A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART I

Jay Reynolds Freeman

INTRODUCTION AND APOLOGY:

"A foolish consistency is the hobgoblin of little minds," wrote Ralph Waldo Emerson, and who am I to disagree? I had been wanting a new small driven mount. My mid-1980s Great Polaris still worked, but the dual-axis drives and simple hand-slewing of my Losmandy G-11 had raised my sights. I had also been wanting to do more effective observing of double stars, the Moon, and planets from my yard, which means repeatedly moving the telescope to see around trees, and fighting light pollution while using the finder. Technology for these purposes has been getting cheaper, and nothing clinches a decision like a bargain.

So in early April, 2001, I ordered a NexStar 8 from Eagle Optics, at the quite good price of $1499. See, I am not really a Luddite, I have been setting you up. After all, I bought a touch-tone 'phone when the 20th century had two whole years left to run, and I occasionally think about getting a television. I usually feel better when I lie down.

There were many go-to telescopes to choose from. At the high end, Roland Christen's latest mounts are not just computer controlled, but voice actuated. That's scary. I might wisecrack "Scotty, beam me up!", and disappear in a shower of sparks, to who knows where. Seriously, Astro-Physics's offerings were too big and too costly. Losmandy recently introduced a go-to option for the G-11, yet I needed a smaller mounting, and problems have been reported with early Losmandy units.

The well-regarded Meade LX200s are not really too noisy -- you can always select a slew rate slower than espresso grind -- but they are much heavier than Celestron's counterparts, and their two-arm fork mounts are more difficult to adapt to other telescopes than are the Celestron single-arm forks. Meade's small entries are not all two-arm forks, but they seem not to be very accurate.

Celestron offered several options, but the NexStar 11 is too big, and the very small stuff is also reportedly inaccurate. The NexStar 5 and 8 have larger databases and more software features, including a rapid two-star alignment that facilitates evading banzai charges by my yard's anti-astronomer ninja attack trees. I went for the 8 instead of the 5 because aperture wins, and for nostalgia: A generation ago, Celestron turned amateur astronomy upside down with the compact, inexpensive Celestron 8, but I had never owned one.

Eagle provided exemplary service. UPS messed up delivery, but Eagle promptly responded to my EMail with help chasing down the missing parcel. Celestron's overseas manufacturers messed up, too -- the tripod arrived with the wrong attachment hardware for the accessory tray -- but Eagle promptly called Celestron on my behalf, arranged for replacement parts, and 'phoned to let me know they were on the way. (The tripod box showed no sign of having been opened previously; I am confident the problem was not some kind of restocking error.)

FIRST IMPRESSIONS:

My initial impressions were unsurprising -- everything worked, the mechanicals seemed robust, the user interface to the software was easy to learn, and the optics were good. NexStar 8s are pretty common by now, and have been reviewed in _Sky_&_Telescope_ (November 2000), so there is ample information available to let newcomers decide whether they want one. Thus the thrust of my report will be how well this telescope suits an observer more experienced than a beginner, how well the software works, and what interesting modifications you can make to the telescope if you need a substitute for a life.

First light was Sunday evening, April 22, in the San Francisco Peninsula hills. High haze reduced transparency, and the air was very wet. Setup took only a few minutes, and my stab at "north and level" was good enough that the telescope slewed within a few degrees of the stars it chose for alignment. I started hunting Messier objects through the haze, and found them rapidly.

Even with no tripod tray to make the mount rigid, pointing accuracy was acceptable. Most objects ended up well within the field of the 40 mm Plossl eyepiece that Celestron supplied, even after long slews. The software makes it easy to let whatever object you are looking at become one of the alignment reference points; I did that frequently. Slewing was a tad slow -- I can find most Messier objects without charts, and could have gotten to them sooner with a hand-powered mount.

I did not have a dew shield for the NexStar, and had not brought my big battery, so could not use one of my Kendrick anti-dew heaters on the OTA. Thus I was not surprised, given the wet weather, when the corrector dewed. Quick alignment facilitated a simple solution. I moved the tripod next to the car, pointed the tube into the open door, started the engine, and swiveled a heater duct to blow hot air on the corrector. The dew disappeared in minutes, whereupon I realigned and continued to observe with the door open and the heater running. The extra warmth kept the optics dew free. The heat probably didn't help with seeing, but at only 51x, who cares? I logged 56 Messier objects and a few other things in about two hours.

Two nights later, I had bought a dew shield, but conditions at the same site did not require it. The tray hardware had arrived, so I set up with the tripod legs extended about a foot beyond minimum length, to provide a more comfortable eyepiece position, and started working on Herschel 400 objects. Finding accuracy was again good enough to bring nearly all of them into the 51x field. Pointing seemed worse a long way from the last alignment target, so I realigned often. The slow slew rate was less bothersome, for two reasons.

First, I organize my H-400 lists into strips of sky an hour wide, each sorted by declination. I work north or south in one strip at a time, so most slews are quick ones, through short distances.

Second, between checking my lists for the next object, and occasional reference to a chart to untangle a rich or confusing field, I made good use of the slew time. Typically I would be viewing one object with the NGC number of the next one already in mind. I would enter it and set the telescope slewing while I did paperwork, turned chart pages, and memorized the number of the next object to come.

I logged 124 H-400 objects in three hours. I can work that quickly by star-hopping, when I zig-zag across whole atlas pages, where targets are only a few degrees apart, but for objects as widely spread as the H-400 stuff, that's fast. I didn't spend a lot of time observing specific objects -- in many cases, there wasn't much to see -- but even with abbreviated viewing, it was pleasant not to have to spend noticeable time finding things in the first place.

At the end of the evening, I tried higher magnification, using a Brandon 8 mm for 254x. Seeing became noticeable: The Airy disc and first ring or two were visible, but generally in motion, so higher magnification would not likely have provided more detail. Collimation was a tad off, so I tweaked it, and star-tested on Polaris (which split nicely even at only 51x). With four or five interference rings visible, images on opposite sides of focus looked the same, though better seeing would be required for a more precise test. I slewed over to Epsilon Bootis, and had an easy split at 254x, then called it a night.

The third session was a few days later, on an evening when everyone but me thought the coastal marine layer would get far enough inland to clobber our best local site. It didn't. I had a clear, dark sky all to myself, for another run of deep-sky observing, plus a view of an occultation of mu Gem and a quick look at Mars. In three nights with the NexStar 8 I had logged 251 objects from the Herschel 400 list, 92 Messier objects, and a small handful of other things. Clearly, the telescope is usable and friendly.

THE VIEW FROM AN EXPERIENCED OBSERVER:

My list of NexStar 8 pros and cons of interest to an experienced observer so far includes the following:

1) Set up and take down are *very* fast -- well under five minutes each, much less if you have a quick and easy way to stow the telescope for transportation. The whole thing is light and portable enough to keep set up indoors (perhaps with a lamp shade to disguise it in the living room) and take outside in a single trip, as well.

2) Slewing is not as fast as by hand, but many observers will likely have other things to tend to while the telescope is in motion.

3) Alignment and object-finding seem sufficient to put things in a low-magnification field of view with great regularity, but ...

4) Serious users will probably want a finder, not only to save the bother of switching to a low-magnification eyepiece for finding things, but also for occasional orientation to charted stars when the eyepiece field is confusing due to an imperfect slew, and the object is so nondescript as to be unidentifiable if you don't know precisely where in the field to look for it. (Such objects include faint fuzzies, and also double stars too close to resolve at low magnification.)

The "right" finder is probably something like a 15x50 or a 20x50 -- such an instrument will show all the stars on my _Millennium_Star_Atlas_ even in a less than perfectly dark sky, and its two or three degree field will include the target and plenty of surrounding stars even with a very poor "find" by the NexStar. Finders with that much magnification are scarce. I expect I can cobble one up, or a 7x50 or so would probably do, but there may be an opportunity for an entrepreneur to offer a special, high-magnification finder, for a niche market.

5) Battery life is an issue. I have been using rechargeable alkaline batteries, and after three hours of heavy use they are drained enough that slewing is a lot slower. Nickel/ metal-hydride units are perhaps better, but they don't hold charge very long. The NexStar will run off a car battery -- Celestron lists an adapter for NexStars -- and an AC adapter comes with the telescope, so there are plenty of ways to provide external power.

You may well need to haul a big battery for an anti-dew system. If so, there is little penalty in using it to power the telescope, as well.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART II

Jay Reynolds Freeman

A NERD REVIEWS NEXSTAR SOFTWARE:

By choice, I don't often mix my profession with my hobby; however, I do work as a programmer, and my career has included everything from microcode on a super up through high-level applications and their user interfaces. I tell you these things by way of introducing and perhaps justifying some extended remarks about Celestron's NexStar software, as perceived by a jaundiced and cynical computer geek.

I should state clearly, that NexStar 8 software mostly works, and is mostly easy to learn. I do have complaints, and I am going to discuss them, but the length of my subsequent remarks should not obscure the bottom line: The software is pretty good. Notwithstanding, its designers seem to have missed a few key points that would make the system more robust, more useful, and more friendly, all for very little extra effort.

First, let's consider the algorithm for finding targets; that is, for driving the motors to get to a particular right ascension and declination. I don't know what the algorithm is, but I do know that it lacks an obvious good feature: It will not accurately find the last reference point -- the last object selected to update the alignment. That is, suppose I am examining epsilon Bootis, and decide to update alignment using that star. Following the instructions, I press buttons, carefully center it, press more buttons, and see a display confirming that the alignment has been changed. Then suppose I tell the telescope to find epsilon Bootis again. The telescope slews away from the star and sneaks back toward it -- that's fine, what it is trying to do is carefully take up slack in the gear train. Unhappily, it doesn't put the star back in the center of the field. It finds it, all right, but the error in finding is comparable to the error in finding any other object I might choose to slew to.

The problem persists even when I am particularly sneaky about aligning. I had best results when I aligned on two stars in the usual way, then went back to each of the two stars in turn and used it to update the alignment, replacing itself as an alignment target. I would watch through the eyepiece carefully, as the NexStar slewed to the star, keep track of which direction it approached from, and when I recentered the star to update the alignment, I made sure to use the keys to move the star in from the same direction that the NexStar itself had chosen. That was an attempt to take slack out of the gears during alignment, the same way the NexStar itself did when finding the star. (Celestron recommends approaching alignment targets from those directions, in a note in the back of the manual, but I hadn't found the note when I improvised this procedure.) I figured that would at least get rid of errors in finding due to gear-train slop, and it did make the NexStar have better luck when asked to find targets near either of the alignment stars, but the errors were still uncomfortably large.

It would almost certainly have been possible to choose a finding algorithm for which the errors diminished in proportion as the new position was close to the last alignment point. In effect, the software merely needs to remember "the gear positions for epsilon Bootis were thus and so", and correct them for the Earth's rotation. It would have been desirable to select such an algorithm, because one of the most common and best ways to use a telescope to find difficult targets -- ones hard to see unless you know *exactly* where to look for them -- is by making small offsets from a known object. Unless the finding algorithm is good at small offsets, that mechanism doesn't work. This poor choice of finding algorithm is the most important failing of the NexStar 8 as a serious telescope, that I have yet encountered.

Second, speaking of small offsets, why doesn't the telescope have a mode where the "arrow buttons" move the telescope north/south/east/west, instead of up/down/right/left? That would help enormously in finding things by small offsets, because none of my charts show which way is up/down/right/left, yet they all show north/south/east/west. There might be a case for not having such a mode if Celestron had done a determined job of implementing a modeless user interface, but they didn't -- the NexStar 8 has more modes than a Swiss Army Knife. So why not another one, particularly one that is very useful?

Third, still on the subject of finding and alignment, there is a very simple omission in the interface design. The telescope can *only* align with targets listed in one or another of the built-in catalogs. You'd think that if I had spent time finding something not in one of those catalogs -- perhaps a comet, or an object from the IC, UGC, MCG, or ESO catalogs (there are plenty bright enough to see with an 8-inch), that I should be able to use its position to update the alignment, if I wished, before going to the next object. The telescope probably already knows the position, because the likely way I found a non-cataloged object was by entering its coordinates and telling the telescope to go there. Yet if I try to update the alignment once such a position has been found, it doesn't work. It doesn't even work if I store the coordinates as a user-defined object. It ought to, in both cases.

Fourth, the telescope does not deal gracefully with gimble lock -- the property of a two-axis pointing system that makes Dobson-mounted telescopes hard to use when pointing near the zenith, and that makes equatorially-mounted telescopes hard to use when pointing near Polaris. Now, gimble lock is a mechanical phenomenon that I do not expect Celestron to be able to solve with software -- it does not surprise me that the NexStar 8 has difficulty dealing with objects that require pointing the OTA at right angles to the bottom of the drive base. But I expect the telescope to do something sensible when faced with this difficulty, and it doesn't. Operating close to gimble lock sometimes results in the telescope not being able to track the object, or tracking the wrong way. What is worse, it sometimes results in a system crash, in which no buttons on the controller do anything, with the only way out being to turn the power off and back on.

There are many possible underlying causes of such behavior. Perhaps the telescope can't send pulses to the drives fast enough to make them swivel at the appropriate rates, and merely refuses to do anything else until it has caught up. Perhaps it is enmeshed in some mathematical conundrum, such as a sequence failing to converge, or an attempt to calculate the arc sine of 1.02. Perhaps it's something else. I don't care, that sort of behavior is inexcusable. Software can calculate that the telescope is close to gimble lock, can predict that the anticipated drive rates are too large, can perform range checks on trigonometric and other arguments before calling the functions that use them, and can deal with out-of-range or indeterminate results when they occur. In every programming job I have ever had, if I had not been able to avoid software crashes due to something as simple as trigonometry, I would have been out of work the next day.

What I might have expected of Celestron, is that NexStars identify potential problems with gimble lock, make the display read "too close to zenith" or "too close to celestial pole" (depending on whether the telescope is in altazimuth or equatorial tracking mode), and stop trying to drive. The software will richly deserve hoots and catcalls from programmers until it behaves sensibly in such simple error conditions.

This particular problem is an example of failing a more general system design principle: "The controls shouldn't be able to get you into any situation they can't get you out of." Perhaps that should be "The system should protect users from their folly." To be fair, that principle is difficult to implement -- cars and airplanes can be made to crash all too easily by improper use of the controls, and I don't just mean their software. But telescopes? Please!

Fifth, I am not done complaining about alignment. Suppose you turn on the telescope, bypass the alignment, and start looking at things just by using the controller arrow buttons. Perhaps you are looking at the skyline while waiting for the sun to set. Later you decide to try a celestial object, and the telescope quite properly reminds you "no alignment" -- it cannot do what you ask.

What you are supposed to do in that case is turn the power off and back on, which brings up the menus for alignment. That's not a terribly bad solution. Many gadgets require a power reset at times. Yet the NexStar controller has an "align" button. If the system is not already aligned, why doesn't pressing the "align" button bring up menus for doing so? It could be confusing to a beginning user, who might think, "Gee, the controller says 'no alignment', and when I press the 'align' button, it still says 'no alignment' -- something must be broken."

This is an example of failing another more general system design principle: "The controls should always do something predictable and useful." The "align" button should help you do an alignment when you need one.

Sixth, still on alignment: In the June, 2001 _Sky_&_Telescope_, Gary Seronik comments that what really counts in a NexStar alignment is not getting the telescope level, but pointing it at right angles to the azimuth axis. If so, that's fine with me, but why doesn't Celestron just paint alignment marks on the fork arm and say "Align the marks" as part of the set-up procedure? That would be lots easier and more accurate than trying to guess which way is horizontal.

Seventh, there is a menu item for setting the date and time. As far as I can tell, it is used when you have aligned by the two-star method, and then decide you want to find a planet. The system has no way to tell where on the celestial sphere the planets are unless it knows the date and time, and the menu item lets you tell it.

Fine, but suppose you have aligned by the fancier method, and so have already provided the date and time. The menu item is still there, but as far as I can tell, it does absolutely nothing. I have tried to use it, providing a time a few hours different from the time the system already knows, but after doing so, when I try to find, say, Vega, the system still thinks that Vega is where it was before I provided the different time -- it does not go slewing through several hours worth of right ascension to look for Vega in a different part of the sky.

I don't have a big problem with not being able to change the date and time, but an inoperative menu item is confusing. A user might think, "Gee, I tried to change the date and time, and it didn't make any difference -- something must be broken."

The general principle here is "When the system can't do what you want, it shouldn't just sit there, it should tell you." The NexStar 8 does a good job advising when objects are below the horizon, and a similar "can't do that now" message would fix the problem with the date-and-time menu. Even better would be to have the menu item not appear on the scrolling list when it can't do any good -- why put something on the menu if it isn't really available?

Eighth, the telescope occasionally hangs -- no button pushes do anything, and there is no recovery short of cycling the power -- even when it is not near gimble lock. The problem has occurred for me most often when interrupting a slew to get the instrument to do something else. That kind of thing shouldn't happen, period. It is perfectly reasonable practice to design software which *must* check for a button-push every so often, and to make certain button pushes override anything else the system may have been trying to do. With such design, only a hardware failure can hang the system completely.

Ninth, there are errors in the databases. I found three that mattered in my first three nights' viewing. M2 and NGC 4666 had the signs of their declinations wrong, and M10 was shown at the position of NGC 6253, at more than 50 degrees south declination -- but M10 is not NGC 6253, it is one NGC catalog number away -- NGC 6254. I suspect these are human errors made during data-entry. That error rate is about one percent, which seems small, but errors like this will be very confusing to beginners, and surely it makes sense to double-check something that is going to be burned into ROM and distributed world-wide. There is perhaps a relevant general principle: "Writers of application software should be familiar with the application domain." I suspect that most amateur astronomers would have become suspicious if a "Messier object" turned up in central Ara. Yet I must say "perhaps", because there are all too many amateur astronomers who have never even seen M10, much less have any idea what constellation it is in.

Tenth, one possible technical explanation for these problems deserves to be addressed. Perhaps the amount of memory available for the NexStar control program was small enough to limit the ability of programmers to do their job. Perhaps Celestron decided not to spend money on more capacious memory chips. If so, then the programmers who created this code are not to blame. Celestron is to blame, though, for having made a bad choice in allocation of resources. The current on-board memory wastes lots of memory -- probably at least 50,000 bytes -- with a catalog of over 10,000 stars which are not identified. This catalog is only useful if you download and print out more than 200 pages of text data from Celestron's internet web site, and even then, it's not good for much. I would gladly give up some or all of that catlog in return for software that worked better, and I am sure that 50,000 bytes more for program memory could make a big difference.

I will close this part of my report as I began it, with the comment that nerd's-eye view notwithstanding, the NexStar 8 software is pretty good. It just makes my teeth itch to realize that for only a little more effort, Celestron could have put a professional software product in the NexStar line of telescopes.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART III

Jay Reynolds Freeman

SUMMING UP, OUT OF THE BOX:

My report on the NexStar 8 is not done, not nearly -- I have modifications and refinishing in the works, and will post about them in due course. Yet before then, I want to offer some conclusions about the telescope as shipped, and some recommendations, not only for users and prospective users, but perhaps also for Celestron.

First, the NexStar 8 works well. By and large, it does what it is supposed to do, with a user interface that is easy to learn, and with acceptable pointing accuracy.

Second, it is lighter and at the moment notably less expensive than corresponding Meade models (though a price war may be in the offing). Based on modest experience with other peoples' Meade LX-200s in the field, I suspect the LX-200 is more functional -- bigger databases, better software, better pointing accuracy, and more features. (I haven't seen an LX-90 yet, so have no opinion on that model.) Someone willing to wrestle with a heavier unit, or have it permanently mounted, might prefer an 8-inch LX-200 over a NexStar 8, but that someone isn't me -- I already have a Celestron 14 for pumping iron and practicing astronomy at the same time. I wanted a lightweight instrument with minimal setup time and effort, and that is exactly what the NexStar 8 provided.

Third, it looks like a cinch to modify the NexStar 8 mounting to hold other small telescopes. I am surprised Celestron doesn't offer the NexStar mount as a separate product, perhaps with a dovetail clamp or something similar. I think it would sell well.

Fourth, the software has problems that will puzzle those who do not understand them and annoy those who do. I don't think the problems are occur frequently enough to warrant not recommending the NexStar 8 to beginners, but Celestron's image is at stake here -- like it or not, the NexStars are going to be perceived as Celestron's main battle line, engaged broadside to broadside in a do-or-die gunnery duel with a fleet of Meade LX200s. Software isn't like optics -- you only have to get it right once, then you ship a zillion identical copies. Celestron *ought* to get it right.

Fifth, Celestron should upgrade their web site with a list of known bugs and work-arounds in the software, as well as with text discussing any frequently-asked questions or other matters that should have been in the manual but were omitted. If anyone at Celestron is reading my words, that person is probably thinking "We can't publicly admit problems with our product." Not to worry, most of your user community has been using personal computers for a decade or two by now. They already have cried all the tears they have to cry, about buggy software. Shucks, some of them probably get lonesome with no bugs to talk to.

In conclusion, I would certainly recommend a NexStar 8 to a beginning stargazer. I will also venture that a serious and experienced amateur astronomer will find the NexStar 8 to be a high point on the curve of optical performance versus portability. It is a very compact telescope with quick set-up time, that can easily be picked up and moved around, with an enormous aperture -- eight inches -- for that degree of portability. It has computer-controlled pointing ability that is fast and easy to use, and is more than accurate enough to be useful. For me, the NexStar 8 is a keeper. I will be using it a lot once the new paint job dries.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART IV

Jay Reynolds Freeman

MODIFICATIONS:

I bought the NexStar 8 partly to use the mount for other telescopes, and I wanted to repaint the tube. So after three nights' use I threw caution and the warranty to the winds, seized a 15-inch crescent wrench in one hand and a fist full of Allen drivers in the other, and advanced relentlessly on the cringing telescope.

It wasn't obvious how to get it apart. I took the plastic cover off the inside of the fork arm -- perhaps I could get at the OTA attachment screws then. No luck, and I damaged the head on a screw that that would have been nearly impossible to drill out. Yet brawn triumphed where brains had failed -- I finally freed the tormented fastener.

The way in was through the recess where the controller parks. With a 1/16-inch Allen driver, I removed three tiny screws that secure the plastic part containing the main controller hook. Underneath lay a thin hex nut -- 3/16 inch thick, but 1-1/4 inches across the flats. You thought I was kidding about that crescent wrench. The nut was aluminum, and had deformed during installation, so it tried to strip its threads as I unscrewed it. I chased the threads with a tap successfully before rethreading it, but if it had been beyond repair, 3/16-inch aluminum is a hardware store commodity. I could have made a new nut with a hack saw, file, drills, and a 1/2-20 tap.

That nut and its washer held the OTA to the fork arm. With them out of the way, and after a little wiggling to separate the gears that drive the altitude shaft, the tube came clear of the mounting.

Still attached to the OTA was a black metal bracket with a wide bearing surface for altitude motion. The bracket included the long, thin, black bar, visible in NexStar 8 ads, extending along the side of the tube up to the corrector. Between the bracket and the fork arm were a thin fiber washer, a big aluminum gear, and three thick plastic washers recessed into the gear surface. The plastic washers and the surfaces they bore against were heavily greased, while the fiber washer and its side of the gear were clean. I kept the clean stuff sparkling as I washed the greasy parts, and bagged gear and fiber washer separately. I cleaned and regreased everything when I got around to reassembling the mount.

The black metal bracket attached to the OTA with three screws. The one at the top took a 1/8-inch Allen driver; the other two needed a 3/32-inch one. The top hole bottomed out in metal, the others went through the OTA wall; if you take them out, use caution you don't get something into the tube, or damage the primary.

With those screws removed, the OTA sat ready to mask and paint; I will describe that process in a subsequent report. I bagged parts and put things away for a while, then considered what to do next.

What I wanted was an easy way to swap the original OTA with others, without disassembling the fork arm. I toyed with designs for a fancy additional bracket, permanently mounted on the black metal one, that could accept the NexStar OTA and would be drilled to attach other telescopes. Fortunately, I was too lazy to start building one, so I hadn't wasted any effort when I saw the light.

I mean that literally. With the plastic cover and plastic hook gizmo off, you can see through the fork arm. It is a rather open casting, with brackets, gears, and motors inside, but the internal parts don't block all the space. With the plastic pieces removed, it is easy to poke a long ball driver through the arm from outside, and turn the screws that hold the bottom OTA end to the black metal bracket. Those screws are all but impossible to reach with the plastic parts in place. (The screw at the front end of the OTA is easy to reach as is.)

I left the hook gizmo intact -- the hole through it that I would have had to drill is a in curved surface, which would be awkward to plug. I filed a semicircular cutout, half an inch or a bit less in diameter, in the upper edge of the plastic cover for the inside of the fork arm -- I can fit a piece of tape there. So I need to take the hook gizmo off to get at the lower screws.

The modification to the black bracket, to install other OTAs, was equally simple. That bracket resembles a clenched fist, with an extraordinarily long middle finger rudely extended. The holes to mount the NexStar 8 OTA are a 1/4-inch one through the middle finger nail, and smaller ones through the thumb and little finger sides of the heel of the hand. I drilled through and tapped 1/4-20 at the mid-point of the heel of the hand, where there is plenty of metal, hence minimum chance of weakening the bracket. That hole position clears the fixed portions of the mount, so if a screw protrudes a bit through it in the direction of the fork arm, it doesn't rub up against anything.

I made a jig for locating that hole. I drilled 1/4-inch through a piece of thin bar stock, then measured the position corresponding to the requisite hole in the black bracket, and made a pilot hole through the bar stock there. To drill the bracket, I secured the jig to it at the "finger nail" hole, with a 1/4-inch bolt, then put my drill through the pilot hole in the jig to make a matching pilot hole in the bracket.

Next I used the jig to lay out and drill 1/4-inch holes in several lengths of 1/4 by 1-inch aluminum extrusion, at the same distance apart as the holes in the bracket. Thus I can use 1/4-inch fasteners to attach these pieces of extrusion to the black bracket; they fit exactly. The lengths of extrusion run from the "finger tip" to the heel of the hand, and about six inches beyond -- I made them as long as possible in that direction, because I anticipated needing counterweights there.

These pieces of extrusion serve as adapters to tube rings, camera attach fittings, and so on. I drilled 1/4-inch holes through them in several places, countersunk for flat-head machine screws from the side of the extrusion that faces the bracket, to attach things to the adapters. I made another hole near the end of the adapter opposite the "finger tip", for attaching counterweights.

I got a five-pound lead ingot from a plumbing supply store, and cast two counterweights, one of about 3.7 pounds and the other of the rest of the ingot, in 5-1/2 ounce cat food cans. I melted the lead in the cans and left it there; the less contact with lead the better. The big weight nearly filled its can, so I cut a plywood disc to fit where the can top had been, sealed the lead surface with silicone adhesive, screwed the disc to the lead, caulked around the edges, drilled through for a 1/4-inch bolt, and painted the assembly. The small weight filled only about a centimeter of the can, so I snipped off most of the extra metal and hammered the jagged rim down on top of the lead, before proceeding with the wooden disc.

Suppose I want to mount my Vixen 70 mm f/8 fluorite on the modified mounting. I attach its tube rings to an adapter, then temporarily install the OTA in them, and play with counterweight size and OTA position till I get the assembly to balance at the altitude axis. Then I remove the OTA, to turn the screws that fasten the adapter to the black bracket. After the adapter is in place, I put the OTA back, at the position for correct balance. I have several other OTAs that will mount similarly. I could probably come up with a way to attach stuff that uses dovetail bars, but I don't happen to have any such equipment.

When I want to use the NexStar 8 OTA itself, I reverse the process to remove the Vixen 70, then remove the plastic cover from inside the controller parking well, to get at the lower attach points. The entire swap takes about five minutes.

The NexStar 8 OTA weighs ten or eleven pounds, so many interesting telescopes, like my Vixen fluorite refractors, or the small f/5 achromats that have become popular, should not overload the mount, even with counterweights. The OTA of my Vixen 70 mm fluorite weighs four pounds, and that of my Vixen 90 mm fluorite weighs six pounds. Some telescopes that are too long, or that weigh too much to counterweight, might balance with the eyepiece far enough aft to prevent observing near the zenith, but as Dobson users know, that is not really a big deal.

My first impressions of this modification are that it is very clean and will be very useful. I suspect I am about to retire several old, cranky, hand-operated altazimuth mounts.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART V

Jay Reynolds Freeman

PAINTING:

I know little about painting. Others, with greater knowledge and specialized equipment, can surely get better results refinishing telescopes. Yet many people have been amused by my oddly-colored instruments, so I thought I would tell how I dealt with this one.

The essence of painting seems to be cleanliness in general and surface preparation in particular. Paranoia about such matters formed the basis for my operations.

I was happy with the black finish on the NexStar 8 tube ends, but I wanted to repaint the gray part. I chose not to disassemble the OTA; I worked with optics installed. I taped the dust covers on and masked the black parts. Then I permanently sealed the cracks between tube wall and end fittings with red glazier's putty -- often used for auto body work. With a wet fingertip and a wooden shish-kebab skewer, I forced a tiny bead of putty into the cracks.

After it dried, I roughened the gray with 150 grit sandpaper, so new paint would stick. Sanding also got rid of smears of glazier's putty. I wiped the surface with a tack cloth, checked the masking, and sprayed on several coats of white primer -- Orchard Supply Hardware's house brand. I supported the tube horizontally with wooden v-blocks at the ends, and worked a section at a time, rotating the tube as I progressed.

I also painted an old tin can, for experiments. I put it in a warm part of my house, stashed the tube in the garage, and left them alone for a week, to dry.

The choice of white primer was made carefully. Paints are often somewhat transparent: Primer color affects appearance, even after many finish coats. I once sprayed horizontal stripes of several colors of primer on a test piece of cardboard, then overlaid them with vertical stripes of several finish colors, using two or three coats. Primer color made a noticeable difference in results. White primer made the light-colored finishes brighter and more intense.

I have trouble painting strongly curved surfaces, like telescope tubes, from spray cans. Enough paint for a smooth finish runs or sags on the slopes, so I use many light coats, which tend to give a matte surface, even with gloss enamel. This time, I wanted something shinier. So I used another hardware-store commodity, "No. 7" brand of white polishing compound. An hour with it and a wet rag got the primed surfaces acceptably smooth. The compound cleans up with water.

The color coat was a different kind of spray paint, that dried much more quickly than the primer. The recommended application was several light coats, a few minutes apart. That worked on my witness sample, but for the larger OTA, I painted more or less continuously for fifteen or twenty minutes, rotating the tube as before. By the time I worked around the tube, where I began was dry enough to recoat. After putting on four or five layers, I again set everything aside to dry thoroughly.

The weather was hot, so in a few days, I could spray on AerVoe clear acrylic, to improve gloss and protect the color. It went on like the color, and also dried quickly. On inspection, I found a place where I had not smoothed down the primer sufficiently, and had to repolish and touch up that area. After more time for drying, I very lightly applied white polishing compound, removed masking tape, and neatened the edge of the black with a magic marker, and also by using a hypodermic syringe to flow black ink into the crack where the black OTA end fittings mated to the orange OTA main tube. Then I waxed the paint with a liquid car wax, "Nu Wax", and was done!

You who have seen my pink and gold modified Brandon 94, or my goth-hued 10-inch truss-tube Dobson, or Refractor Red, will wonder what color the poor NexStar 8 is now. I gave a clue earlier. Out of respect for the classic Celestron 8, what used to be metallic gray is now red-orange -- fluorescent red-orange, one of Rustoleum's specialty paints. And it's bright! So when bunny-suited bureaucrats from atomic regulatory agencies show up, checking out reported violations of the nuclear test-ban treaty, tell them it's just me. And you'll need shades and sunblock when my NexStar 8 attends a star party.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART VI

Jay Reynolds Freeman

FURTHER NOTES FROM THE FIELD:

Since starting this report, I have had the NexStar 8 mount in the field on several nights, using my modifications to attach different OTAs. My first alternate was an excellent small refractor, a Vixen 70 mm f/8 fluorite doublet. It weights four pounds, so the mount can carry it and my four-pound counterweight, too. With the weight at the bottom of an aluminum-extrusion adapter, the OTA can slide far enough skyward so the eyepiece clears the mount at the zenith, and still be in balance.

This combination is light, portable, and fun. With it, I like a

Vixen 8-24 mm zoom eyepiece, with a field of view nearly two degrees across at 24 mm focal length, and most of the magnifications I need for deep-sky observing elsewhere in its range. I had a Herschel-400 survey under way with this telescope when I bought the NexStar. I had been using a good-quality hand-operated altazimuth mount, but it was awkward and annoying close to the zenith. The NexStar mount makes it easy; I can log scores of Herschel-400 objects in an evening without getting tired or vexed. I work that fast even though many of these objects are so faint in a 70 mm aperture, that I need charts even with computer pointing, to find out exactly where in the field to look for the target.

Computer control was particularly useful at a recent educational event. I was at Lick Observatory, helping as a docent with a college class that had come up for a tour. The class was small, so there was plenty of time for staff astronomer Elinor Gates to show us half a dozen objects with the 36-inch refractor. Alas, it cannot work close to the horizon, so that night, we couldn't look at the Moon or any bright planets: They were all too low when the group was there.

People wanted to see the bright stuff, so I set the NexStar / Vixen 70 up west of Lick's main building in early twilight, aligned as soon as I could see two stars, and picked up Jupiter, Mercury, and Saturn low in the west. Jupiter was obvious, and Mercury was visible to the naked eye if you knew where to look, but Saturn was so low I could not see it at all, even in Lick's clear sky. The NexStar found it easily. The tour had to leave by midnight, and Mars wasn't high enough for the 36-inch by then, so I moved my setup around the building to view its tawny disc. Even with just 70 mm and 70x, we could see markings. The Moon rose about then, so I swung the telescope to it and showed craters while Luna was still orange from horizon obscuration. It's not often that a tiny telescope can compete with a Great Refractor twelve times its aperture, but those students were really glad to see the Moon and planets.

The lightweight tripod that came with my NexStar 8 -- newer models ship with a heavier one -- continues to be adequate. The secret to using it is to install the accessory tray, tighten everything down, be sure the legs are fully spread, to take up any remaining slop in their joints, and avoid touching the mount. I observed with the 70 mm OTA one evening, in a 20-knot breeze, from the lee of my car, and was not bothered by wind. I had a set of Celestron's excellent vibration dampers with me, but forgot to use them, and did not miss them.

I have adapted three more OTAS to the NexStar, but have tried only two in the field so far. My Vixen 55 mm f/8 fluorite, Refractor Red, points at the zenith in balance, with no counterweight, and looks really cute on the mount. My Vixen 90 mm f/9 fluorite weighs six pounds, so a counterweight for it might overload things. I will use it for objects less high than the zenith. My Intes 150 mm Maksutov-Cassegrain weighs as much as the NexStar 8, so I don't counterweight it, and it won't reach the zenith, either; I am still playing with extension tubes and star diagonals, but at the moment, it hits the mount at elevations higher than 60 to 65 degrees.

As many people have suggested, it helps to minimize pointing error if you know that when the software asks you to level the tube, what it needs is the telescope optical axis set at right angles to the azimuth axis. I haven't gotten around to making reference marks to help with this operation, but I can often eyeball it accurately enough to reduce average pointing error below ten arc minutes. Celestron should rewrite their manuals and software prompts to tell users what the system really wants, and ship telescopes with reference marks in place.

Furthermore, though I do not have enough experience to be sure yet, I think I have figured out a bit more about NexStar pointing errors. To begin with, I seem to get more satisfactory alignment -- less pointing error when finding objects -- when I align by the two-star method, instead of using the default full alignment. Perhaps that wouldn't be so if I entered latitude and longitude with high precision, and took great care to level the drive base when I set up, but the two-star method is quick and easy, so I have little cause to use the default.

I have also noticed that after centering an object and pressing "align", the drive stops for five or ten seconds while the NexStar tells you alignment is satisfactory and asks you to turn off the star pointer. I think rotation of the Earth during that interval is not accounted for: The telescope does not immediately recenter the object aligned on, which drifts during the no-drive period. Drift during (say) ten seconds with drive off is at most 2.5 minutes of arc, but NexStar pointing is too sloppy to afford losing even this small increment of accuracy. I help deal with the problem by using Polaris as one alignment star; it drifts very little...

I suspect that more secrets remain, to getting around the software deficiencies of this otherwise pleasant little mount. For example, as presently equipped, with the new finder discussed below, my NexStar 8 OTA balances slightly tail-heavy on the mount, and it doesn't seem to drive as accurately that way as it did before I added the weight aft. I intend to check that out.

I bought a DC / DC adapter, that plugged into an cigarette lighter fixture and provided user-selectable polarity and output in the range 1.5 to 12 volts, with a whole lot of different output plugs ganged together. That let the NexStar work with several different lead/acid batteries I regularly use, but the adapter died a smelly electrical death after only a few uses. A simple plug-and-cord works just as well, but I did not happen to have one with the right polarity. I do now.

I have long thought that unit-magnification finders are worthless junk, so I bought a finder bracket for the NexStar 8. I have an old Parks 8x50 finder which takes 1.25-inch parts; it has enough focus travel for an Amici 90-degree diagonal, which gives an unreversed view, like star charts. Normally I prefer straight-through finders (which also do not reverse the view), so I can keep both eyes open and use the finder as a reflex sight, to find the start point of a star-hop. But the NexStar points well enough to put things in an 8x50's field of view, so I will forgo reflex for comfort. I use the finder when I want more than minimum magnification on the main telescope, so as not to take time to swap eyepieces, for the NexStar cannot get an object into a field much smaller than a low-magnification view.

It works very well -- matching the view on my charts with the views through a non-reversing finder is easy. The drill is to look up the chart pages while the NexStar is slewing, find how the object sits in a recognizable pattern of stars, then step to the finder and use the pattern to center the object. I spent part of one night handily finding and separating double stars down to about 8th magnitude, while an eight-day Moon restricted naked-eye limiting magnitude to three or four. There were plenty of stars visible in the finder field, but getting the finder pointed to the right field by star-hopping would have been very difficult in such a bright sky.

I bought JMI's hard case for the NexStar 8; it is expensive, but the grab-and-go virtue of such a telescope is compromised if you have to fuss and baby an exposed OTA for transport. The case has space enough for many accessories, too.

I may make more reports as I learn more about the NexStar 8, but that is probably all for a while. The bottom line is that the NexStar 8 mount, despite vexing software problems, is a versatile and lightweight computer-driven mounting, and that the Schmidt-Cassegrain optics in my particular NexStar 8 are very good.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART VII

Jay Reynolds Freeman

FURTHER MODIFICATIONS AND DISSECTION:

A session or two with the modifications showed that the new, heavy, finder was causing a balance problem. I think I can explain without ASCII graphics.

Imagine a NexStar 8 set up in altazimuth mode, pointed straight up. You are looking down on it from the zenith. You see a round circle, the front of the OTA, with the fork arm off to one side of it -- let's say the right side, for the sake of argument -- at 3 o'clock from the center of the OTA. Thus the altitude axis runs from 9 o'clock to 3 o'clock, directly through the centers of OTA and fork arm.

The problem was, that as originally installed, in that view, the finder did not line up with the altitude axis. The rather long finder bracket stuck off from the tube toward 10:30, putting the two-pound finder almost six inches toward 12:00 from the altitude axis. The OTA was out of balance from the weight of the finder, increasingly so the higher it pointed. The tube wanted to tip over backward. The NexStar drive system was not happy -- someone mentioned in EMail that the NexStar will drive correctly only when nose-heavy -- the drive system counts on nose-heaviness to take out slack in the gear train. On the basis of my experience, I believe it.

I thought about adding counterweights, but was reluctant further to overload the mount. So I decided to move the finder to 9:00 on the tube, directly opposite the fork arm; that would eliminate most of the top-heavy moment. It would leave a little, because the longitudinal position of the finder center of gravity is a bit aft of the altitude axis, so I might have to put in a counterweight even then, but it would be smaller and could attach to the upper end of the black metal bracket that holds the OTA to the mount, instead of at a kitty-corner position.

I demounted the OTA and set about drilling new holes in the bottom casting. First I twirled the focuser to move the primary mirror full aft, well clear of the new holes. To keep debris off the optics, I pulled the corrector plate and secondary. (I was careful to mark the positions of everything as I went along, so I could get things back together in correct alignment -- I also noticed that the corrector was centered in its cell with shims of cork and paper of varying thickness, and kept track of where the thick and thin shims were.) Then I reached down inside the tube and used masking tape to fasten a few layers of surgical gauze -- in essence, coarse cheesecloth -- inside the tube, at the position where the drill would break through.

I set the tube corrector end down, so escaping chips would fall toward the open front end, and drilled cautiously, using a hand drill, starting with 1/16-inch holes and stepping them up in small increments to the no. 29 drill size required for tapping 8-32 threads. The gauze did a fine job trapping chips, though I had to smooth it occasionally, when the tip of a drill twisted it. Tapping was uneventful, as was reinstalling the corrector, and when I had the telescope operational again, it was still in collimation, in much better shape than my nerves.

I had another problem in mechanical reassembly. When reattaching the OTA to the mount, one of the aft screws, that hold it to the black metal bracket, fell inside the fork arm and shorted wiring near the on/off switch. I had the switch turned off, but had not been smart enough to remove the batteries, and the short was on the hot side of the switch, between power and ground. That was harmless to the telescope control electronics, but it did burn out a rectifier diode installed to protect the batteries from reverse current flow when the external power voltage exceeds the battery voltage.

I live a short walk from a good electronics supply store, so it was easy to replace the diode. However, I noticed that the wiring near of the switch was poorly done. Several wires route from that area to the batteries or to the main circuit board, and they are deliberately made longer than necessary, for ease of assembling the drive base. The extra lengths of wire get stuffed back in the switch area when assembly is complete, and there were no terminals there to help keep them apart. In particular, the wires that came off the positive and negative sides of the external power plug were free to move, and might well have shorted of their own accord due to vibration or to the telescope turning this way and that during transportation and setup. I improved things a little bit with shrink tubing and tape, but this area of construction is shoddy, and other NexStar 8 owners may well encounter problems with it.

The good news is that with the finder moved, the telescope required no counterweight. There was enough built-in nose-heaviness to handle the aft center of gravity of the finder.

The finder is handier in its new position than in the old one. Its eyepiece is seven or eight inches right of the main telescope eyepiece, and stays almost exactly at the height of the main eyepiece. That makes it easy to switch between finder and main eyepiece when I am seated -- I don't have to get up or stretch to do so. And there is enough space between the two eyepieces that I do not touch or jiggle the main telescope when using the finder.

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A DEEP-SKY WEASEL BUYS A CYBERSCOPE -- PART VIII

Jay Reynolds Freeman

FIXING THE TRIPOD:

Recurring looseness in my NexStar 8 tripod prompted a fix. The tripod is the early model, with telescoping legs made of lengths of satin-finish aluminum extrusion. I believe similar tripods are used for other telescopes, not only Celestron's but also other brands.

Each telescoping leg uses three lengths of aluminum extrusion. Two lengths, spaced a little apart, form the upper part of the leg, which is attached to the tripod head. The third length slides between the first two. The extrusions are shaped to guide the sliding piece.

Each upper extrusion has an end fitting which fits into its top end, that is pierced for a long bolt. The bolt goes through one end fitting, the tripod head, and the other end fitting, to a washer and acorn nut.

The problem is that the end fittings are plastic, and are fastened in place with little sheet-metal screws that grip poorly. The screws loosen up easily, and after being retightened a few times, the inside surface of the plastic holes becomes too scuffed for them to take hold.

Briefly, the fix was to replace the sheet metal screws with machine screws and T-nuts. A T-nut is a thin-walled metal cylinder, threaded on the inside, with a flange at one end. Seen from the side, it resembles a letter "T" with a very thick vertical stem -- the cylinder. T-nuts are available in hardware stores in many sizes.

Size 6-32 T-nuts had outer diameters slightly larger than the holes in the plastic end fittings. There was enough extra plastic so that I felt comfortable enlarging the holes, but I worked carefully, in small increments, inserting drill bits in a hand drill and twisting the chuck by hand. The plastic was so soft that using a power drill, or even cranking the handle of a hand-powered unit, might have risked cracking or melting the material, or having the bit not follow the existing hole. To fit the T-nuts I used, I bored out the holes from their original diameter of about 1/8 inch to 13/64 inch, and then counterbored the inside end of the hole about 1/8 inch deep, using a 7/32 inch drill. The counterbore was because the T-nut barrels tapered slightly.

The T-nuts I used were 1/4 inch long. A length of 3/8 inch might have worked, or might have been a hair too long. The T-nuts had four barbs sticking down from the flange, parallel to the barrel. They were intended for use in wood or similar material to keep the nut from rotating in place. By coincidence, the barbs were placed just right to fit the inside of the plastic end fittings. I did not have to modify the barbs or flatten them out.

I inserted the T-nuts from the inside of the end fittings, then reattached the end fittings to the extrusions using 6-32 x 1/2-inch round-headed machine screws, with a star washer and a flat washer between the screw head and the extrusion. With the screws tight, and the bolts that attach the end fittings to the tripod head snug, the tripod was a lot more rigid.