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An Easy Way to Learn the Night Sky

By Rev. Eugene Brown

The recently-released mySKY by Meade is an easy-to-use device to help persons ages 9 to 90+ become familiar with the planets, stars, galaxies, star clusters and nebulae that are visible to the naked eye. I had it at Onan for several public nights and other events and found that after one minute of instruction as to its use, anyone over fourth-grade level was off on his or her own, pointing mySKY at objects in the night sky in order to learn their identity or following the arrow on the illuminated (night vision) panel to find any sky object currently above the horizon.

After reading a review in Sky and Telescope earlier this summer, I decided to purchase mySKY. I waited four months because it was back-ordered and in short supply and finally received my copy in late September. I read the very short manual, inserted four AA batteries, and took it outside that night for a trial run. I was not expecting it to work, because there was nothing in the manual about aligning it with Polaris or with two other stars, as must be done with any GoTo telescope. The instructions simply said to allow the instrument to take a GPS fix and then place it on a solid support for a few seconds so that it can calibrate its magnetic sensors. That was it! This thing can't work, I said to myself.

But it does. In identify mode, you simply sight along the top of the instrument (it has something like gun sights, but illuminated) at any sky object you can see and then pull the trigger when you have it in your sights. mySKY will take a few moments to calculate and will display the name of the object and (in most cases) a close-up photograph from its database of 30,000 sky objects. You may then put an ear bud in your ear and listen to a short description. You may also press the button marked "Info" for a list of technical data, such as catalog number, constellation, apparent magnitude, celestial coordinates, distance, size, mass, diameter, day and night temperatures, gravity, orbit, number of moons if any, and when it rises, transits and sets from your location; some of this information does not apply to all sky objects.

It is great to see a young person excited about the night sky. Maybe she will be an enthusiastic amateur or professional astronomer when she grows up.

Continued on Page 2

mySKY resting on the reviewer's tripod support.

In search mode, mySKY allows you to select solar system, stars, constellations or deep sky from a menu; sub-menus will open up for planets, Moon, asteroids and comets, and each of these will subdivide into inner and outer planets, named stars, constellations in alphabetical order, Messier objects or other catalog items. You choose the object, press "Goto," and move the instrument in the direction of the arrow that appears on the display panel. When the arrow turns into a circle and crosshairs, you center the crosshairs in the circle until mySKY captures the object. Then, as before, you may listen to a description of it and read the technical data. Search mode works for any object in the database that is above the horizon, even if it cannot be seen with the naked eye.

On the solar system screen, there is a button called "Events." This will list the dates of solar eclipses (partial, total and annular, from 1996 to 2040) and lunar eclipses (partial and total, from 1996 to 2038); the names of artificial satellites from ARIANE to UARS; and meteor showers from the Delta Aquarids to the Ursids. When any of these is selected, mySKY provides additional information and an audio narration about the object or event.

When you first turn on mySKY, you may watch an instruction video that explains its basic operation. This is useful for first-time users, especially if they have not read the manual. There is also a demo mode for exploring the capabilities of mySKY while indoors. When you are ready to use mySKY outdoors at night, you may allow the instrument to determine time and location from GPS, or you may manually enter the date, the time, and the name of the nearest city. When this is done, the screen defaults to the Sky Map, which is the identify mode. To go to search mode, press "Object."

If you choose a constellation, mySKY offers you an option called "Trace." Using the arrow, it will guide you to the principal stars in that constellation, at the same time showing the traditional stick figures, whether of Ursa Major, Cassiopeia, Hercules or any other of the 88 constellations. This seems to be a good way to learn the names and shapes of the constellations as well as the stars which comprise them.

mySKY also has an button for "Tours." This will take you to a screen with these guided tours: "A Star's Life," "How Far Is Far?" "Looking Further," "mySKY Overview," "Our Moon," and "Tonight's Best." These tours provide pictures and basic astronomical information. Because mySKY has a removable memory card (Secure Digital), these tours can be updated and new tours added as they become available from Meade. This is also a method for updating the mySKY software.

This young fellow could be aiming at a deer instead of Capella.

mySKY has a number of handy features which make the operation of the instrument easier and more enjoyable. The illumination

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mySKY is so much fun to use that adults and youngsters will even venture out in the cold to learn about the night sky. Notice the two ear buds; two people can listen to the narration at the same time.

of the back panel and of the sights can be set to a comfortable level, from dim to bright. In addition, the sights can be set to blink on and off or to remain on; I found that it is easier to sight a dim star when the sights blink on and off than when they are on all the time. I guess it is a matter of personal preference.

There is a battery level indicator that shows the percent of battery power remaining; this is something that I wish were available for all battery-operated devices. When the batteries in mySKY are changed, the GPS fix is lost and must be reacquired.

With the optional cable, mySKY can be used to control any Meade GoTo telescope; instead of pressing “Goto,” press “Point Scope,” and the telescope will slew to the object chosen. If the telescope does not have GPS built in, mySKY will supply it.

When I used mySKY for the first time, I discovered that it is difficult to hold the instrument steady when seeking to identify a sky object or putting the crosshairs in the circle when in search mode. For this reason, I came up with a support that I mount on a tripod. I drilled a hole in the middle of a piece of 1/2" plywood (about 4"x12"), attached a tripod socket, and glued a strip of leftover padding from an equipment case to the top of this board. It is very easy to rest mySKY on this support and keep it steady while aiming at a sky object; the height and angle can be adjusted.

A father and son search the night sky together.

There are several features which I wish mySKY had; perhaps Meade will add them in a future upgrade of the product:

- The manual says that it can take two to six minutes to acquire a GPS fix. This seems excessively long, as Meade’s GoTo telescopes acquire GPS in a few seconds.
- For setting the location manually, it would be better to be able to input longitude and latitude. mySKY lists only some of the larger cities in Minnesota; the closest to Onan are Mankato and Litchfield, 60 to 75 miles away. Even so, the instrument seems to be accurate in identifying sky objects.
- There could be a button to turn off the screen display when in identify mode; it is difficult to sight the sky object against the glow of the screen. The display could come on again automatically when the trigger is pulled.

Just point mySKY at any sky object and the instrument will identify it and provide a short description.

- Alphabetical lists can scroll down only; it is not possible, as can be done with AutoStar, to scroll in the opposite direction and get to an object at the end of the alphabet faster. It takes some time to go from Albireo to Zubenelgenubi!

Considering its few limitations and the potential for software upgrades, mySKY is a fascinating instrument for becoming more familiar with the night sky. It would be a great family Christmas present.

A Tale of Three Telescopes

By Dick Jacobson

(Continued from October Gemini)

The completed bearing sat in my basement for a year or two until I finally got serious about finishing the project. I made a front ring for the secondary cage by bending some 7/8" aluminum tube into a ring using the same ring roller. The spider is attached to this ring. A "mini-truss" of eight 1/2" diameter aluminum tubes connects the front ring and the inner ring of the bearing. The aluminum framework of the secondary cage is very strong yet weighs only 6 pounds including the bearing. The focuser board is a trapezoid-shaped piece of plywood that fits into one of the eight triangle-shaped areas formed by the mini-truss. The finder is a half-binocular. I made a dew cap for the finder from a PVC pipe fitting; this is attached to the front ring of the secondary cage. Two threaded rods connect the back end of the finder to two of the mini-truss tubes, using turnbuckles to align the finder.

I mounted a 5-pound lead acid battery on the opposite side of the secondary cage. This provides power for my anti-dew heaters and counterbalances the focuser, finder, and the binoviewer that I usually use. The focuser board, finder, and battery are attached to the small aluminum tubes using electrical cable clamps so I didn't have to drill holes through the slender tubes. I couldn't think of a good way to work a Kydex light shield into all this apparatus, so instead I used a piece of black fabric which is attached to the frame with safety pins. Part of the light shield extends beyond the front of the scope on a piece of aluminum tube that I bent into an ellipse. The light shield does a good job but it's kind of ugly and I might replace it if I think of something better.

The rotating secondary cage has proved to be a tremendous convenience. It makes it much easier to find a comfortable eyepiece position when standing on a ladder. This works in all sky locations except very near the zenith, where rotating the cage doesn't have much effect on eyepiece height. When using the finder, I usually rotate the cage to get the finder in a comfortable position and then spin the eyepiece into position. Even if I were building a conventional Dob, I would seriously consider including a rotating secondary cage. Instead of going to the trouble of building the bearing myself, though, I would probably try to find a suitable commercially-made one.

This shows the upper half of my 14-inch scope, including the bearing for rotating the focuser and finder.

This shows the split tube of my 14-inch scope.

Moving on down to the truss, I did a few unusual things here too. The truss tubes are 1" square aluminum tubes. I used square tubes for two reasons. There was an article in Sky & Telescope quite a few years ago that claimed that square tubes don't vibrate as much as round ones. And it was a lot easier to work square tubes into my design. My eight truss tubes are permanently connected in pairs. At the top of each pair is an aluminum plate. One of the tubes is rigidly connected to the plate with two bolts. The other tube is connected with a single bolt and lock nut and is free to pivot. For compact storage and transport, the two tubes pivot together. (I can hold the entire truss in one hand.) When clamped into the mirror box, each pair of tubes forms a completely rigid triangle. A single knob and a small piece of oak clamps the bottoms of two tubes into each corner of the mirror box. There are shims at the base of the tubes which cause them to angle outward, preventing them from intruding into the light path despite the fact that the mirror box is a compact Obsession-style design.

The plate at the top of each truss pair has a slot for clamping the secondary cage bearing outer ring. Four bolts and clamping knobs extend out from the outer bearing. Since the mount is equatorial, the clamping points are at the north, south, east, and west sides. You would expect all of the clamping slots to point upward when the tube is vertical. Instead, only the north plate has the slot pointing upward. The east and west plates have their slots pointing north, so they are sideways when the tube is vertical. The south plate is the most bizarre of all. It has a large hole in the middle, with a slot adjacent to and above the hole pointing downward. The reason for this strange design is that I don't like the idea of climbing a ladder while holding a big clumsy secondary cage out at arm's length. The system I designed lets me attach the cage with the scope horizontal. Here's how I do it:

Once all the truss pairs are clamped into the corners of the mirror box, they form four rigid triangles. First I grab either the east or the west truss pair and pull the tube down so it is horizontal. While holding it down with one hand, with the other hand I set the secondary cage into the slots of the east and west trusses. (If you were paying attention to the previous paragraph, you will realize that these slots are pointing upward when the tube is horizontal pointing south.) At this stage, the bolts at the east and west points of the secondary cage are supporting it, but the cage is pointing downward at a crazy angle. Then I rotate the cage into position. The north bolt approaches the slot in the north truss, and at the same time the south clamping knob passes through the large hole in the south plate and its bolt enters the slot from below (that is, from the mirror box side). Due to inaccurate construction, it takes a little bit of wrestling to get all the knobs in position, but once they are there and clamped, I've got my secondary cage attached without setting foot on the ladder!

The usual solution for avoiding secondary-cage ladder vertigo, which is used on the club's new 30" Obsession, is to clamp a small lightweight wooden ring onto the tops of the truss tubes with the scope vertical, and then pull the tube down horizontal, hold it down with a heavy weight, and hang the secondary cage on the wooden ring. My system eliminates the need for this ring.

The mirror box is pretty much a standard, "by the book", Obsession style box. ("The book" is The Dobsonian Telescope by Kriege and Berry. This book is packed with valuable information and is indispensable regardless of whether you follow their design ideas or take off on a tangent like me.) I made the box a few inches shorter than normally needed for balance, because I planned to add a removable fan/battery/counterweight assembly on the back. An 18-point cell made exactly to the Kriege-Berry specifications supports the mirror. Instead of the usual ladder frame supporting the mirror cell, I made a triangular frame out of square aluminum tubes. This frame is about half the weight of the standard frame and is, I think, stiffer because of its triangular shape. The collimation knobs are recessed into the corners of the triangle so there is no force on them when the box is lying on its back.

The biggest innovation inside the mirror box is the system for supporting the edge of the mirror. Since my equatorially mounted tube has to tip in all directions, the usual nylon or kevlar sling that is used to support Dobsonian mirrors would not work. (In my 10" and 14" scopes, made by Discovery, the mirror is glued to the cell with silicone glue so edge support is not an issue.) I was skeptical about using silicone glue on a mirror this large and wanted to use a conventional flotation cell. To support the edge gently in all directions, I used four overlapping slings. The slings are made of $\frac{3}{32}$" galvanized wire rope. I used the plain, uncoated rope, not the vinyl covered type, since the high friction of vinyl could put unwanted stress on the rim of the mirror. Picture four U-shaped slings with the open ends up, down, left, and right. Two of the slings have a wing-nut tension adjustment so I can separately adjust the east-west or north-south pair. By this means I hoped to avoid any possible astigmatism caused by uneven force and might even be able to correct the "potato-chip"

This is the back of the 20-inch mirror box, also showing the fan/battery/counterweight assembly.

Here is a view into the front of the 20-inch mirror box.

distortion that occurs when big mirrors are aimed below 15 degrees. So far I haven't put this theory to the test and have just left the wires alone; they seem to work fine.

Instead of the usual 180-degree half-moon side bearings, mine are 270-degree "Pac-Man" bearings. The mouth of the Pac-Man points toward the top of the tube. These bearings let me rotate the tube all the way from the southern to the northern horizon. Actually it wouldn't have been necessary to make them this large, since the fork can rotate in a complete circle. I could reach the northern horizon by turning the fork upside down. But then the 150-pound tube would have been supported by the two aluminum straps that anchor the centers of the declination bearings to the fork sides, and I wasn't crazy about that. I could have saved several pounds by making the declination bearings out of aluminum bars bent using my ring roller, but I wasn't sure what thickness would be needed to avoid vibration, so I played it safe and just made them out of plywood.

I already mentioned the fan/battery/counterweight assembly that snaps onto the rear of the mirror box. This is on an aluminum frame that runs all the way crosswise and is thin enough front-to-back so it doesn't scrape the bottom of the fork as the tube is rotated toward the pole. For counterweights I used 3/4" threaded rods, nuts and washers. These allow me to carefully balance the counterweight horizontally and vertically if necessary. I had to add several pounds more counterweight than planned because when my mirror finally arrived it was 1.75" thick instead of 2" as planned. Fortunately, 3/4" washers are cheap!

Now that you know more than you ever wanted to know about the tube, I'll describe the mount. Just as with the mounts for my 10" and 14" scopes, the mount consists of a fork that rests on a base. The two parts are not fastened together but are held together by gravity. The base of the fork is primarily two layers of 3/4" plywood glued together. The bottom layer is a 24" circle. The top layer is approximately square, but the part that is highest above the ground is cut away to match the curve of the bottom layer. I added some 1" boards around the periphery of the square part to provide reinforcement and also provide a larger area for attaching the fork arms to the base. I was careful to check that the Baltic Birch plywood circle was perfectly flat. A warped base would cause inaccurate tracking.

The fork arms are made from 1"x16" edge-glued oak boards (actual thickness 3/4"). Two boards are glued together so the finished thickness is 1.5". I used solid wood instead of plywood since the arms are stressed like cantilevered beams and most of

This is an overall photo of me with my 20-inch scope.

the strength should be in the longitudinal direction. I did not glue the arms to the base because I thought I might need to rebuild one or the other. Instead, I joined the arms very tightly to the base using eight lag screws on each side. This seems to work very well. When I turn the fork 90 degrees so the tube's weight is against one fork arm, the arm deflects about 1/4". This is not enough to cause an imbalance problem about the polar axis and I don't think there is any risk of the arm coming off. Each arm has two Teflon pads that support the tube. In addition, there is a Teflon pad on the inside of each fork arm to support the mirror box laterally when the fork is turned sideways. The mirror box has a semi-circular strip of Ebony Star Formica adjacent to the outside of the declination bearing on each side.

The base supports the bottom of the fork at three points. At the center is a 1/2" bolt inside a bronze bearing. The other two support points are roller bearings (on the base) near the edge of the 24" diameter circle. The roller bearings roll against an aluminum track. The track is made from 10 aluminum plates cut from a 1/8" x 2" bar. I was concerned that there could be a bump as the bearings moved from one plate to the next, so I cut each plate so the seams are not radial but are 18 degrees away from radial. This may sound complicated but actually was very simple. Each plate is cut at a right angle at one end and at 54 degrees at the other end, so that when the plates are laid down end-to-end there is a 36 degree curve at each joint (times 10 makes 360 degrees). This has worked out just as planned; there is no perceptible bump or jerk as a bearing passes from one plate to the next. On my 14" scope I had originally used smooth laminate for the bearing surface. This worked okay, but adding an aluminum track greatly reduced friction and vibration.

As you can see in the picture of my fork, it will be obvious that the fork is not symmetrical about the polar axis. It is very bottom- heavy. To restore the balance, I offset the declination axis 1-1/16" above the polar axis, so the weight of the tube balances the entire assembly. This was the most exacting calculation of the whole project. I had to carefully weigh or estimate the weight and center of mass of everything that rotated about the polar axis, to determine how much offset I needed. As it turned out, I was right on target. If I had miscalculated, there are many ways I could have brought it into balance.

This brings me, finally, to the foundation of the entire scope, the tilted base. Overall, the base consists of two wooden triangles. The lower triangle rests on the ground and is made from two Douglas Fir 4x4 beams bolted together (one side of the triangle is missing). The upper triangle is made from three layers of 3/4" Baltic Birch glued together. A hinge along the lower edge of the upper triangle connects the two triangles. The hinge is simply a piece of 3/4" galvanized pipe which is bolted to the upper triangle and is connected to the 4x4 beams by a pair of strap clamps. The biggest mistake I made when I first built the mount for the 14" scope was to use door hinges to connect the triangles. These proved to be much too flexible. The peak of the upper triangle is connected to the peak of the lower triangle by a turnbuckle. The turnbuckle makes it easy to adjust the angle between the two triangles, providing latitude polar adjustment from 25 to 50 degrees. (The upper triangle faces the North Pole.) I used a forged turnbuckle, which is much stronger than the usual bent-wire turnbuckle. These are available at Fleet Farm, Beisswenger's, and a few other hardware stores.

While the turnbuckle enables north-south polar alignment, there is no mechanism for east-west adjustment. Before the tube is in place, I can easily shove the mount to the right or left. With the tube in place, I would probably need to use a crowbar. In practice, I just align it by setting the base on the ground and visually aligning it with Polaris. This is good enough for visual observing. On my 14", I attached a polar alignment scope to the side of the fork, but I never used it much so haven't done the same on the 20".

If you've been able to follow all of this, you have probably figured out that the upper triangle supports the fork by means of the three bearing points. At the peak of the triangle is an aluminum plate with a V-shaped slot in the top. The bronze bearing at the bottom center of the fork rests in this V-slot. When the scope is resting on the fork, gravity tries very hard to pull the bearing out of the slot (toward the north.) To resist this, the bearing has a flange on one end. For safety, in case the flange somehow pulls loose, I added a much wider washer behind the flange.

The two lower bearings are trailer wheel bearings, available at marine stores and other places that sell trailer equipment. I used a pair of bearings back-to-back at each bearing point, because otherwise the bearings fall apart, the outer races being separate from the rollers. For axles, I used short pieces of 5/8" threaded rod and nuts. The outer points of the nuts just happen to fit perfectly into the 1-1/16" inside diameter of the bearings. The whole polar bearing system—bronze center pivot, trailer

This shows how I attach the secondary cage without needing to climb a ladder.

This shows how I load the 105-pound mirror box onto the fork with the help of the 2-wheel hand truck that I modified for this purpose.

wheel bearings, and aluminum track—-is extremely efficient. It takes only about 8 ounces of force at the eyepiece to turn the 200 pounds of rotating weight. Low friction is important because I use a friction mechanism to drive the scope about the polar axis.

This brings me to the motor drive for the polar axis. As I mentioned before, I wasn't trying to build a highly accurate drive for imaging; instead, I just wanted it to be accurate enough to eliminate most of the nudging. It turned out to exceed my expectations.

In keeping with the low-tech approach, I used a simple DC gearhead motor. Through a pair of external gears, the motor rotates an ordinary threaded rod (available at any hardware store). The rod passes down the center of a 1" square aluminum tube. (You may have noticed by now that I love square aluminum tubes!) A pair of ordinary plastic tube end caps connects the rod and tube. I drilled and threaded a hole in the center of each end cap to match the thread of the rod. The square tube presses against a round polyethylene tube that is wrapped around the rim of the 24" plywood base disk of the fork. As the motor rotates the rod, the square tube is pulled toward the east, causing the polar axis to rotate by friction between the aluminum tube and the polyethylene tube.

To control the speed of the motor, I built a small control box containing a potentiometer. The motor is rated at 23.5 volts but I usually run it at about 10 volts. The control box also contains a double-throw switch and a little 9-volt battery. In one position, the switch routes power from the main external battery through the potentiometer. In the other position, the 9V battery is switched in series with the main battery, approximately doubling the motor speed. This gives me a simple but effective speed control. Considering that only voltage and not frequency control the motor speed, the motor is surprisingly accurate. I usually have to tweak the potentiometer several times early in an observing session to get the right speed, but once that's done the drive speed hardly varies at all. The motor should run for about 50 hours on a charge of the small 12V lead-acid battery (attached to the underside of the upper wooden triangle of the base).

The drive runs for about 3 hours before the square tube reaches the drive gear, at which point a small switch cuts power off. To reset the drive, I unscrew the threaded rod from the coupling nut that attaches it to the drive gear. Then I flip the rod-and-tube assembly end over end and screw the other end of the rod into the drive nut. This takes a couple of minutes.

The main problem that I've had with these friction drives on my three scopes is that there isn't always enough friction for reliable tracking. On the 20", it takes something like 20 or 30 pounds of force between the aluminum and the polyethylene to track reliably. Ideally, there should be just enough force to track, yet the force should not be excessive so it is easy to push the scope back and forth around the polar axis. There is an adjustable spring that provides tracking force. I usually have to adjust the spring a few times during an observing session. Despite the occasional tracking problems, I really like the friction drive because I can move the tube at any time without needing to disengage anything.

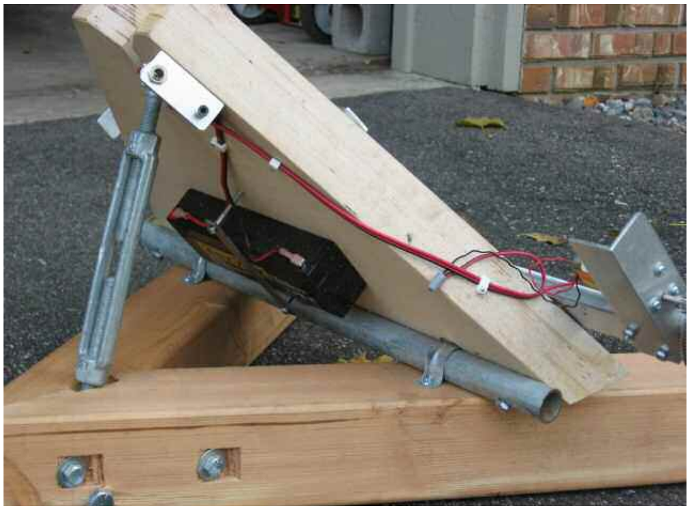
One other problem, which I first encountered and fixed on the 14", involved the polyethylene tube. The drive would run for about half a minute and then stall. I finally figured out that the hollow polyethylene tube was developing a flat spot. To correct it, I slit the tube lengthwise along the inner side (toward the plywood) and forced a piece of rope into the tube to keep it from collapsing. In retrospect, it would have been simpler to just obtain a solid polyethylene rod from a plastics supplier, but I wanted to stick with the approach of building everything with stuff I found at the hardware store.

This completes the description of the telescope itself, but there is one additional very important part. The mirror box for my 20" weighs 105 lbs. I have never even tried to lift it. For me, that would just about guarantee a back injury. Instead, I modified a small, light-duty 2-wheel hand truck to help me handle the mirror box. I attached two wooden brackets to the hand truck which hold the mirror box by the top and bottom, keeping it 17 inches above ground level. With the help of this truck it's easy to gently lower the mirror box onto the fork bearings, which hold the bottom the mirror box 14 inches above the ground. It's also easy to load the box into the back of my wagon, which is 21 inches high—-I just tilt the box up slightly and tip it in. No ramp is needed.

Performance

Overall, I'm very happy with the performance of my 20" scope and am not planning any major changes. It's easy to observe visually at 640x with it. I don't have any plans to use it for imaging. I suspect that if I tried to do imaging, I might be disappointed with the accuracy of the drive or the steadiness of the mount.

This shows the base for the 20-inch, including the bearings and the motor drive system.



This shows the back side of the base of the 20-inch, including the turnbuckle for adjusting latitude.

Optical performance

John Hall, the optician at Pegasus, claims that my mirror has a Strehl ratio of .985, which would be outstanding. I have no way of verifying this, but I haven't seen any hint of optical deficiency in my observing so far. I believe that whatever optical defects exist are insignificant compared with the problems caused by the atmosphere or turbulence at the warm mirror surface. The job of the telescope is to hold everything in alignment and the scope seems to perform well in this regard.

The only significant problem I've had since completing the scope was a problem with the rotating secondary cage. I would collimate the scope with the eyepiece on one side of the tube. Then when I swung it around to the other side it was obviously out of alignment. When I finally bought a laser collimator, put it in the focuser and spun the cage around, it was clear what was causing the problem. The axis of rotation of the secondary cage had missed the target, the center of the main mirror, by about an inch. I had to adjust the length of the truss tubes so the cage would point squarely at the center of the mirror. I had already trimmed the tubes four times and they were starting to get too short. To fix the problem, I drove eight flat-headed wood screws into the gusset plates where the bottom of the tubes rest. The tubes now rest on the screw heads. This enabled me to precisely adjust the position of the bottoms of all the tubes. The laser spot still wobbles about an inch or two as I rotate the secondary cage, probably because my bearing is less than perfect, but this doesn't cause any visible problems. (Interestingly, the web site for the JMI NGT scopes, which also have rotating secondary cages, also mentions that the laser spot moves as the cage is rotated, so the problem isn't unique to me!)

The scope seems to hold alignment very well. Since it is always assembled exactly the same way (the east truss on the east side of the mirror box, etc.), only a small collimation adjustment is usually needed, and I can get by without collimation if necessary.

Mechanical performance

I think the biggest shortcoming of the scope is that the drive, at this point, isn't as reliable as I'd like it to be. Most of the time it works fine, but it's not unusual for it to slip due to wind, tube imbalance, or excess friction. I don't think this is an inherent design problem; instead, it just needs a little more work. I should probably use a stronger spring and maybe a larger diameter polyethylene tube.

Imagers are concerned with measurements of the drive error. I don't have any quantitative measurements to offer here. I have experimented a little with trying to hold a star at the exact edge of the field. After quite a bit of tweaking of the potentiometer, I can get the drive rate just right so the star wanders slightly back and forth—-I'd guess maybe 10 or 20 arcseconds of variation. I'm not sure if this is a periodic error or a random variation. The longest period in the drive is the 46 seconds that it takes for the drive rod to rotate once, so there isn't much time for a periodic error to accumulate (compare this to the 4 minutes for a 359-tooth worm drive). My point of view is that if you're serious about imaging, it's best to purchase a good commercially built mount.

Another shortcoming is that the mount is not as solid as a well-built Dobsonian. This should not be surprising. On my mount, the bearing points for the polar axis form an equilateral triangle 11 inches on a side, and the bearings are mounted on a wooden plate tilted up from the ground. By contrast, a typical 20-inch Dob would have azimuth pads in a triangle about 17 inches on a side, resting directly on the ground. My design has an inherent disadvantage here. I'm pretty sure that I could improve the mount's performance by replacing the wooden 4x4 base legs with metal tubes. But in my view the relative lack of solidity is not a practical problem. When you thump the tube, it vibrates for 3 to 5 seconds. The vibrations are quite small and decay rapidly enough so I don't consider them a problem. There are maybe 2 or 3 arc minutes of rebound when moving the tube. This might annoy someone who is accustomed to a rock-solid mount, but I don't consider it a problem. And of course, since the tube is motor driven, I rarely need to push it except when moving to a different object.

An interesting point about bearings: When I move the scope around the polar axis, most of the friction comes from the polyethylene ring rubbing against the aluminum drive tube. The declination axis uses the traditional Ebony Star Formica running on Teflon pads. I've found that the polyethylene-on-aluminum polar axis has a much better feel than the Teflon-formica declination axis. The polar axis seems totally free of "stiction" while the declination axis is stickier than I would like. Maybe I used the wrong brand of car wax on the Formica. If I build another telescope, I'm

This is a photo of the fork or cradle that holds the 20-inch mirror box.

tempted to forget about Teflon completely and just use high efficiency bearings with adjustable polyethylene-aluminum friction.

Portability, usability:

As it turns out, in my case the equatorial mount may actually be more portable than an altazimuth Dob. Because of its height, I would have trouble getting a 20" Obsession mirror box - rocker combination into my vehicle, a Passat wagon. I might have to separate the mirror box from the rocker, or else remove the altitude bearings. By contrast, my equatorial scope fits in with no problem. The mirror box goes in first, then I slide the fork in behind and partially around the mirror box. With the rear seats folded down, there's plenty of room left over for the remaining components. The heaviest component that I have to lift is the 50-lb fork, which is easily manageable and balances well when I carry it with the fork arms on either side of my body. Assembling the scope takes about 10 minutes and is not tiring at this point in my life.

Actually, the thing I dislike most about the scope is the fact that I have to stand on a ladder to use it! The eyepiece height is several inches higher than it would be on an altazimuth mount, which is a disadvantage. With any fork mount, there is a limit to how far below the equator you can point until the tube hits the base of the fork. I designed my 10" and 14" mounts to reach -50 degrees. On the 20", I decided not to worry about the southern limit and just made the mount as compact as possible. As it turned out, it reaches to -37 degrees, which is far enough south to track the southernmost Messier object, M7 (-35 degrees). I can observe almost down to the southern horizon by cranking the turnbuckle down, but I cannot track accurately in this area. I don't regard this as a serious problem.

Alternatives

You may ask, "Why bother with an equatorial mount? The problem of equatorial motion has already been solved with Dob drivers and platforms." A perfectly legitimate question. As I see it, each approach has its own benefits and drawbacks. Dob drivers are computer-controlled motors that drive the altitude and azimuth axes to track the stars. We have the ServoCat system installed on the club's 24" Starmaster and new 30" Obsession scopes, and it works superbly. Coupled with digital setting circles, it provides go-to functionality and spiral searches in addition to star tracking. If you just want to get to your objects as fast as possible and don't mind being dependent on electronics to get you there, it's a natural choice. Since it adds nothing to height and little to weight, I think it will remain the system of choice for telescopes 30" and larger. On the other hand, you need to use the control pad to move the telescope unless you disconnect the drive, in which case you lose tracking.

I'm not a big fan of electrical telescope controls. I own a 6" Maksutov-Newtonian on a very fine Vixen GP-DX mount. This mount has electric slow motion controls on the polar axis and a mechanical worm gear on the declination axis. I have always found the mechanical control to be much faster and more accurate. With a Dob driver the image rotates, which complicates long-exposure imaging. There is the "Dobson's hole" problem where objects near the zenith are hard to track. To a certain extent, a system with a cable-driven altitude axis like ServoCat ties the mirror box to the rocker box, since reinstalling the drive cable is a somewhat delicate and time-consuming operation. Installing ServoCat on an existing telescope is not a trivial task and may be too difficult for some people.

Equatorial platforms employ an ingenious mechanical system to turn a horizontal platform in sync with the earth's rotation. You just set your Dobsonian scope on top of it and voila, you've got equatorial tracking. Its big advantage is that it's easy to install under just about any Dob. But it has to be reset about once an hour when the platform reaches its limit of rotation, and you have to find the object you were tracking again. If you're using digital setting circles, they need to be realigned. Platforms have a limited range of latitude adjustment. While they track through the zenith with no problem, you still have the problem of moving from one object to another in that area.

My equatorial base most closely resembles a platform in capabilities. You could think of it as a high-performance platform. It tracks for about three hours, compared with one hour for a platform. After resetting the drive on my scope, it's easy to find the object I was looking at—-just push the scope west a little to compensate for the time the drive was off. If I'm using digital setting circles, there's no need to reset them. My platform has a much wider range of latitude adjustability. Of course, the downside is that it works for only one telescope.

A traditional equatorial mount (one with actual mechanical polar and declination axes) can track the stars with nothing more than a simple motor. If the motor or battery fails, you've still got the benefit of equatorial motion (manually operated). This reliability is an important plus when you're taking advantage of a rare opportunity observing in a remote location with little or no repair capabilities. There's almost nothing that can go wrong with a mechanical mount, and it should continue working fine for decades. Equatorial mounts can track and move through the zenith, the highest quality part of the sky, with no problem. If you enjoy star hopping with atlas in hand, an equatorial mount is helpful since it naturally moves along lines of declination and right ascension. It's easy to hop two degrees west and one degree north to the next object. On my truss tube scope, it's especially easy since there is a north truss, south truss, east truss, and west truss. If I want to move west, I just pull on the top of the west truss or push on the east truss. Personally, I just like the fact that the mount moves the way the sky moves. On the other hand, most equatorial mounts (except for mine) are substantially larger, heavier and more expensive than altazimuth mounts.

So the type of drive you choose is a personal one, depending on how you want to use the telescope. I think my 20" has proven that there is a realistic, build-it-yourself alternative if you don't like Dob drivers and don't like platforms (and also don't like the pure Dobsonian nudge-nudge system.) As far as I know, there is no telescope similar to this one currently on the market, so you'll have to build it yourself. Once I got started working seriously on it, it took about eight months to complete. I tend to be a slow and meticulous worker so I'm sure a lot of you could get it done quicker. I didn't keep track of the money I spent, but I estimate that the materials cost a little under $1,000, excluding the optics and Feathertouch focuser. It's a fairly challenging project and maybe not the right one for you if you're looking for guaranteed success. But if you enjoy sitting down with some graph paper or a CAD program and working out the details of a design, I think it would make a fascinating ATM project. I'll be glad to offer advice.

I did a quick search for commercially available equatorial Newtonians larger than 10" and could only turn up four. Parks offers 12.5" and 16" scopes on German equatorial mounts. And JMI has the NGT split-ring scopes in 12.5" and 18" sizes. The JMI 18" is probably the closest to mine in overall performance. I've never had the pleasure of trying one out, but it appears to be beautifully engineered. I would expect the split-ring design to be more solid than mine, possibly equal to a good Dob. On the other hand, it's not as compact. In the JMI scopes, the ring is twice as wide as the mirror and it's hard to see how it could be made much smaller. In contrast, my fork is just 28" wide for a 20" scope. The split ring can turn only about 180 degrees about the polar axis while my narrow fork can turn a complete circle. I expect that a split ring would be more difficult for an amateur to build than my fork mount.

Future trends

So, will my narrow-fork (or Dob-quatorial) mount be the next big thing in telescopes? I rather doubt it. Although I think it has a lot of merit, somebody with more time, energy, and money than I have would need to promote it. At last August's Northwoods Starfest, renowned telescope builder Mel Bartels was the featured speaker. He spoke about current trends in telescope making. One big trend is ultra-light telescopes. In these scopes, the mirror box and rocker are reduced to almost nothing and a sturdy ring on the ground provides stiffness. The secondary cage and truss are also made as light as possible, sometimes by using "strings" in place of some of the truss tubes. Dave Kriege at Obsession has more or less thrown away his own book on telescope making with his new line of ultra-lights. My personal opinion is that people are going a little overboard in this direction.

What I would like to see is an ultra-fat telescope—-something like a 36" f/2 about 6 feet high, maybe with a negative coma-correcting lens just in front of the diagonal. I don't know if such a thing is even possible optically. Al Nagler, are you listening?

Mel Bartels also said, "Telescope technology is limited by ladder technology." Or as Kriege and Berry said, in my favorite sentence from their book, "Before you become fully conscious of the tendency, you're choosing the next object near where the telescope is already pointing so you won't have to move the ladder again." Maybe we need to get rid of the ladder. At about 28 or 30 inches, the mirror box weighs about as much as the observer. This suggests a telescope modeled after bicycle pedals. The mirror is on one pedal, the observer on the other, with a single huge altitude bearing in between. I'm sure this could be made to work in a permanent observatory where weight was no object. Could it be made portable without vibration from the observer killing the view? The only way to find out is to build it and see if it works.

MAS Executive Board Elections

Elections for three executive board positions will take place during the December general membership meeting, December 6, 7:00 p.m., at the Science Museum of Minnesota in downtown St. Paul. At the meeting, MAS members will elect new officers for the 2008/2009 term. The candidates are:

Vice President Steve Emert

Treasurer Bob Benson

Board member at large

Father Brown, Merle Hiltner, Bob Young

If you wish to cast your vote and are unable to attend the meeting, contact MAS secretary Bill Kocken to obtain an absentee ballot. Absentee ballots must be completed and returned by November 30.

Information about the Candidates

Steve Emert

Hi everyone. I put my hat in the ring for vice president, but I hope that someone else also decides to run for VP; otherwise, it'll be a pretty boring election but an easy campaign for me.

I've been a MAS member since 2000 or 2001. My first introduction was seeing a small article in the *Pioneer Press* saying that there was going to be something called Astronomy Day at a place called Onan Observatory. My daughter, who was then in a high school astronomy course, and I decided to go. We both got our first looks at Jupiter and Saturn through the telescope and got hooked. The views were tremendous and the people were very enthusiastic and helpful, and I've found that to be the case ever since. Now she's a science teacher in northern Minnesota, including one astronomy course this year!

I'm an Onan keyholder, although it seems I haven't had time to participate in more than a few public nights this year. But those that I participate in are always a blast. I'm also on the Cherry Grove maintenance committee, and if you've applied or renewed your membership you've gotten a letter signed by me, as I've been doing the membership coordinator duties for the last two years, the first of which was also my second year of a term as secretary that wrapped up at the end of 2006.

I guess I'm putting my name in as a candidate for VP because I like to help out and contribute to the society. Besides that, it's easier to keep up with what's going on when you go to board meetings.

Bob Benson

Hello, I'm Bob Benson, current treasurer of MAS. I have been a member since the mid '80s but have only served on the board this two-year term. My involvement in the past has been limited, mostly from the sidelines, so I thought it was about time I gave back to the society by running for this position. I'm once again running unopposed for the treasurer's position, and that's all right with me. I don't mind serving another term. However, if there is anyone interested in the position I would not mind stepping down to allow someone the opportunity.

I would like to see the society increase its public outreach programs and encourage the members to get more involved in outreach, since it's been a very rewarding experience for me. I see my role in MAS centered on these activities in the future. I have enjoyed astronomy all my life and consider it more than just a hobby. I've met many people with that same passion and made many friends in the society. For that I feel very lucky.

Father Brown

I am a Catholic priest of the Diocese of New Ulm, retired from parish ministry and chaplain at St. Mary's Care Center, Winsted. I have been interested in astronomy for many years but never had a telescope. In April 2006 I purchased a 14-inch Meade LX200R and had a home-built observatory set up on a dark farm site near Ivanhoe. (See my article in the October issue of *Gemini*.) When I moved to Winsted in April 2007, I discovered Onan observatory only 15 miles away, joined MAS, and received keyholder training in May. I have been spending more time at Onan than at my own observatory, helping with public nights and other events and doing personal observing. When I learned that *Gemini* was in need of a new editor, I volunteered. I worked on the December issue and will take over from Ron Bubany in January. Ron tells me that it was useful for him, as editor of *Gemini*, to be on the board, because it made it easier for him to get information out to all the MAS members. For this reason, I am running for the position of board member at large.

Bob Young

I am 39 years old and the father of four children. I have had an interest in astronomy since I was a young child. I have enjoyed sparking others' interest in astronomy in my backyard until I found MAS and thought, "Wow, what a great thing!" I joined MAS and found public night to be a great way to keep on sparking interest in astronomy, with it being more exciting sharing a 16" scope than my old 4.5" in the backyard. I have worked project management in the energy industry for quite a while (16 years) and have several other hobbies, such as radio-controlled aircraft and fishing.

I threw my name in the hat when it looked like there was going to be a lack of candidates; that being said, this is a fine group of individuals who have volunteered to help by service. I personally believe that whoever ends up serving as board member at large should and will keep in mind that the primary responsibility is to serve the interest of MAS as a whole, its individual members and the general public, while adhering to the MAS Constitution.

Each of the members volunteering to serve would be a great choice. I am happy to give back to the group that has welcomed me and my family so readily by service, whether it is outreach, cleanup, or serving on the board. I am more than happy to serve now or in the future, and just as happy to see either Father Brown (Padre) or Merle have the opportunity to serve. Thank you.

Merle Hiltner

Science-and especially astronomy-have always been a strong interest of mine. I started using my dad's 16x binoculars before buying my first scope, an orange C-8, which was used for more than 20 years. In 2003 I upgraded to a Celestron GPS11 and more recently a SV105 refractor (it doesn't get any better) has helped fuel my passion for observing.

I've been a MAS member and Onan keyholder since 2005. In running for a seat on the board (board member at large), I hope to be able to participate in making decisions that will continually improve MAS and its facilities. Moreover, I have accepted the informally designated position, "equipment wrangler," at Onan, in addition to working on my own MAS projects. I have been accumulating new materials to show at our public star parties, with the hope of finding new ways to enhance the public's experience.

Admittedly, upon attending my first MAS meeting, I had my astronomy gene revitalized. The people, as well as the facilities available for use, are second to none. I would like to offer many, many thanks toward everyone for their contribution, as well as for making MAS what it is today. Similarly, I immensely enjoy having the opportunity to show the public the wonders of what astronomy has to offer, and MAS has provided me an outlet to do just that. For this I am truly grateful. Lastly, I would like to add that I sincerely appreciate your consideration to further contribute to MAS.

Minnesota Astronomical Society 2007 Star Party Schedule

Date*	Special Location	Moon Rise	Moon % Set	Illuminated
7-Dec	Cherry Grove	5:55 AM	2:48 PM	6%
14-Dec	Onan	11:16 AM	9:31 PM	19%

* The Onan, Cherry Grove and Metcalf Star parties take place on the date listed in the schedule above, which is always a Friday. If the event is clouded out, the following night is used as a backup. For status of the star parties, call the information line at 952 467-2426.

** LLCC events are for members only. Vehicle I.D. card is required. Contact Board of Directors or Dark Sky Committee members for a pass.

Due to the relative distance and driving time to LLCC, in 2007 the MAS will include both Onan or Cherry Grove and LLCC parties on LLCC weekends in order to accommodate those who can take the time to travel to very dark skies as well as those who wish to observe closer to home. LLCC weekends will include both Friday and Saturday night.

This schedule is subject to change. You can also check the MAS online calendar at www.mnastro.org/events for a complete schedule of all MAS star parties, Onan Public Observing nights, monthly meetings and other events.

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If you wish, you can still submit your S&T subscription renewal to the MAS when you renew your membership in the MAS, and we will enter your renewal on your behalf just as we always have done.

New subscriptions to Sky & Telescope at the MAS member discount must still be sent to the MAS for group membership subscription processing. Send new subscriptions to the attention of the Membership Coordinator at the MAS at the Post Office box address shown on the back cover of the *Gemini* newsletter

To subscribe to the MAS e-mail list visit:
http://lists.mnastro.org/mnastro/listinfo/
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There is a general list (MAS) as well as special interest group (SIG) lists. Archives of the lists are also available by visiting the listinfo page for a specific list.

The MAS list has about 40% of the membership on it.