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Evolution of an Observatory Project

From Roll-Off and Fork Mount to SkyShed POD and GEM

By Max Corneau

This is the story of my personal observatory, a project spawned from a vision to build a roll-off observatory at my astronomy club's dark-sky site. What started as "The Roll-Off Project" with a fork mounted LX200 telescope, ended up instead as a SkyShed POD with a German Equatorial mount. As the story unfolds, you may learn firsthand about several heretofore-unknown secrets of the SkyShed POD and hopefully gain a better appreciation of the requirements for observatory construction and the trade-space compromises required for telescopes of various focal lengths.

Start With the End in Mind

Before embarking on any project, especially a technical construction effort, one of the best practices is to precisely define the requirement, or said another way, what you want the system to accomplish. My desired end state for my first observatory was to permanently mount my ten-inch LX200 along with a second telescope that would enable deep-sky narrow-field and wide-field imaging and science.

Site Selection: The Pad

In 2003, I joined the Texas Astronomical Society of Dallas (TAS). Besides a cadre of over 500 members and a history that dates back more than 85 years, the crown jewel of TAS is its 40-acre dark-sky site in southeastern Oklahoma. When a group of visionary TAS leaders purchased the property a quarter century ago, they set aside a significant quantity of land for members to lease and develop their own observatories. The concept was and remains today, to use the lease fees to offset the cost of operating the dark-sky site.

Knowing fully that I wanted to build a facility that would support at least my 10-inch Meade LX200 GPS telescope and allow me and one of my children to sleep inside after observing sessions, I leased one of the club's 20-foot by 20-foot pads. Site selection criteria included elevation, location on the site and proximity to the site's WiFi access point. The only available site meeting my criteria was an uncompleted, abandoned roll-off shed on a 4-inch thick concrete slab with a 31-inch diameter central hole for a pier.

The construction project actually commenced as a demolition project as I had to remove the unusable but substantial structure that was already bolted to the site pad. Throughout time, fathers and daughters have bonded in many ways. My daughter, AstroGirl, had a blast with power tools and banging things as we cut, ripped, and otherwise destroyed the unfinished structure to make room for the future roll-off. At the beginning of the day it looked like someone's old, overgrown shed.

The Line of Truth

Immediately after demolition, as part of site preparation, I laid a true-north line. As a matter of full disclosure, I spent nearly

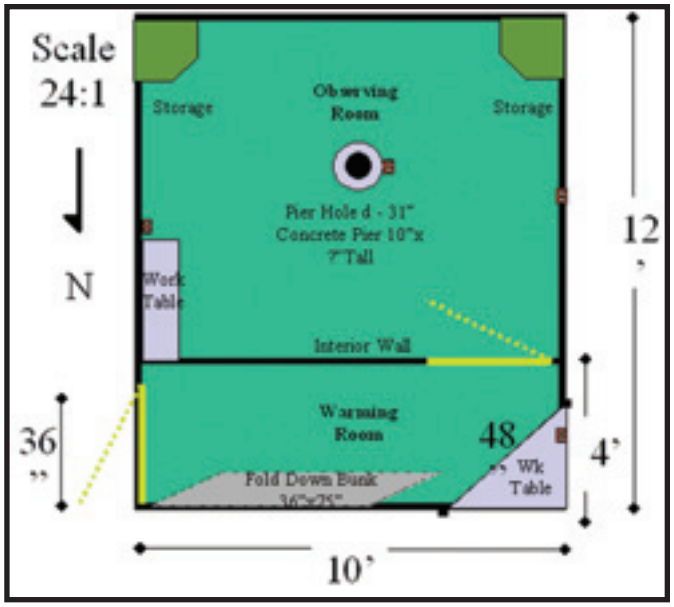

Figure 1. Original Roll-Off Observatory Layout

Figure 2. Demolishing the Old Structure Day One

Figure 3. AstroDad and AstroGirl After Demolishing the Old Structure

a year in Washington DC where, in my spare time, I observed and led tours at the U. S. Naval Observatory (USNO) for the greatest public affairs officer in the U. S. Navy, Mr. Geoff Chester. Geoff is a friend and the great grandson of a previous Superintendent of the USNO, Rear Admiral Colby Chester, so he is truly at home at the USNO. The point to this digression is that at USNO I learned to appreciate the practical nature of astronomy and the various tools used to measure time, distance, and location to extremely high degrees of accuracy.

After some deliberation I conceived of using the Solar Transit method to determine the local true north line, referred to as the "line of truth" for the remainder of this story. Simplicity is beautiful when it works and laying the line of truth was a beautiful thing.

With the help of friend, HubbleJim, and AstroGirl, we erected a ladder on the south side of my slab, propped it at a 60 degree angle using 2x4s, hung a plumb bob from one of the upper ladder rungs, and adjusted everything so the shadow fell across the pier hole. HubbleJim admitted later that he thought I was a bit "touched" until he saw the chalk line appear. My daughter ably manned the chalk line as I dialed my cell phone to the speed dial entry labeled "Time Hack" on my cell phone. The number, (202)762-1401, accesses the USNO master clock time. I laid the phone down on the concrete as AstroGirl aligned the chalk to the shadow. When I announced "snap" at the precise moment of solar transit, she snapped the chalk line beneath the shadow of the line of truth. We later replaced the chalk line with outstretched twine and spray painted it in place. The resulting line of truth is dead-on!

Designing the Roll-Off

To this day, the page on my website devoted to my observatory is titled "Roll-Off Project" because a roll-off observatory was my initial vision. After reviewing several designs, I decided to purchase the plans to

Image 4. HubbleJim and AstroGirl after Laying the Line of Truth

build a SkyShed out of wood and make it look very nice with the planter boxes and shutter options. Walking around the dark site one day with a long-time TAS member, a single word profoundly changed the direction of this project.

This old salt who owns an observatory himself, casually suggested that the SkyShed plans supported a proven observatory that would allow me to build out of metal as easily as wood. I stopped dead in my tracks – actually in the tall, itchy grass – and asked why anyone should consider metal construction. His one word answer spoke volumes then and continues to repeat its wisdom today. "Critters" he said. Presently, Barry's observatory is out of commission, awaiting repairs because the critters ate through the telescope control wiring in the main control room.

Critters

The 100-minute drive from the TAS dark site to my home near Dallas allows for considerable contemplation. On this particular ride home, one word kept echoing through my head: "Critters." After learning that the price of metal construction exceeded my budget, I began to question the entire project. Nearly on a lark, I followed a link on the SkyShed page to their SkyShed POD (POD is the acronym for Personal Observatory Dome) site. The systems engineer in me approached this project as a requirements-driven effort from day one.

Image 5. Pier Hole Substructure with Conduit and "Pier Roots" Sticking Straight Up

Soon I found that the largest SkyShed POD, the five-bay XL-5 option, would support all of the major requirements of size, system compatibility, and sleeping. Indeed, the POD stirred lots of interest in the amateur community due to claims of evolutionary design, low cost, and high-quality, proven material. After "running the numbers," I announced to my wife that my plans had changed and that the SkyShed POD was the way to go. The unique qualities of the High-Density Polyethylene (HDPE) construction of the POD answered my new concerns regarding critter invasions, plus offered other peculiar benefits in this application, as you will soon see.

Enter the POD

Though not one to fear spending money on astronomy gear, I undertook a day of research and sent out a flurry of inquiries to POD owners before ordering my own SkyShed POD XL-5. In the process of ordering, I recognized that the very large shipment far exceeded what my minvan could transport and ran into a bump in the road.

Enter my pal and fellow TAS member HubbleJim. HubbleJim actually spent a couple decades managing systems and programs on the Hubble Space Telescope for the prime contractor. After a happy career, he retired from the city life and, in a true case of life imitating art in the form of the Green Acres sitcom of the 1960s, Jim bought a farm. One of the added

benefits of HubbleJim's farm is that it is located less than two miles from our club's dark site.

After a quick phone call, HubbleJim agreed to have his farm be the shipping destination for the POD. Little did I know that Mrs. HubbleJim would be the one to download the boxes from the UPS truck because Jim had been called back out of retirement to Colorado to fix a problem with the WFPC-3. I make it a point to still bow in the presence of this fine lady and am eternally grateful to her for receiving my POD shipment.

The POD's on-schedule arrival induced a nearly biblical flood of rain in southeast Oklahoma. Due to work schedules, the boxes sat on HubbleJim's trailer for several weeks getting soaked and breaking down. Ultimately, the dome lost some of its shape due to improper handling on my part as it sat on the trailer in collapsed boxes. Wayne Parker, owner of SkyShed, assured me that the inherent memory characteristics of the POD's HDPE material would cause the dome to return to its original shape and he was absolutely correct. As soon as the Oklahoma sunshine hit the dome in earnest, it did exactly that.

Image 6. The POD Field, HubbleJim's Trailer and Our Instructional Viewing Theater (My Minivan)

Digging Holes, Rebar, Concrete, the Pier and Plate

The concrete pad I leased from the club was in great condition and already had a 31-inch diameter central hole to ground that facilitated digging a deep hole in which to build an isolated pier. Rather than spend $400-$500 on a metal pier that would attach to the ground, I built the pier in three sections: (1) lower mushroom and "stool legs," (2) mid-mushroom and the concrete pier, and (3) the upper or finishing surface.

Here's some advice: when digging such holes, find the biggest, best power tools available and avail yourself of the technology. I rented a 13-horsepower hydraulic auger with 12-inch and 4-inch bits and had a heyday chumming through the thick alluvial clay that dominates southeast Oklahoma. My intent was to build the inverted mushroom four feet below ground, but I ran into a pre-existing concrete base that someone obviously had already placed as a would-be pier base.

In response, I dug around the base and then dug four "stool legs" at 60-degree angles to the base down to a depth of four feet. The rebar infrastructure tied into the existing pier base-plate and then I tied that into each of the stool legs with 3/8-inch rebar. At this point, I filled the base with concrete and had four rebar "roots" sticking straight up that would form the base of the rebar in the pier.

Putting It All Together on a Cold Day

Besides being a "Good-News Story," my POD adventure is also somewhat of a comical adventure. Picture a couple of rocket scientists all geared up and ready to assemble a new high-tech observatory the first week of December, 2007. Computer simulations were used to place the POD precisely with respect to the pier – literally no detail was overlooked in assembling the POD.

Unfortunately, the rocket scientists didn't have a hard copy of the assembly instructions, nor did they have a compatible DVD player to view the ultra high-tech step-by-step assembly video. Fortunately for our comedy team, Astro-Dad's minivan provided an onboard DVD player, so we could all huddle in the van to figure out what to do next. In addition to HubbleJim, my pal Jordan was invaluable with his fundamental wisdom in helping assemble the POD on this cold day.

All kidding aside, assembling the POD is simple and straightforward. Few tools are required, video instructions provide "pointy-talkie" instructions, and there's really no heavy lifting required. My only remaining wish is that, rather than saving his customers a few bucks by not printing an instruction manual, Wayne and his folks provide an abbreviated set of assembly instructions. Indeed, I'm told that Wayne and his team will soon be doing just that and are already at work on a manual that integrates screen shots from the DVD with detailed text instructions.

LX200 in the POD: Shake Rattle and Roll

One week after assembling the POD, I hoisted my Meade 10-inch LX200 GPS onto the custom-built Milburn Pier top head-plate that was bolted to the j-bolts now part of the concrete pier. Ken Milburn builds some of the most solid and finest quality hardware in the business and he custom-built a matching head plate to secure my Milburn Wedge to the pier. Fortunately, the head plate was absolutely level and equally as true to north. Perhaps I over-engineered the level and directional accuracies, because the Wedge has adjustments for error, but in my book, there is no such thing as too level or too true to north.

On December 16-17 the observatory and scope saw first light. My goals were simple: align, polar align, and drift align, and then lock it all down. Despite a bone-chilling 25-degree night, all the goals were achieved and the scope was readied for imaging. Note in **Image 7** that there appears to be considerable fog in the picture. Actually, this phenomenon occurred shortly after I removed my gloves to shoot the picture, because my hands warmed the surrounding air and produced a localized fog.

Like a fine lady in waiting, the POD sat patiently on the observing field in Oklahoma until January 13-14, 2008, when I returned to spend my first night

imaging and sleeping in the POD. I slept well, but the imaging part left a lot to be desired. This event foreshadowed the next several months of "fighting the forks" of my LX200. Although the 10-inch model is the size around which the entire LX200 line was designed, the forks and long focal length are considerably less forgiving than my 600-mm refractor on a German Equatorial mount.

After countless attempts at autoguiding, I coined the term "shake-rattle-roll" to describe the absolutely stochastic behavior of guide stars in both my SBIG ST2000 and PHD guide windows. In short order I began to notice the RA slipping occasionally. Armed with this pearl of wisdom, my assessment was that the RA-set worm gear had become loose and was no longer in constant contact with the drive gear. After an initial and successful attempt at tightening the worm, my Meade guide and I managed to slam the LX200 so hard against the hard stop that it snapped it and short-circuited the main board. That was the final straw that when broken, caused me to look seriously at mounting my LX200 on a GEM.

Secrets of the POD

Before taking you to the final chapter of this story, it's most appropriate to share with you what I call "The Secrets of the POD." What kind of secrets could possibly be sequestered in this equipment? In no particular order, here are some I've discovered.

Have you ever seen those sound collector dishes the networks use at sporting events that enable broadcasters to eavesdrop on huddles or on-field action? Those little parabolas are at most 24-inches and seem to work pretty well. Try being at the focus of a 7.5-foot half-dome sound collector such as this.

Not only is this sound collector perfectly aligned for ground line of sight collection, but it rotates easily through 360-degrees of motion. I now know who has been saying what about me and my "playground equipment." Ha! Conversely, as one of my pals pointed out, the dome creates an excellent "band shell" that reflects the cosmic sounds produced from within by my Sirius satellite radio. On cold, windy nights, or just plain-old clear, windy nights, I simply rotate the dome to block the half of the sky from which the wind is driving and life is good.

Perhaps the most striking fact from the dominion of PODs is a function of geometric perspective. To the person,

Image 7. First Light and 25 Degrees during the Second Week of December

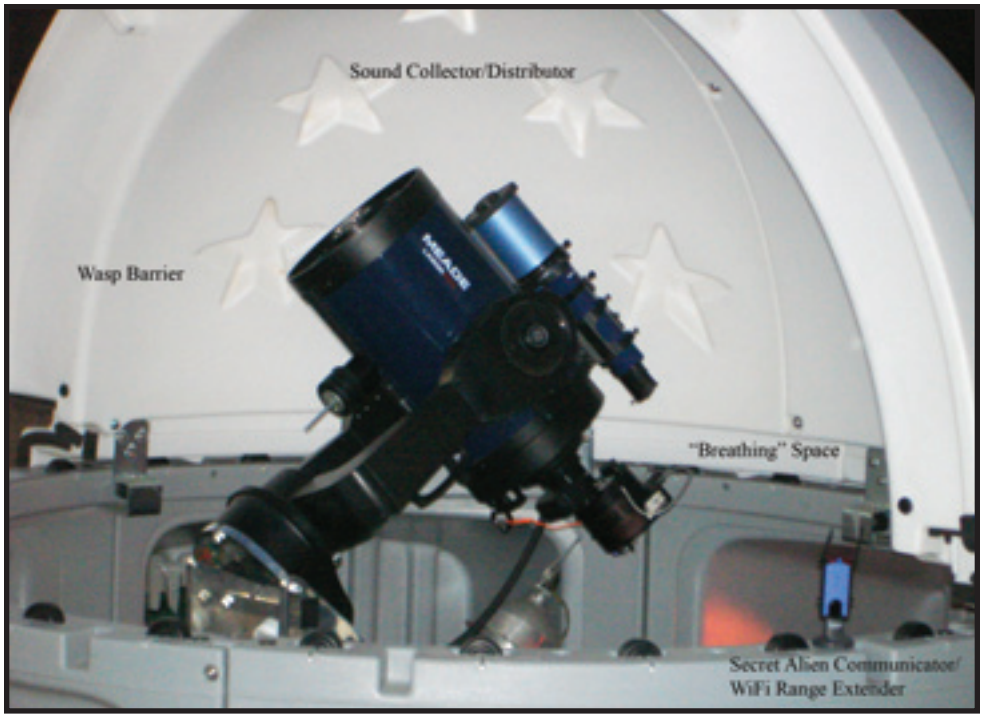

Image 8. The POD Dome as Sound Collector, Band Shell, Anti-Wasp Barrier and More…

everyone who has ever come into the POD or even visited from the outside has remarked, "It's so much bigger inside than it looks from outside!" And yes, they usually make this an exclamatory statement. I thought about this fact and it makes perfect logical sense that most people sense this same thing. You see, from outside the POD, one can only see a maximum of three POD bays. However, from inside, one is surrounded by every bay and all the free space they provide. Hence, the POD is "so much bigger" when viewed from inside.

Here's another quirky secret: The plastic material used in the POD is an unfavorable medium for the notorious Oklahoma wasps to attach a nest. As the TAS Observatory Steward, I'm constantly battling new wasp nests during spring and summer at our site in Oklahoma. However, I have yet to see even a hint of a wasp or hornet's nest attached to my POD. Others have reported that the HDPE surface of the POD is "self-cleaning," in recognition that, as with wasp-nest anchors, dust and debris do not adhere well to it and any that do are washed away by occasional rain.

Yet another secret: Many amateur observatories, especially those far away from their urban dwelling operators, suffer from moisture and mildew issues with equipment and optics. Mildew can destroy precision optical systems. But, the POD does not suffer from moisture issues because it "breathes" from around the base of the dome through a 1.5-inch gap between the dome and base.

The unique design of the POD offers still more benefits. On really cold nights, I fire up a little space heater and aim heat at my feet and legs without impacting imaging. Finally, the POD maintains an exceedingly high "cool-factor" that embodies the best of an open sky roll-off and the astro-coolness of a dome.

The Decision Point: Knives, Spoons, and No Forks

As stated earlier, when I removed the LX200 from the POD my intent was to tighten up the RA worm and then reinstall the entire system. Unfortunately, we did more damage than repair, so once again, my initial vision was corrected.

EQ-6 Pro Mount - Since 2006, I have owned a SkyWatcher Pro EQ-6 mount and the same brand of ED-80 refractor. The mount is tremendously overmatched to the refractor, however I have successfully imaged with this setup in winds exceeding 35mph. In the back of my mind, I always thought I "might-could" dismount the f/6.3 10-inch Meade OTA from its forks and mount the tube on the EQ-6 Pro and have an excellent astro-photographic plat-

Image 9. Mount Mate Adapter Secured to Milburn Pier Top Plate that Attaches to the EQ-6 Mount Mate. The Losmandy Dovetail and ADM Saddle Plate Are Also Integral to the Mount.

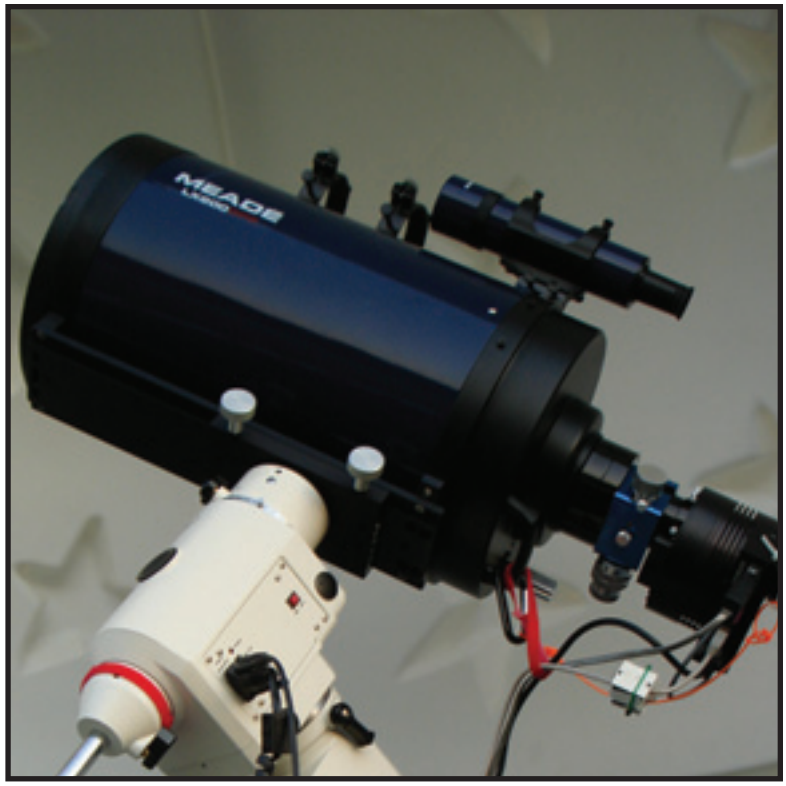

Image 10. LX200 10-inch OTA with Losmandy Dovetail, ADM Saddle on the EQ-6, and Moonlight Focuser during Transitional Period

form. Brief analysis indicated that, meeting my own requirements for such a rig, would necessitate an extensive list of adapters, balancing, and mount improvements.

EQ-6 Pro Mount Mate and Adapter from Telescope Stability Systems - Earlier in this story I commented about the high quality of Ken Milburn's work. Tim Ray, owner of Telescope Stability Systems (TSS) also produces incredibly high-quality equipment to improve or adapt telescope mount systems. Most of Tim's products relate to the Orion Sirius/Atlas line or the EQ-5/6 line. For my needs, Tim produced his first powder coated white Mount Mate Adapter that attaches to the Milburn pier top plate. Additionally, Tim sold me an identically matched Mount Mate that attaches to the EQ-6 Pro and then secures to the Mount Mate Adapter.

ADM Saddle and Losmandy Dovetail - Tim Ray notes that the EQ-6/Atlas mounts generally have three weak areas: (1) the tripod to head attachment, (2) the counterweight shaft, and (3) the saddle plate. Attaching my mount to the pier top plate using Tim's Mount Mate system mitigated one of these weaknesses. To eliminate the second, I substituted the "stock" saddle plate with an ADM saddle plate. Installing this unit required me to fit the underside of my 10-inch LX200 OTA with a Losmandy dovetail plate. The newly integrated system is absolutely rock solid.

Shooting for the Moon with a Focuser - Unfortunately, removing the OTA from the LX200 forks eliminated the ability to use the Meade electronic focuser. Although the 10-inch LX200 does not suffer from extremes of either mirror flop or image shift, the single-speed "mirror jack screw" is hardly an ideal solution for astrophotography. My choice for a new focuser after assessing price, performance, availability, and of course aesthetic appeal, was a Moonlight CS-2. Although this class of focuser is not inexpensive, the actions are so smooth that one is apt to gratuitously focus or rotate the image.

Pier Plate Conversion - The first time I hoisted this new EQ-6, LX200, Moonlight system enabled by Tim Ray's Mount Mate, ADM and Losmandy devices, it was late on a Friday night immediately following one of the TAS general meetings. Since I'm the Vice President, responsible for programs, it's somewhat incumbent upon me to actually show up for the program portion of the meeting.

On nights like October 31, when we hosted Drs. Bob Jedicke and Will Burgett from Pan-STARRS in Hawaii, I even had to show up for dinner beforehand. After Bob's wonderful program on Pan-STARRS's NEO detection mission, I bolted from the University of Texas at Dallas campus with the telescope system in my car and put it all together at the POD. The integration effort began at about 10:30 p.m., and the only issue was that, as I suspected, the Milburn plate attachment holes did not match all the TSS Mount Mate holes. However I matched two of three holes and was able to carefully fire up the scope, polar align and run through a variety of go-tos.

Image 11. M81 at f/42 Using the LX200 with a Takahashi 0.67 Reducer/Flattener

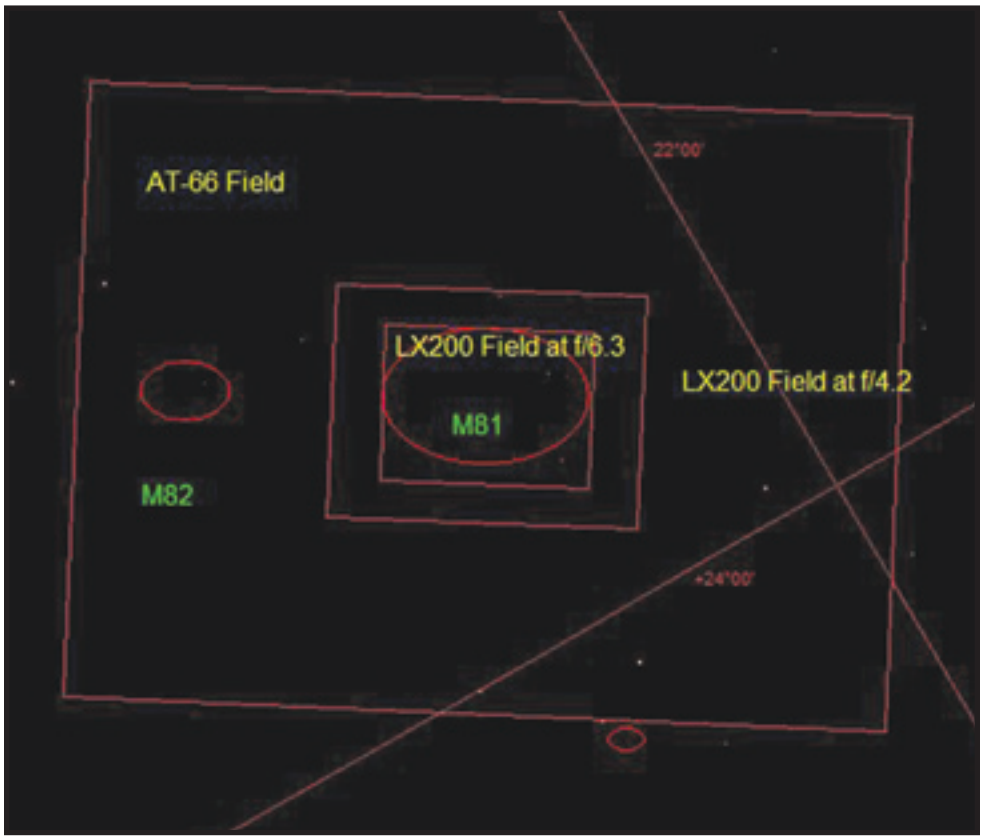

Image 12. Various Fields of View with the Instruments in My POD

The next morning, I got an early start with every intention of driving to Shawnee, OK, to pick up a new portable EQ mount for home use. Unfortunately, the night before on the ride into the dark site, I must have hit a hazard and had a tire blow out. Since everything indeed happens for a reason, in my quest for a tire shop, I found an outstanding metal shop just down the road from our dark site and had a new hole bored through the Milburn pier top plate to perfectly match the EQ-6 to its new pier mount.

Achieving the Desired End State

For several months I searched for a lightweight, refractor of 60 mm or so of aperture to piggyback on the LX200. This scope would serve double duty as both a guide scope and a wide-field imager. Given these requirements, my ultimate choice was an Astro-Tech AT-66 ED refractor with a dual-speed, rotating focuser.

One of the smartest features of the AT-66 setup is the ring set sold by Astronomics. The rings mount to the standard LX200 finder scope attachment points without modification and are rock-solid. The 400-mm focal length AT-66 will be a very forgiving instrument for astrophotography. The true test of how well the mount works emerged from the LX200. I'm pleased with the first galactic image from the LX200 shown in **Image 11**. For a full resolution version, please see http://www.geocities.com/astrodad32/M81_LRGB30ea_ddp_proc_ano.jpg.

Applying requirements to achieve a desired objective works only if one abides by the appropriate restrictions and boundary conditions. Most of us are restricted by cost and a variety of other factors. The most critical restriction facing this system in its final evolution is weight. Most mount manufacturers hesitate to quantify a maximum load for astrophotography purposes. This is because factors such as

balance, focal length, type of guiding applied, and moments of inertia all vary widely and greatly impact any mount's operational capabilities. My self-imposed maximum load on the EQ-6 is 40 pounds and the whole rig, including my SBIG ST2000XM with CFW-8, weighs almost exactly that.

Extending the M81 example, let's examine the instruments in the POD and their field of view. Once again, a picture is worth a thousand words and **Image 12** sums up the practical field of view quite well. Consider the canonical galaxy grouping of M81 and M82, so inviting in common 12-inch and larger short focal length Newtonian telescopes. The system in my POD makes handy work of either the pair in wide-field or a detailed, individual galactic examination.

My first observatory project has been successful to this point as it is both aesthetically pleasing and achieves the objectives I originally prescribed. I'm smiling all the way…ATT

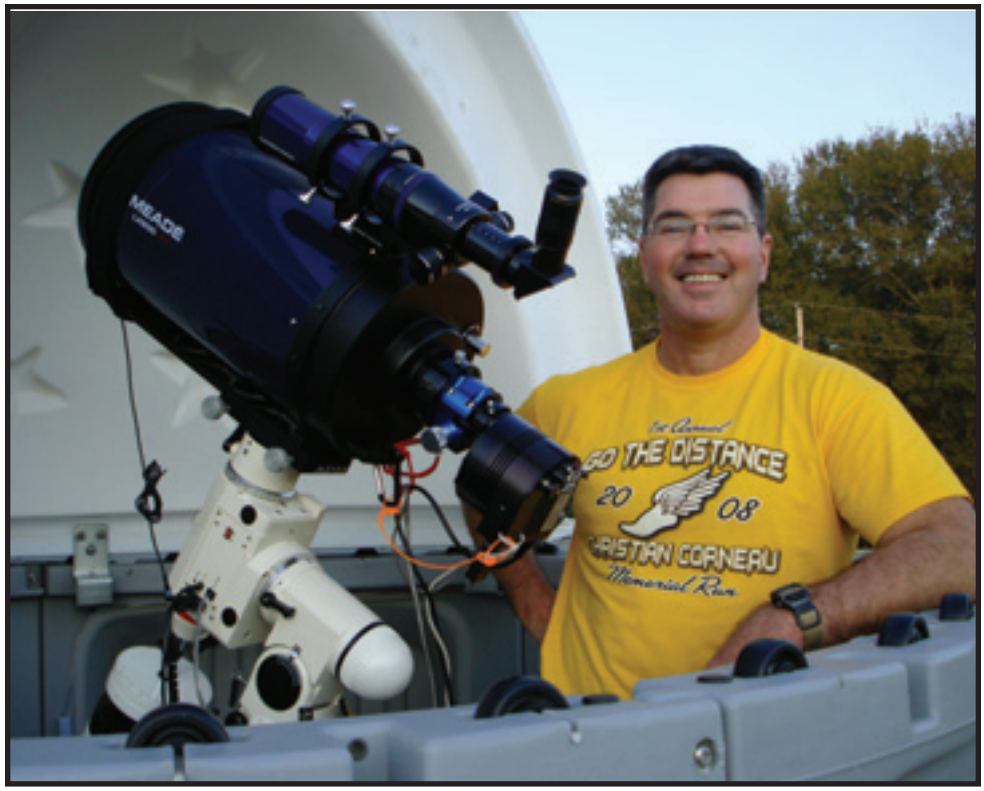

Image 13. The Final Result: a Scope that Looks Good and Meets All Requirements Brings a Smile