there are four pads with the weight equally divided among them, the normal force on each pad is:

$$\vec{N} = \frac{\text{Weight}}{4 \text{ pads}} \times \frac{1}{\sin(45)} = \frac{48.3}{4 \times \sin(45)} = 17.1 \quad 1$$

Many authors have recommended that the pressure on the Teflon pad be held close to 15 psi. The size pad required is:

$$\frac{17.1 \text{ lbs}}{15 \frac{\text{lbs}}{\text{in}^2}} = 1.1 \text{ in}^2 \quad 2$$

The length for each side of a square pad is the square root of this number or approximately one inch. Teflon is hard to cut accurately, so you'll only approximate this result in the shop. You'll achieve your best results cutting Teflon using fast speeds and a fine toothed saw; I use a metal cutting hacksaw blade.

The friction that you feel is the sum of all the pads, or

$$fr = k\vec{N} = k \frac{W}{\sin 45} \quad 3$$

then, using $k=0.105$ for Teflon on Formica:

$$fr = 0.105x \frac{48.3}{\sin 45} = 7.17lb.s \quad 4$$

If we push at the eyepiece, which is about 29 inches from the center of the bearings, we find that the friction will hold:

$$\vec{F}x29 = 7.17x4.0 \quad 5$$

$$\vec{F} = \frac{7.17x4}{29} = 0.99 lb \approx 1 lb. \quad 6$$

before it slips. If the tube balance has been found with an average eyepiece, we can probably put any eyepiece or filter in the scope without having it slip. If you don't like this answer (say you want to have more or less friction), re-read the discussion in chapter two, especially the section on increasing friction for more information on how to change the design.

We can repeat an analysis like this for the azimuth bearing. We add the weight of the telescope to the weight of the rocker box, or everything above the pads. Since our OTA weighed 48.3 pounds, we can approximate the weight of the total as this plus an additional 16 pounds in the rest of the mount. Let's just call it 65 pounds to get an approximate number. We then size the pads to accommodate the weight of the OTA and the rest of the mount; since the load is less than 100 pounds, three pads will suffice. They become bigger to keep the desired 15 psi load. Each pad supports 65/3 pounds and needs to be just about 1.25 inch on a side. The friction force is then:

$$fr = k \vec{N} = .105x65 \quad 7$$

or just about 6.8 pounds.

Assume the pads are 10 inches (20 inch diameter) out from the pivot bolt and the eyepiece is being pushed at a point 25 inches away from the pivot. The force required to move the scope is:

$$\bar{F} = \frac{6.8lb.sx10in}{25in} = 2.7lb.s$$

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The exact torque required to move the tube can be modified by bolting the rocker assembly to the ground board, as is commonly done. (This works by increasing the normal force and, thus, the pressure on the pads).

The builder who decides to modify an existing Dobsonian design for a different size or thickness mirror, or who changes the weight of the instrument a lot can easily run afoul of the friction control that is needed here. Weight tends to go up in a mount roughly as a function of the mirror size cubed; if you try to mount an eight inch mirror in a small clone of the mount used for a 20 inch, you may well be disappointed. Sizing the pads is important, but hardly ever mentioned. Similarly, the tricks discussed in chapter two (such as changing the bearing size, materials, or angles) for increasing or decreasing friction can have a large effect on how the mount feels.

The mount shown in figure 1 has some cutouts in the rocker box that save weight while removing material that contributes little or nothing to the mount's stability. Empirically, I have seen mounts made from plywood have their weights dropped by 25 to 40 % and show no effects even at high magnifications. The drawback to this, especially for things that affect the tube's weight on the altitude bearings, is that the friction becomes harder to control. A clamp arrangement of some sort that would allow variable pressure on the altitude bearings seems ideal. It would allow you to add all sorts of weight to the scope, including large eyepieces and even a camera. Although the Dobsonian is not intended for photography, the moon is bright enough to photograph with today's fast color films or a DSLR, and the filtered sun is as well. I'll have more to say on photography with the Dob later in the chapter.

How do you determine how much weight is removable? Remember that in the Dob, the loading is strictly compression. The side boards are pushed straight down on by the OTA. As was discussed in chapter two, the cross-sectional area of the board determines the amount of compression. Here, the area of the cross section (thickness by width) is all that matters. There is no force acting to bend the rocker box, only compress it.

A conservative approach, then, is to cut out the wood leaving a triangular structure like the one shown. Leave the material width in the "spokes" equal to roughly twice the thickness of the board, and a border of the same width. You can actually leave almost as many cubic inches of wood in the scrap pile as you keep in the boards without risking performance.

The same is true for the box that holds the tube and altitude bearings. Here, all you need is a surface to attach the bearings to. This assembly will be under bending moment due to the tube pushing out on it, but the area moment of inertia is determined by the cross section in a direction perpendicular to the bending force. The material

removed this way simply does not affect the area moment of inertia.

II. Big Dobsonians

If your passion is large mirrors, there are special considerations that you need to have in mind. Although not strictly an emphasis of this book, let's look at some of the design problems of making big, portable Dobs. If you live on a farm, alone on a tropical island, or somewhere else that's a hundred miles from the nearest light pollution, this may not be of interest to you.

If you have to (or want to) transport your telescope to a remote observing site, you have some problems. First, the sheer weight of the 25 or 30 inch mirror puts a lower bound on how light the telescope can be. Second, a 25 or 30 inch Newtonian has a tube length of around 100 to 120 inches in an f4.5 design. Shorter f ratio Newtonians tend to have optical problems with coma, so you may choose to keep the optical system this length (although the coma can be overcome to a large extent with the proper eyepieces, or something like the Televue "Paracorr" coma correctors). This length means that part of the room you have in your car for the telescope must go to carrying a ladder or other way of reaching the eyepiece.

The mirror box is a major contributor of both weight and size in the parts that you are trying to transport. If you are attempting to support the OTA by the mirror box, the size and weight of the box is determined by how high the altitude bearings must be. Getting the CG as far down as possible is the key, and that implies making it bottom heavy. The OTA can be made back heavy by two methods: the first is to add a counterweight to the mirror box. This is a bad choice: you have to carry this weight, and the box must be built strong enough to support it without falling apart. The best method is to reduce the weight of every component above the primary mirror. Then the OTA is relatively bottom heavy.

For portability's sake, it is assumed that you are using a simple truss structure for this telescope. That means that the top end is the most critical weight reduction area. For a finder telescope, the lens of conventional magnifying finder weighs too much to put it out there. Go with a Telrad® finder if your eyes allow it, or mount the finder on the mirror box instead of at the top. The spider and diagonal holder need to be reduced in weight. This is a good place to try making spider blades from thin pieces of aluminum, epoxy-reinforced fiberglass or even graphite cloth. Or eliminate the blades with a wire spider. Even the diagonal mirror can be reduced in weight. It can be special ordered in a thinner glass than usual.

The size required for the top tube is probably not as large as you think it needs to be. Steven Overholt has evolved the design of his already-revolutionary "Lightweight Giant" telescope Magellan into "Starship 30" where he merely has a ring to fasten the top of the truss. This is accomplished by the use of a shielding tube around the diagonal and by his innovative use of a shield in the shape of a plastic "butterfly" around the diagonal itself. This further reduces the light scattering into the eyepiece from the

environment. David Kriege, in his Obsession® telescopes, uses a section about a foot long, and this length is common in telescopes from Tectron and others.

The material in this tube section does not have to be exceptionally strong or rigid. Lightweight aluminum sheet (as Overholt uses) or a thin layer of fiberglass can be made into the tube and reinforced with a ring made of wood or aluminum at both ends. Kriege uses Kydex plastic. Most builders use small (1/2 to 1 inch diameter) straight tubes between the top and bottom rings for further reinforcement and mounting the finder. Sources for end rings, ready-made and extremely convenient, are suggested by Overholt. Wooden rings are available at craft stores, where they are used for embroidery; aluminum rings are bicycle wheels, often available at sale prices from bicycle mail-order companies. (Try Bike Nashbar, 1-800-NASHBAR, or Performance Bicycle, 1-800-727-2433. Garage sale bicycles are another source for wheels). Although they are only available in a limited range of sizes, bicycle wheels are truer circles than the embroidery hoops, and have yet another advantage: spoke holes. Along the circumference of the ring is a set of holes intended for the bicycle spokes; it makes locating a hole for hardware easy when there's always a pre-drilled hole nearby. Of course, you can always cut out rings from plywood or hardwood.

A way to further reduce the size of the mirror box is with large altitude bearings. These bearings can then act as supports for the box, instead of the usual vice versa. Kriege's telescopes are famous for their large, aluminum side bearings. Overholt uses closed cell Styrofoam reinforced with a 1/8" thick layer of hardwood plywood on both sides. In both telescopes the semicircles are mounted at 45° to the vertical, so that when the telescope is pointed at that angle, the top of the bearing is horizontal. The mirror and rocker boxes themselves can be made from the same material, or from fiberglass reinforced foam.

Friction control, of course, is essential in these large telescopes. Here, though, the problem is often too much friction. The large altitude bearings that both telescopes use increase friction and the force to move the telescope (as was discussed above), so Kriege has put a lot of effort into researching the optimum combination of materials for these bearings. He has settled on using a type of fiberglass reinforced plastic (FRP) sold to the food industry; it is white with a pebbled texture, and is often found in lumber yards. If this doesn't reduce friction enough, the bearing surfaces are waxed with silicone car wax, like Turtle Wax®. Overholt uses this FRP material as the final surface on his wood/foam composite bearings. Kriege also recommends a Formica-like laminate called "Ebony Star" from Wilsonart (part number 4552-50). Either material is also appropriate between the rocker assembly and the ground board.

Overholt's "Starship 30" telescope weighs in at just under 200 pounds. That sounds like a lot of weight, but it's less than a standard Coulter 17.5" Dobsonian! Overholt's contribution to the Dobsonian design cannot be overlooked and must be credited. Like most improvements, his work started out as incremental improvements to the work that someone else started; in this case Kriege in the design of the Obsession line. From there his work has "boldly gone where no one has gone before".

III. The Dobsonian Design Method

All of the design methods we've looked at are as appropriate for these giant telescopes as they are for the standard OTA already analyzed. Here's a summary of how to design the Dobsonian.

Step 1. Once the mirror's focal length, diagonal size and other optical characteristics are determined, choose the components that will go in the scope and then choose an OTA. If the OTA sag is not known, use the methods in the chapter on tubes to design it. Once the tube is chosen, measure (preferably) or calculate its weight, and weigh all of the components.

Step 2. Determine the CG for the optical tube assembly and all its components. Note: the CG is needed to calculate the sag for a solid tube in step 1: you may have to go back and forth between steps 1 and 2 until you are happy with the choice of tube.

Step 3. Determine how the altitude bearings will be attached to the tube. Add this weight to the weight of the tube to find the amount of friction force on each altitude bearing.

Step 4. Find the size of the altitude bearing friction pads required for optimum pressure.

Step 5. Using the weight of the entire tube and clamp, find the force that the mount will hold at the eyepiece without slipping.

Step 6. Using the weight of the entire mirror box, OTA and tube clamp, find the size of the friction pads for optimum pressure.

Step 7. Modify the system as needed.



Figure 2 – Gary Wolanski's 16" 40 pounder, an almost-all aluminum Dobsonian.

IV. Tracking With the Dobsonian

Tracking a Dobsonian by hand is easy for targets far from the zenith and gets harder as the telescope approaches being pointed vertically. Amateurs often refer to this phenomenon as "Dobson's Hole", but is well known among designers of camera tracking systems, satellite antennas, and anything else placed on an altazimuth mount.

The rate of change of the azimuth axis increases dramatically as the object approaches the overhead point. If you've used a Dobsonian, you'll know that you end up rotating the telescope almost exclusively in azimuth as it goes overhead; for objects lower in the sky you nudge the scope along both axes. If you haven't experienced this, try the following experiment.

Pretend your arms are the telescope with your elbows acting as the elevation axis. Hold your hands together and your arms straight out in front of you. Your arms can only go from pointing straight out in front of you to straight up. The only way to point at anything that's not directly in front of you is to swivel your whole body. Now pretend you are following an object going from directly in front of you straight overhead. You will bend your elbows to follow it, but when your hands point straight up (elbows bent at a right angle), you'll find that you need to swivel your entire body to track the object through the overhead position. It's the same thing with anything on an altazimuth mount. The altazimuth style of mount was abandoned by the professional observatories centuries ago because of this chief limitation; its inability to track out the earth's motion.

Modern observatories, like the Keck Telescopes on Mauna Kea and the MMT on Mt. Hopkins, are returning to altazimuth mounts for the same reason amateurs are returning to them: stability. What about photography? To use an altazimuth-mounted telescope for photography, you need three drive motors; one each for altitude and azimuth, and a third for the camera. The camera? During the course of an object's apparent movement across the sky, it rotates. This is something that most of us only think about when we see the moon about to set in the early morning sky. This motion will blur out a photograph even in short exposures, and needs to be tracked out.

Coordinating the motion of the three axes is done by computer control, something only possible in the latter half of this century. A fast, sophisticated, computer is not needed; most any old small computer will do. The equations that turn the celestial right ascension and declination into your local elevation and azimuth depend on your local latitude, longitude, and the celestial time (hour angle). A BASIC-like algorithm for determining the local az and el for an object follows.

To perform this calculation, we need to find the number of days (ND) between January 0.0, 1980 and the date in question. January 0.0, 1980 is defined as the midnight between December 30th and 31st. The algorithm uses GMT or UT, which can be obtained via radio broadcasts or through correcting your local time by adding or subtracting the number of hours you are from GMT (+5 for US EST, +6 for CST, etc.).

Definitions: HA = Hour Angle of Object in Hours
LT = Local Time at Observer's Location in Hours
LON = Longitude of Observer in Degrees
LST = Local Sidereal Time in Hours
GMT = UT = Greenwich Mean Time
GST = Greenwich Mean Sidereal Time
RA = Right Ascension of Object in Hours
YY = Year
MM = Month (1-12)
DD = Day (1-31)

ND can then be calculated as follows:

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A = 365 * (YY - 1980)
B = INT((YY - 1981) / 4) + 1 (INT means take integer part of)
C = INT(30.6001 * (MM + 1)) - 63
IF MM = 1 THEN C = 0
IF MM = 2 THEN C = 31
IF (INT(YY / 4) = (YY / 4)) AND MM > 2 THEN C = C + 1
ND = A + B + C + DD
GST = GMT*1.002738 + ND*0.0657098 - 17.355521
    IF (GST > 24) THEN GST = GST - 24
    IF (GST < 0) THEN GST = GST + 24
LST = GST +(LON/15) ...if Longitude is West of Greenwich.
LST = GST -(LON/15) ...if Longitude is East of Greenwich.
    IF (LST > 24) THEN LST = LST - 24
    IF (LST < 0) THEN LST = LST + 24
HA = (LST - RA)
IF (HA < 0) THEN HA = HA + 24
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Once we have HA, we can use the following to determine Az and El.

Definitions: EL = Elevation of Object in Degrees
AZ = Azimuth of Object in Degrees
RA = Right Ascension of Object in Hours
DEC = Declination on Object in Degrees
LAT = Latitude of Observer in Degrees
LON = Longitude of Observer in Degrees
HA = Hour Angle in Hours

$$EL = \text{ArcSIN}(\text{SIN}(\text{DEC}) * \text{SIN}(\text{LAT}) + \text{COS}(\text{DEC}) * \text{COS}(\text{LAT}) * \text{COS}(\text{HA} * 15))$$

$$AZ = \text{ArcCOS}((\text{SIN}(\text{DEC}) - \text{SIN}(\text{LAT}) * \text{SIN}(\text{EL})) / (\text{COS}(\text{LAT}) * \text{COS}(\text{AL})))$$

$$\text{IF SIN}(\text{HA} * 15) > 0 \text{ THEN } AZ = 360 - AZ$$

The Arc (inverse) sin and cos functions are shown on many calculators as \sin^{-1} or \cos^{-1} for those planning to do these equations on a calculator.

The rate at which the motors have to be driven is a function of both the object's and observer's positions. The rate that the camera must be rotated varies with the object's position in the sky. The maximum for camera and azimuth rotation occur as the object passes overhead (through Dobson's Hole). Practically, this means that these telescopes often define an area around the zenith where they won't operate. This is not a large concession because not every object can even pass through the zenith, and, of those that can, they spend a small fraction of their time there.

Computer control of telescopes is an advanced topic, but one well within the reach of amateurs. There are a lot of subtleties in this area, especially if the goal is a telescope that is capable of remote or autonomous operation. An excellent book on this subject is Microcomputer Control of Telescopes, by Mark Trueblood and Russell Genet, available from Willmann-Bell, Inc...

V. The Equatorial Platform

The second method of tracking with a Dobsonian is to use an Equatorial Platform, frequently referred to as a Poncet platform (as the inventor, Adrien Poncet, is French, it should be pronounced "Pon-say"). The Poncet platform is one of the few really new innovations in amateur astronomy. While the equatorial mount dates back several centuries (in at least one case), and the altazimuth even further, the Poncet platform was invented in the late 1970's!

Let's examine figure 3.

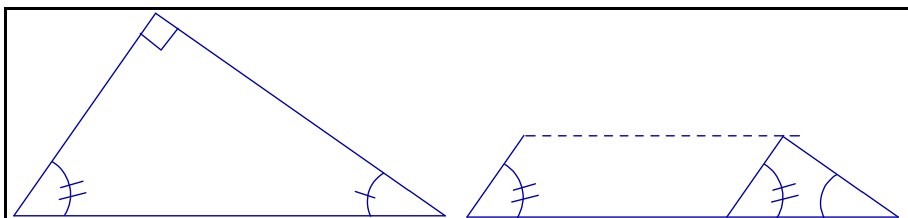


Figure 3 - Geometry of the Poncet Platform

The shape on the left is a right triangle. The angle on the right is the latitude angle and the side inclined to the left points at the pole. If this object could rotate about that axis, anything mounted to it could track across the sky. If the angle on the right were twice what is shown, and the triangle a solid circular cone, it would roll easily on friction pads or rollers. This can be done for the triangle shown by making it half of such a cone, so that the cross-section of the left side perpendicular to the page is a semicircle. It could then rotate on a set of bearings for one half rotation.

Now here's the interesting part. Cut off the top of the cone parallel to the ground, as shown by the dashed line in the right half of the figure. The top is now flat, and a Dobsonian could be placed on it. If the cone is still rounded on the bottom, it will still rotate and the remnant of the axis seen as the smaller triangle at far right, still points at the pole. Because it is cut off, the cone can no longer make a complete revolution, but rather can only rotate some small number of degrees on either side of level. This is the basis of the Poncet platform.

Figure 6 shows a cross section of a Poncet Platform. The latitude angle is still shown on the right, and the complementary angle on the left. The platform itself, at the top, rides on two pivots; a large diameter rod at right, and a simple pivot point on the left. On the left, the end of the platform supports bearings that ride on the angled base of the platform. Teflon on Formica works well here, but so do ball bearings mounted on a bolt and rolling their outer housing on the angled base. The vertical support at left just keeps the center of the platform from moving, allowing it to rotate about a line from the center of the bolt to this support. That line is the projection of the polar axis onto the mount. The axis is really a sort of virtual axis in the sense that a long shaft pointed

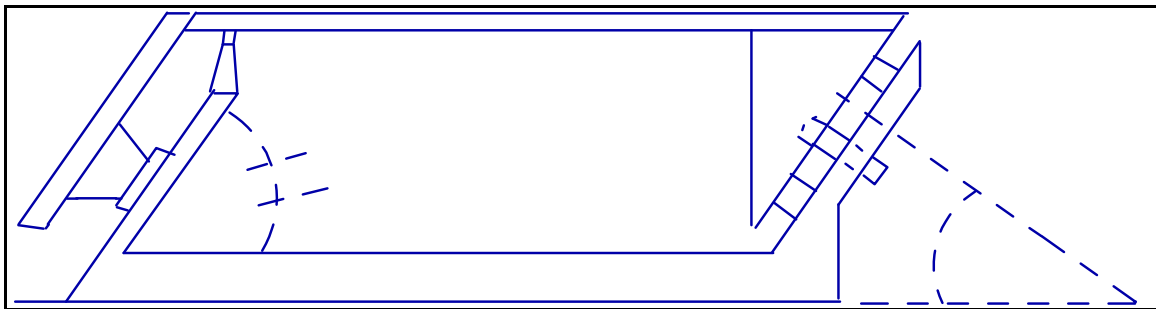


Figure 4 – Cross Section of a Poncet-type platform

at the pole isn't there. These platforms are often motorized by adding a small motor to the left side of the base. The motor drives a threaded rod which, in turn, drives a nut that is held by a rod hanging from the upper part of the platform. As the rod turns, the nut moves along it, and this motion turns into rotation about the pivots.

The Poncet will provide a small amount of tracking time, but not hours. Periodically, the platform needs to be reset to the east side of its range and restarted. The exact amount of time available varies with the implementation of the platform, because the limiting factor is usually that the moving platform hits the ground. During

this readjustment, the platform and the telescope must both be moved, but this probably isn't a major concern. The combination of mount and platform gives three degrees of freedom for motion. The telescope itself can find any object with just two, so the third is ignored while finding the object. Once the object to be tracked is located, the platform drive motor is turned on and then becomes the only part that is moving.

The equatorial platform does allow photography, but resetting the platform limits exposure length. This is not much of a problem for the modern DSLR's and webcam photography; in this style of photography, multiple short exposures are combined in software. Another limit is that it is difficult to get a good polar alignment with the equatorial platform. This is because of the inconvenient geometry, there is no polar axis to put a polar alignment telescope in or on, and drift alignment may take more time than the tracking allows. Still, for webcam photography of the planets, or exposures of the brighter DSO's, it can and does work.

The platform is loaded in compression, but a heavy telescope in the middle will make it sag there. You certainly don't want the platform to be vibrating like a diving board, so reinforcement may be necessary. The load of the telescope can be modeled as a distributed load on a simply supported beam rather than as a point load, unless your platform is very big compared to the size of the telescope. This is described by the equation:

$$Sag = \frac{5(W + W_p)l^3}{384EI} \quad 9$$

where W is the weight of the telescope and mount, W_p the platform's own weight, l is the platform length, and E and I are Young's modulus and the platform's moment of inertia. The I value that is important is the value that you would compute for bending, so the platform can be reinforced by adding stiffeners along its bottom surface. Angle iron, aluminum, or even wood I beams will work. As the percentage of the area covered by the telescope goes down, the deflection approaches that of a single point load where the telescope sits.

The Poncet is not the only design for an equatorial platform that works. Whenever a new idea like the platform is developed, many other workers who had not previously been able to envision the concept will then be able to develop modifications or improvements. This is always a fertile time in the history of any invention. An interesting design was presented by Davies in [ATM Journal #3](#). While the Poncet depends on the pivoting of the platform on a polar axis bearing and a triangular base, Davies' design depends on an unusual property of the geometry of isosceles triangles. If a platform has two bearings in contact with the equal sides of an isosceles triangle, the point on the platform corresponding to the apex of the triangle will translate horizontally. That means the platform will move horizontally while it rotates about the polar axis. Davies' platform is made from two solid isosceles triangles that are sized

and spaced far enough from each other to make the angle of the platform equal to the latitude angle.

VI. Direct Automation of an Alt-Az Mount

The obvious disadvantage of any equatorial platform is that it removes the main advantage of the altazimuth mount: that the load is well centered over the bearings. The mount is now loaded not only in compression, but there are bending forces at work as well. If the telescope is not constrained on its elevation axis, as is usually the case, when it goes through the meridian the telescope will slide from one side of its cradle to the other. That's certain to ruin any photograph.

With today's computers and microcontrollers, the direct approach of driving motors directly on the two axes is much easier than it used to be. All of the modern telescope manufacturers provide motorized Alt-Az mounts. Like most software, once the method has been designed, it is very easy to duplicate. ATM Mel Bartels was a very early adopter of computerized Dobsonians – maybe the first. Along the way, Mel designed the software, hardware and the complete approach to computer operation of a telescope. Much of this information is available free or at low cost at: <http://www.bbastrodesigns.com/tm.html>

Computer driving a Dobsonian is not going to be as simple as strapping some motors on your existing Dob – it's better to design it that way to start with. You will want to replace Teflon bearings with ball bearings, and limit the mechanical "slop" in the mount. You will want to make the mount more precisely.

The computer control method will deliver superior results to a platform. The reader interested in computer control is urged to consult both Mel Bartels' website and Trueblood and Genet's book, which covers all the subtleties of this topic in great depth. They include discussion of mount and tube flexure, misalignment, non-perpendicularity of axes, accelerations required from drive motors and more. The computer required will be not be exotic; early work involved computers that are very slow by today's standards. The modern crop of PCs or their clones will be cheap and will exceed all speed requirements. Laptops that will work cost in the range of \$100 as used, near-throwaways.

Don't overlook the possibility of adapting commercial hardware to your design. Meade Autostar motor and hand controller sets are available as add-on accessories as of this writing (fall of 2006) and can be obtained for well under \$200. There is a whole group of telescope "hardware hackers" (to borrow a term from electronics hobbyists) who have retrofitted the Meade 493 GoTo kits to commercially made mounts. More information is available in an online discussion forum dedicated to the subject: <http://tech.groups.yahoo.com/group/roboscope/>

Despite all this, the simplest way for an amateur to do photography is still an equatorial mount with the polar axis driven. The declination axis can be corrected if

needed with another, smaller motor. The geometry, strong points and weak points of various types of equatorials will be the next areas we cover.

References and Further Reading

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11. Online document, "Retrofit*.pdf" – where * is the latest version – shows the methods of adapting Meade Autostar kits to other telescopes. Available in the "files" section of <http://tech.groups.yahoo.com/group/roboscope/> membership in the group is required to access this file.