Let’s Build a Binary Dob !

This is an experiment. A Binary Dob, has two Dobsonian telescopes modified to allow each eye a separate view! This draft outlines an approach I will use. It might be original or not, I don’t know. It feels original, but it is OK if it isn’t. I am both awaiting parts, and snowed in down here in Alabama. I outline the problems, and solutions. Feel free to shoot down anything you don’t think will work.

First recognize its value: Are you satisfied looking into telescopes with only one eye? We humans have two eyes. Millions of years of evolution are behind two eye integration and our ongoing dynamic cognition of meaning. We see to understand. Brains and eyes develop together. We are bright eyed with both eyes open, and a little slower with only one eye. Why then are we giving up on two eyes, just because it seems a bit complicated? Helicopters do fly don’t they? It didn’t look possible, that machines could fly without wings. But they did, once someone tried to do it. Perhaps it is time for two eyes, and two Z10 dobsonian telescopes to be combined. John Dobson redesigned much of the complexity out of our modern telescope, so with his passing, we might challenge this idea of only using one eye. I want to view the stars with two eyes. I don’t want to be at this party all alone, so I invite others to join me.

The older ways are expensive: Binoviewers do work, but they are expensive. Compared to a Z10 which I bought new two months ago for $468, Binoviewers are very expensive. Further, they limit the lowest magnification by requiring small 1.25 inch barrels, and the extra optics needed to bring them into focus.

Using off the shelf Binoviewer Equipment: To add a Binoviewer to my Z10 would cost me lots of money. First it is difficult to get the optics to focus. From Cloudy Nights website I copied this Z10 forum post :

> “I have a 10" dob which is used with WO BV'er set. It needs a better OCS than the one WO supplies (1.6X), to get enough inward focus on Newtonians especially. Got a Seibert multimag (1.25X/ 2X/ 3.5X) which works a treat. Works in all my Newts and refractors with this OCS.”

1. Let me translate “WO BV'er set” = William Optics Binoviewer w/ 2 20mm Eyepieces & 1.6x Barlow Nosepiece E-BINO-P. On Amazon this would cost $263.50.
2. The OCS is a Seibert multimag (1.25X/ 2X/ 3.5X) = (SBW-1235) = $169.

Purchase of these two items becomes $263.50 + $169 = $432.50.

That is a lot of money. My question became, why spend another $432.50 when I can buy ***another Z10*** new for just slightly more, or a used Z10 for as low as $350? Besides, two scopes have twice the light gathering power, allow both 2 and 1.25 inch eyepieces, have large fields of view, and are twice as bright.

Here is the main idea. A Dobsonian telescope has two dimensions of free motion, Azimuth and Rotation. A Dobsonian avoids electronics in favor of simplicity and function. I do this same idea but with two telescopes. I call this Binocular Telescope a Binary Dob, because it follows John Dobson’s ideas about astronomy. The Binary Dob has three degrees of free motion, Azimuth, Rotation, and side-to-side.

Let me unpack and decode this newly added ‘side to side’ motion: Two telescopes are mounted on ball bearing cabinet drawer slides, bought-off-the shelf at Lowe’s Hardware. With added ‘side-to-side’ motion either scope can easily move side to side. We only need 6 inches of motion. The drawer bearings are 600mm long (23.62 inches) and extend smoothly with two layers of ball bearings to 47.25 inches (48mm high, 12mm thick). They are heavy duty and designed to hold up 100 pounds while cabinet drawers are fully extended. (I bought them for another project.) This motion (starting length 23.62” -> to -> 47.25” extended length) allows sliding separation between scopes. Each telescope uses this side to side space to control (in 3 inches) its own focus, without a need to bump into the other scope. The operator just learns to keep them from hitting each other. The operation is simple, intuitive, practical, and this is so, principally because we want to concentrate on the night sky. We are in an experiment, but we don’t want to forget what is important, our time with the sky. We want to spend lots of our time with two eyes looking skyward.

The idea of a Binary Dob is very simple, but the devil is of course in details. With a standard Dob to change Azimuth one just pushes on the tube. In contrast, with a Binary Dob, one pushes on a handle mounted to the center of a steel drawer bearing assembly. Two optical tubes then both move at the same time. This is because of how the drawing bearings are attached, and also how the azimuth bearings are aligned together.

Let’s first start with the cabinet steel bearings and how it is mounted to the optical tubes. This bearing mount is solidly attached at a 90 degree angle to the optical tube. Therefore if you lift one inch up on the handle attached to this cabinet bearing assembly, the 90 degree attachment lifts the top of the tube up one inch. There is no flexing on this 90 degree angle. Up on the handle makes up on the one telescope tube. The handle and the telescope tube always move together.

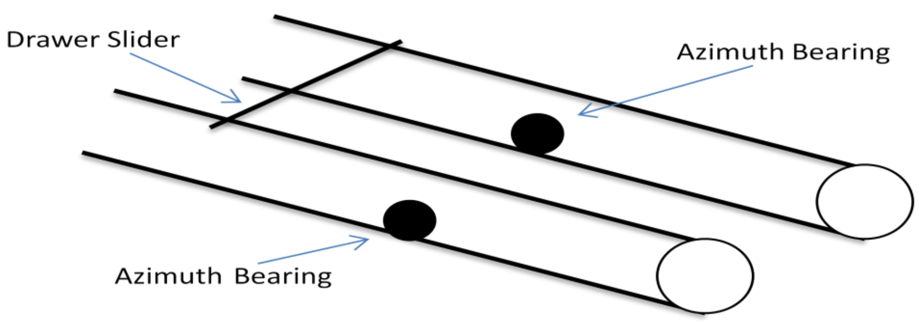
The other telescope tube is also attached with a strong 90 degree metal bracket. Both telescopes thus move together. There is no bending; one is not up while the other is down. Here is the critical point, while up and down motion of the handle forces both telescope tubes to travel together, the cabinet bearing assembly does ***not prevent*** a side to side motion ***between*** the two telescope tubes.

A Binary Dobsonian requires this third dimension, this added flexibility, this side to side motion. Both telescope tubes are cupped and held by Azimuth bearing cradles, aligned together. Both tubes can only move around in circular motion around that alignment. Recognize that this azimuth bearing really helps us. Therefore we only need one steel bearing assembly attached at right angles on top of the tube. On the bottom side of the tube, will be our head, near the eyepiece. (The eyepiece viewing location is shown in another diagram later in this paper.)

While keeping the two Optical Tubes parallel, there is still the ability to move the two tubes a few inches apart or a few inches closer together. We have flexibility, but this flexibility is only in one dimension, along the distance between the two tubes. Keeping both tubes parallel is necessary. We are making an assumption here, that only one bearing assembly will be needed to keep the two optical tubes parallel and thus pointing at the same place in space. If that assumption isn't true, then we can add another steel bearing assembly to the bottom of the optical tube assembly, ten inches away from the first bearing assembly.

Imagine this as two boxes built out of three points. Two points are the two centers of the Azimuth bearing surfaces, and the third point is where the drawer bearing attaches to the top of the optical tube. The three points of attachments allow this box to only move in an ark motion on the Azimuth bearings. One point moves, and the other two points rotate. Now imagine another box just like the first box. Align the two Azimuth bearings, and notice that the bearing attachment is exactly 90 degrees in its attachment to the top of the optical tube. This means that moving to a new spot in the sky in one eye, moves the other eye too. Both tubes move and stay pointing to the same place in the sky. A picture will make this much easier to understand. (For now, perhaps just a poorly done stick drawing.)

Optical Tube Assembly with Drawer Slider and Azimuth bearings

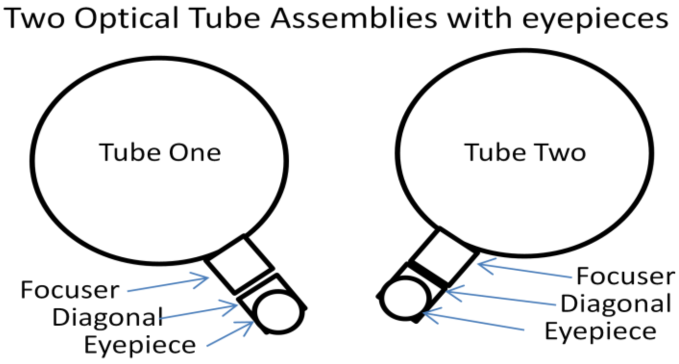


The left side of the drawing shows the optical tubes that point towards the sky, and the right side of the drawing shows the bottom side of the optical tubes, holding the primary mirrors that fit into the base box. We can't attach anything to the bottoms of the two scopes.

Now let's return to the optical path that each scope takes. We will talk more about side-to-side motion later, but now consider that both telescopes must (to save money) be modified. We must modify the optical path in the Z10 dobsonian. We need two 90 degree turns (2 inch diagonals) so eyepieces point, like binoculars, in the same direction. Most likely the eyes will look ahead to the scope which will look over our heads and back behind us.

Yesterday I bought two used high quality diagonals (one for $90 plus $10 shipping, and one $70) from the classified ads on the Cloudy Nights website. In a week or so I can start my modifications. I plan to add a two inch diagonal to each scope, and then move the primary mirrors to bring back focus. If we don't move the primary mirrors, we will have to buy expensive corrective lens, or we will not be able to focus our eyepieces. Saving money with a Z10 is easy. The primary mirror on the Z10 is just held on by 6 small bolts. Moving it will be easy. (Later, I will explain how, using two lasers and scrap plywood, one can find this exact distance.)

Two Optical Tube Assemblies with eyepieces



To have both eyepieces meet, a nose apart, it seems best to have the eyepiece below the scope and hanging down at a 45 degree angle, each pointing at the other. One OTA is just flipped 180 degrees so its eyepiece is pointing down. The other OTA will need a more complicated 135 degree shift, and this is accomplished by moving the Azimuth bearing assembly. Feeling into the Z10, I find three small bolts holding this on. Since the primary mirror is removed, with care work can start on drilling 6 new holes. The exact location can be carefully measured by using a paper template traced over the old locations.

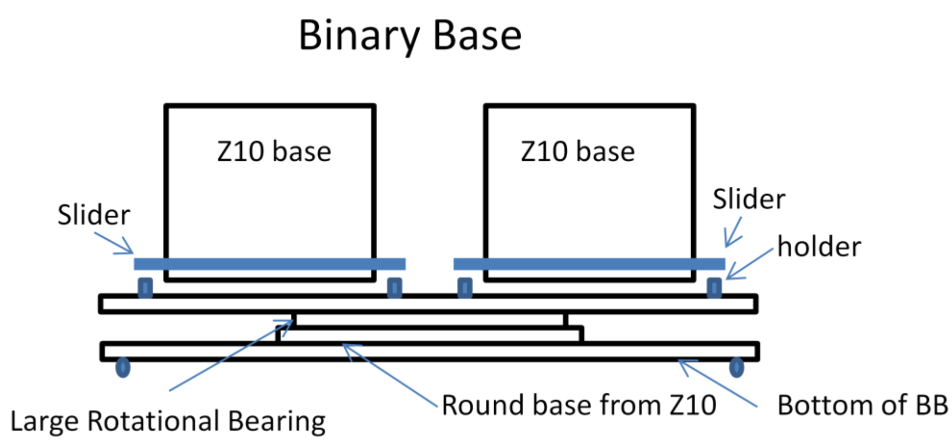
Reality Check: This binary Dob is experimental, so I have to be careful. If it fails I want to undo all the changes and return the two Z10 telescopes to working condition. They can then be sold on Craigslist, along with the two

Diagonals. Time spent yes, but not much money. Also the Binary Dob development time is entirely aligned with bad weather, cloudy nights, and time not spent with my new even bigger 17.5 inch F6.0 home built used Dobsonian telescope. What another telescope? Got it at a great price! A bit of background to explain my motivations, I got a bigger telescope after owning a new Z10 for only 6 weeks! Yes, it was fast! That is what love is, it sweeps you off your feet. I spent $468 for the Z10 and in the next 4 weeks, $775.75 on eyepieces, $122.14 on books, and $347.49 on support equipment. Every night in the freezing cold, I was outside looking up. Love sweeps you off your feet and also it takes your money. Yes, nothing new here. This Z10 was my first, my very first telescope. It caused my heart to up-beat as I gazed at it. Now an even bigger scope came into my life?!

My wife studies me and then she slowly asked, 'you loved this Z10, … what happened?' She was asking about me and my condition, in effect, was our 16 years of marriage on shaky ground? Of course not, love is good. Love grows better with age. That was an easy question to answer, but her concern, got me to really consider the Z10. What was it to me? My heart still lifts when I look at this Z10. That just got me thinking about getting another Z10! Why not make a place in my life for two telescopes, a big 'one eye' and another for 'two eyes'. Life happens, and I make adjustments. In building this experiment I don't want to give up Astronomy. Open views of the sky feed my soul. Now, stop! Wake up from this fluff and get me back to reality. There is another practical consideration in this project, Modularity.

The Z10 weighs 60 pounds, and I am now 68 years old. I can see the writing on the wall. I can see a time, if I am not careful, that my optical instrument will not be able to move without help. Therefore I want to construct the Binary Dob in a modular way. It must easily come apart with parts that don't weigh much. I can't just bolt two Z10s to a plywood frame. Not acceptable. I also don't want to spend a lot of time setting up the equipment and taking it down.

Modular Base Integration: A plywood base (called from here on, the Binary Base, see diagram next page) fits under two Z10 circular base structures. The Z10s do not directly touch the Binary Base, but rest inside a 3 inch tall wooden notch protruding up. Further each Z10 base does not directly touch the wooden notch but rests on top of another drawer slider bearing assembly. In other words, the notch (connected to the binary base board, holds by a gravity only connection, a metal slider plate which in turn is bolted to the Z10 base. This allows the Z10 base to be just lifted from the Binary Base. Since each Z10 weights 60 pounds, they are not going anywhere. They stay in the three inch notch. The slider allows side to side motion, from the Binary Base to each of the two Z10 bases. Two bearing sliders for each Z10 base to keep the Z10 bases together and parallel to each other, and above the supporting Binary Base. This allows either Z10 to move from side to side. There are now 5 bearing assemblies involved. One above, to keep the OTA together, and four below to keep the two Z10 bases supported.



Now let's look a bit more at the Binary Base, this structure is supporting everything above it. It is about 48 inches long by 24 inches wide, and the corners are rounded off. Two Z10 telescopes will fit on top of it with an inch to spare, close but not directly touching. On the Binary Base there are four different 3 inch tall wooden notches coming up (protruding up). Into these notches is a gravity fit with 4 bearing assemblies, which are attached by bolts to two Z10 base structures. Gravity alone holds the Z10 in these notched slots. They can be easily lifted out when there comes a time to move the system. The bearing assemblies allow the two Z10 bases supports to freely move side to side. Everything must be allowed to move side to side, or else we will not be able to put our nose tightly into the nose space between the two eyepieces. My nose is very sensitive.

The Binary Base has two parts, a top connecting to all weight from two Z10 telescopes (about 120 pounds), and a bottom part of exactly the same size and thickness. The two parts must rotate together so we can point our Binary Dob in any direction. Because we are cheap and this is an experiment, we simply reuse the **two** existing Z10 rotational bearings, one on top of the other, on a center hole in the middle of the Binary Base. Two bearings are used for extra height. We need height because the weight is displaced from the center and the outside top plywood might sag and make the bottom plywood part touch, and we don't want that. It won't rotate. If it fails we can add in (for more height) one or two of the unused and remaining Z10 bottom base 23 inch wooden circles. If we leave them off it is lighter.

Once this system is built up to the point of viewing through even one eyepiece, the question can be answered, has moving the primary mirror positioned the secondary mirror to occlude or diminish the Optical Tube Assembly?

Did it degrade the view? One solution is to buy a smaller secondary mirror. Another solution is to buy a thinner focuser, or to purchase another lens to fix the optical path.

Telescopes are good but they are not finished. As an Electrical Engineer, I have come to recognize, that if it isn't changing, it should be. The old way has some good and some not so good. Let's find the good and move on. For years we have been satisfied with only using one eye for astronomy. Perhaps it is time to change, to reinvestigate our telescopes, and simply put more eyes to the sky.

Working Issues for this Prototype

1. **Modified light path:** Because the light travels through the Diagonal, the primary mirror must be moved some amount closer. If a Diagonal adds 2 inches to the light travel, then this is the distance the primary mirror must move. As an alternative, shorten the struts (Lightbridge allows this) if that is easier. Another possibility is you must buy another reducing lens, and do this for each telescope (expensive).
   a. **Distance:** What is the exact amount the primary mirror must move?
   b. **View:** Does the closer secondary mirror now occlude or interfere with the view?
   c. **Weight:** Moving the Primary Mirror will change the balance point, is a fix needed?
2. **OTA Control:** The slider attached to the Optical Tube Assemblies need experimental testing.
   a. **Control:** Do scopes stay in parallel?
   b. **Number:** Would more sliders provide better control?
   c. **Handle Placement:** Can the operator change Azimuth for both scopes at the same time? (Is the operator handle in the best place on the slider, is it effective?)
   d. **Setup Time:** Is it (OTA control assembly) easy to attach and take down?
3. **Collisions:** How do we keep the two scopes from hitting each other while manually focusing?
   a. **Procedures:** Perhaps just a formal procedure will be enough. Simply push the two apart, adjust focus on each, and then push it all back together in front of both eyes.
   b. **Where to Touch:** What one touches might change how the two scopes remain in parallel, so this might require some experimental testing.
   c. **How the eyes and nose fit:** Allow different sized human faces to line up the scope on both eyes. (human eye separation=53mm to 75mm)
4. **Extra Stability:** When the system is focused, clamps might be attached to keep the system stable. One does not want a fragile and too sensitive scope.
5. **Modularity:** Can one person easily move and set up this Binary Dob?

Best practice for each of these issues.

Step 1: Modified Light Path: Moving the primary mirror is not difficult. On my Z10 the Primary mirror is held in place by 6 small bolts. They need to be carefully removed (and store the mirror in a soft bath towel). Once the mirror is free, drill 6 new holes x inches higher, and now remount the mirror closer to the focuser. With the mirror moved the system must, of course, be collimated.

Step 1a: Distance: Each Z10 comes with a Laser collimator. If like me you purchased a full Z10, you now have two lasers. Having two lasers can be quite handy when doing experimental optics. Drill two 1.25 inch holes 9 inches apart in a piece of scrap plywood. Place two laser collimators into the two holes, and place the plywood on top of a Z10 OTA pointing up. Turn the lasers on, which now point at the main mirror. With a piece of white paper and any eyepiece removed, measure the focal point from where the eyepiece would attach. Now add the Diagonal and measure this new focal point. This difference is the distance the primary mirror must move.

Step 1b: View: Not quite sure how to test this parameter, except to see over time if images are degraded with respect to an unmodified Z10. Perhaps others will have better answers? From the Internet I found this. "Planetary observers tend to be fanatical about keeping the secondary mirror as small as possible and don't mind if the edge illumination drops to zero. Deep-sky observers, on the other hand, usually prefer wide fields of view with full illumination. For most people, so long as the illumination at the edge of the field doesn't drop below 50 percent (amounting to roughly ½ magnitude), it will go unnoticed."

Step 1c: Weight: The more modern Z10 has an adjustable clutch for each Azimuth bearing attachment. Simply tightening this clutch might be enough compensation for the new Mirror position. If not counter weights might be added, or the Azimuth Bearing mounts might be moved (changing the balance point).

Steps 2-5: OTA Control: Collisions: Extra Stability: Modularity: With two Z10 attached, the issues will be obvious.

End the prototype process: Did it work? Are the resulting star views great? How about m-42? What did we learn? Now decide how to conclude this adventure, keep it? Sell it? Or turn it back into two separate Z10s to be sold on Craigslist? One might decide, this was so much fun, why not start new phases?

Start a new prototype? Motorize the side-side motion. A second more sophisticated phase could be to install a dual limit switch which detects either side closing distance and activate a small motor (two motors used) which would then pull the telescopes apart, or drive them back together. As a retired control engineer, I could see some sophisticated tweaks that might improve the system.

Ongoing research: I have a cheap ($42) Raspberry Pi computer, with an intelligent daughter board (GertDuino) for I/O. At first this computer could help the Binary Dob operate, or to make it easier to operate. Second level might be to add navigation capability, to know where it is pointing. Third level might make a goto system, some little stepper motors. Forth might be to add two 5 megapixel cameras (two x $25) attaching to two Raspberry Pies. All this electronics can provide a Wi-Fi hot spot to connect into your tablet. Why stop? Perhaps voice recognition programs, or play classical mp3 music. Once we have power to a computer, we might just do anything. Of course, at any stage of this project, since Diagonals are removable, that extra focus distance makes it easy to couple into a powerful digital camera, or for that matter, a pair of cameras. The Binary Dobsonian is a wonderful place to play.

The Point of it all, some five years from now: In Tibet the Buddhists have a practice they call sky gazing. One goes to the side of a big mountain, and just lets the sky in. They contemplate space itself. The size of the mountain allows them new perspectives. It becomes an exercise in wholeness, in transcendent awareness, or in Western language, we might call it 'a God perspective'. It's a kind of inner awareness of the vastness of the universe, which because of its infinite vastness heals little problems, like life and death.

Space in its infinite nature, has a transformation, that sky gazing allows in. With a fine binary Dobsonian, your eyes can move you into aspects of space much larger than any earth mountain. As in Tibet, one just lets it all in. It is this experience itself which teaches. The experience itself is non-conceptual, and of the highest order. If that fails, well then you are just here, back on earth. Back on Earth, this new binocular system would be much easier to sell, because there are not many of them. Further it helps to solve the problem of what to do with your less than ideal eyepieces. Those eyepieces that sit year after year in you eyepiece collection, but never get used? You just get rid of these old eyepieces, when the Binary Dob is sold. Your 'beyond earth experience' can be balanced with human reality. All is Good.