Building an Observatory for Public Outreach

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Figure 1. Department of Physics Observatory, the building dimensions are 12 feet X 24 feet X 10.5 feet (3.6m X 7.3m X 3.2m) (W X L X H). Notice the red lights on the exterior.

Introduction

A public-access observatory is a natural extension of planetarium operations. Ideally it would be located next to the planetarium, have dark sky, be inexpensive, have the capability to expand, be wheelchair accessible and easy to maintain and operate. Clearly, most of these features are impossible for the average planetarium. This paper details an observatory that actually comes fairly close to meeting these parameters.

We built an observatory for under $30k (USD) that fits in the parking lot next to the planetarium (we used six parking spots). We can control the parking lot lights from inside the observatory. It was easy to build and it is very solid and will support future expansion. It is largely wheelchair friendly. Finally, one or two students can have it set up for an observing session in under 30 minutes.

The project had other unexpected results too. We have received substantial media coverage, donations and funding as a result of the observatory. Every newspaper, several radio and TV stations all picked up the story with nearly zero public relations efforts on our part. We also acquired a large number of donations ranging from a CCD camera to several fairly new 20-cm (8-inch) Schmidt Cassegrain telescopes (SCT) and a 64-cm (25-inch) Dobsonian telescope. Finally, it has been remarkably easy to obtain both internal and external grant monies for expansions and improvements in the telescopes.

Location

We own a remote site on top of a 2,700 meter (9,000 feet) mountain top that is an hour's drive from the planetarium. The sky is quite dark and we are planning a future observatory for that site. However, we didn't want to use that for our weekly public star parties and planetarium shows because of the distance. One option is to control it remotely and view the results on the dome. But remote access observatories lose the personal interaction that one gets by viewing through the eyepiece directly. Additionally, a remote observatory is much harder to maintain and access than one located directly next to the planetarium.

We choose a location in the parking lot adjacent to the planetarium. This solved many problems but presented new issues too.

In choosing a parking lot location you must be attentive to the direction of car headlights from the people leaving the star party early. You also need to make sure that other parking lot users, i.e., traffic that is not associated with the observatory activities, do not generally illuminate the observing area with their headlights. It is paramount that you gain easy control of the parking lot lights too. Of course, you need to carefully assess the positions of external lights that you can't control. (We had to contend with both on and off campus light intrusion, including stadium lights. Choosing the location carefully has minimized the impact of the surrounding lights.)

Figure 2. Removing the base half from the flatbed truck.

An important safety issue is the potential for auto-pedestrian accidents. While this is always a concern, it is made worse because the parking lot lights are turned off and it is fairly dark. This is especially troublesome with children due to size, activity and clothing choice. An example of this problem in the USA is cub scouts in dark blue uniforms excitedly running around on a black asphalt parking lot with no lighting. These children are nearly invisible. For this reason we actually encourage the use of headlights near the observatory. We have found that the vast majority of headlights are from cars leaving the star party and are thus pointed away from the observatory.

In an earlier safety study when were doing "sidewalk astronomy" we had the campus police use radar to monitor traffic. Several cars were measured at speeds exceeding 50 MPH (80 KPH) in the parking lot. For our observatory we choose a short "dead end" parking lot. The size and lack of through traffic help to naturally reduce automotive speed. By placing the observatory at the far end of that lot we have nearly eliminated traffic next to the telescopes.

As you choose your location, you need to consider the entire route that people will take from the planetarium to the observatory to their cars to the road home. Make sure that people walking between the planetarium and the observatory do not have to cross unlit heavy or high speed traffic lanes.

It is worth noting that the administration funded the observatory in large part due to safety concerns. Our earlier sidewalk and roof-top star parties were just not worth the liability risk. It was decided that a well thought out public observatory program was less expensive than a single lawsuit. (Of the many safety issues with the roof-top location, the two most common ones were people hanging over the edge and children throwing objects down to the sidewalks below.)

An unanticipated advantage to locating an observatory in the parking lot is ease of access by the local amateur astronomy society. By roping off a large portion of the parking lot we can easily accommodate large attendance events such as eclipses, transits, etc. The amateur astronomers simply drive into a parking spot then unload and setup their telescopes right next to their car. This encourages support from such groups and has been a valuable asset for us.

<u>Observatory Design</u>

The building is a prefabricated, two-piece, concrete storage building with an “L” shaped concrete slab region around it for setting up telescopes. On the concrete slab we mounted several permanent, polar-aligned, telescope piers for the SCT’s. The structure is strong enough for future expansion with a roof mounted telescope and dome.

Figure 3. Setting the base half on the prepared ground.

The most common building method for small structures is wood frame construction. This is easy to do but is labor and cost intensive. Further, it does not dampen vibrations well and is not suitable for later installation of a roof mounted telescope and dome. Concrete is an excellent building material but is expensive to create on-site. Roll-off-roof observatories take up a lot of space with the roof supports and, by design, can never be expanded to have a dome installed on top. Roll-off-roof observatories are also significantly more complicated than the simple storage facility we wanted for phase I of this overall project.

We looked for an alternative method based on concrete burial vaults. The reasoning was that since they prefabricate small concrete boxes maybe they could make a larger one. We discovered that several local companies that make burial vaults also create larger preformed concrete products. The key to reducing the expense of the project is locating a company with a pre-existing form (mold) of the right size. This turned out to be our solution.

Figure 4. The crane is fitting the top half of the observatory to the bottom half. There is a tar sealing strip in between the two halves.

The main building is made from two mated concrete shells. The shells are modified preformed concrete bridge supports used for highway construction. There are two types of bridge supports - arched and square. The arched supports are the most common and are not usable. The square ones are perfect however. The companies that supply these have reusable forms that they pour the concrete into thus eliminating on-site forming costs. The forms can easily be modified to have end walls added and those can be "blocked out" to allow for a door. The two halves are then transported by flatbed truck to the building site. A 60-ton crane (each half of the shell weighs over 34 tons) sets the bottom half on the prepared ground or existing parking lot surface. The crane then mates the top half to the bottom and your building's shell is nearly complete in under two hours. While these manufacturers often modify their forms, it was the first time this company had used them to make a building.

Figure 5. The finished observatory building, phase I.

Of the many advantages to this method, one is the lack of footings. The bottom half of the building shell is solid reinforced concrete that is continuous with the walls. There is no need for a separate concrete floor pouring or for footings to anchor the monolithic structure to the ground. This eliminates engineering, excavation, forming and pouring costs.

The interior was left as unfinished concrete but could easily be covered for aesthetics. We added electrical outlets, lighting and lighting controls. We also laid several runs of large diameter electrical conduit that passes under the concrete slab from the telescope sites to the interior of the building. This allows us to chase wires for electrical power and for future CCD cameras and computerized telescope control. Thus, we have almost completely eliminated wires that people could trip on. It is also wise to stub out several empty pieces of electrical conduit from the outside to the inside of the building. This will allow for unanticipated future modifications without needing to drill holes into the building.

The exterior is covered with stucco on the walls and a rubberized coating on the roof. The concrete is alleged to be waterproof and there is a tar seal between the two halves. The manufacturer claimed that we would not have to do anything to the exterior. In practice however the appearance is pretty rough so we added the surface treatments mostly for aesthetics.

Finally, we have been slowly adding permanently mounted, polar-aligned, telescope piers. A collection of small SCT's is kept in a cabinet by the front door. The cabinet allows us to keep the scopes at the ready with eyepieces in place and finder scopes fairly well aligned. The shelves in the cabinet will have wide slots routed out

Figure 6. We installed a storage cabinet for small SCT's next to the main door of the observatory.

to allow the top mounting screw on the telescope base to remain installed. The result is that we can have a clock-driven telescope ready for use in under sixty seconds.

The entire cost was just under $30,000. This included the building, steel double doors, lighting, electrical work, poured reinforced concrete slab on two sides, trenching for power lines, three telescope piers and wedges, and exterior stucco and roof treatments.

Operation

Phase I of this project has no dome. The telescopes are simply stored inside like a shed. When we need to use the observatory we pull out the telescopes and distribute them around the building. A single staff member can set up the entire operation in about 45 minutes. (It is easier and safer for two people to roll out the 25-inch dob, but one can do it.) About half of that time is spent on star alignments for the digital setting circles that four of the scopes have.

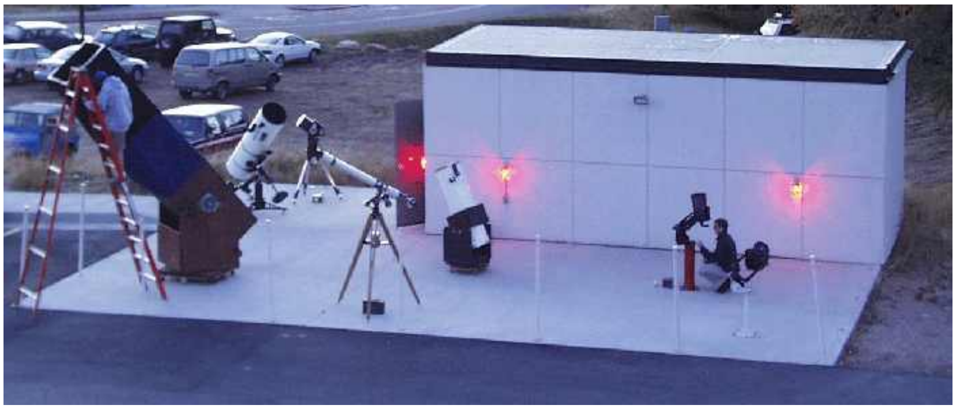

Figure 7. Two people can easily and quickly set up the facility for public star parties. Typical setup time with two staff members is 30 minutes.

For rapid use the four SCT's can be pulled out of the front cabinet and set into place on the piers in under 10 minutes. These telescopes have solar filters available and with the polar aligned piers are exceptionally easy to use during the day for tracking the Sun.

We are a small planetarium with a part-time staff comprised of students. To work in the planetarium and observatory you must be a physics major, have earned an "A" in the Introduction to Astronomy course and promise to enroll in the advanced Astrophysics course. Yet, despite this solid background, they are not amateur astronomers. Rarely do they know the sky well enough to find faint objects in a city sky. Having large crowds standing around while the observatory staff are hunting back and forth for faint fuzzy objects just doesn't work. What we do is start by getting bright and/or easily located objects (planets, Moon, M57, etc.) in those scopes that don't have digital setting circles (DSC). Then, with the DSC equipped scopes and pre-aligned piers they are able to quickly locate the fainter celestial objects.

One advantage to this ease of operation is that I can rent out the observatory to private groups. We have two approaches to this. Of course there are the usual large group star parties where people just look through the scopes and ask questions. We also offer (and encourage) star parties for very small groups. With the small groups (ten people or less) we educate them about the different telescopes and show them how to setup and use the telescopes. Soon we will also be able to teach them how to use a CCD camera with a telescope.

Finally, we added a work bench inside and a set of hand tools for maintaining the telescopes. While all these tools are available next door in the planetarium, it is simply impractical to run over there every time you need to adjust something.

Problems

We have found three significant problems with the facility - dust, heat and light pollution.

There is a lot of dust generated in a parking lot. The door needs to be better sealed against dust intrusion. We plan to add additional rubber sweeps and rubber seals. We want to try to keep the number of telescope covers to a minium so that we can setup the telescopes more quickly.

The second problem is heat. Both the parking lot and the building heat up substantially during the day. Heating of the parking lot is only a major problem when the telescopes are used at high magnification. It is worth noting that eliminating the parking lot would not solve the problem because the surrounding city generates its own heat waves. With the building being hot the stored telescopes are hot. This causes subtle image, focus and alignment problems when the telescopes are first pulled out and used in the cool night air. Again, this has turned out to be a fairly minor issue that can be solved by pulling the telescopes out a little earlier in the night.

Light pollution is our biggest problem. There are two aspects to this problem - the nearby lights that directly affect the telescopes and the low contrast, bright sky caused by the encircling city. (On the "bright" side this tends to wash out image turbulence problems caused by heat.) The obvious problems are not having enough contrast for galaxies and other nebulae and not having enough stars to easily find faint objects with the finder scope. Just as annoying as the city lights is the stray light at the eyepiece from nearby lights. Often we will arrange for a staff member to stand in just the right spot to cast a shadow on the observer. We have obtained agreements from most of the owners of surrounding lights to change to shielded lights if they ever upgrade or replace the existing light fixture. By inviting the neighbors over for a free star party or two we have been able to get some of them to turn off their exterior lights on the nights that we have our scheduled star parties.

An small unexpected problem also arose, because we are in a university parking lot we had students parking on the telescope pads. We solved this problem by installing removable posts made of PVC pipe with a cap on the top and a few strips of reflective tape. This was accomplished by boring slightly oversized holes in the concrete pad spaced at about the width of a car. We then set the poles into the holes. We rarely need to remove these posts, but when we do they simply lift up out of the hole. One person discovered this and parked behind the poles. A parking ticket solved that problem and it has never happened again. The advantage to PVC pipe is that a wayward car will simply snap off the pipe without damage to the car or the concrete. You can then saw off the damaged bottom of the pipe and reinstall it. Even if it is completely destroyed, the cost of a replacement post is insignificant.

Results

We have been running this facility for two years now and feel that it is an unqualified success. There were over a dozen newspaper articles in seven daily and weekly newspapers for the opening nights alone.

The biggest surprise was in the form of equipment donations of telescopes and accessories to the new observatory. A local health science professor had a 25-inch Dobsonian telescope that was too large for him to move around near his cabin. He donated it to us, we changed the wheels and it is now easy to roll out and use on the concrete surrounding our observatory building. Two people each donated excellent-condition 8-inch SCT's. A local amateur astronomer donated an SBIG ST-6 CCD camera.

So many people wanted to donate 60-mm and 90-mm refractors that we started referring them to scouting and school groups. (We kept a couple of these refractors for demonstration purposes and for casting images of the Sun.) One person asked what we needed to improve our 16-inch Dobsonian telescope and donated $1,500 on the spot for a new equatorial mount! Not a single one of these donations were solicited, they were all spontaneous once they saw the articles in the papers or came out to one of the two opening night star parties.

With the facility in place and a good record of attendance, it is proving to be reasonably easy to obtain small amounts of additional funding. We secured a state Office of Museum Services grant to buy a small automated "goto" scope for $3,000. An internal university grant provided digital setting circles for the 25-inch scope, eyepieces and computers. We are awaiting word on a $5,000 state grant for a color filter wheel and a new Dobsonian truss tube assembly for the 25-inch scope.

Figure 8. The donated 25-inch scope.

This brings up a curious point that we had not budgeted for. With all the donations we received there were unexpected direct expenses on our part. For example, we needed to purchase an industrial strength 12-foot ladder for the 25-inch telescope. All total, the donations actually cost us over $1,000. Of course we gained much more than that, but do be forewarned. Additionally, it was felt that several of our telescopes needed some well overdue upgrades, repairs, adjustments and accessories. No one wants to open a new facility containing ragged equipment. All this adds to the cost and needs to be anticipated in any grant requests.

Usage

The observatory has experienced significant use in the two years that we have been operating it. Below are examples of the activities that have been scheduled for the facility.

1. Public star parties, scheduled weekly.
2. Private star parties for school groups, honors students, families, individuals, scouts, etc. We even had two birthday parties use the facility.
3. Astronomy classes: solar viewing and special event viewing (comets, eclipses (here and at Jupiter), special projects, etc.).

The Ott Planetarium only has public shows on Wednesday nights. For many years we setup telescopes on the sidewalk or roof. Typically, about half of the audience in the last planetarium show would stay to look through the telescopes. With the observatory that has clearly changed to nearly 100%. Indeed, some people who attended the earlier planetarium show specifically wait around to come out to the observatory. There are also a few people that come only for the observing session. On an average Wednesday night we have 30 to 40 people visiting the observatory for the star party. The duration of their stay depends mostly on the ambient temperature. (Northern Utah winters can be severe.) Visits of 30 to 60 minutes are common with occasional visitors staying for more than 90 minutes.

When renting the facility we charge an hourly rate that matches the price of our planetarium shows - $40 per hour. The direct costs to the planetarium budget for two staff members to operate the observatory (including setup and tear down) is about $20 per hour of usage. The vast majority of patrons who rent the facility use it for one hour with the extreme being three hours.

Future Plans

In the near term we plan to complete installation of the donated CCD imaging system and the computer interfacing for two of the telescopes. A major reason for this is accessibility for disabled patrons that can not easily look through an eyepiece.

We also plan to add a simple adaptive optics unit and a spectrometer. This will allow us to use the facility for research with our physics majors. We can also pursue summer programs such as “teacher as scientist” and elder hostel type activities with this equipment.

We will eventually connect the observatory to the Internet. The cost of trenching in a line is much higher than installing a wireless LAN. Once that is installed, we can download pictures real time into the planetarium dome.

We plan to mount several more piers and improve the mounting systems for some of our older telescopes. We also want to add DSC to all of the scopes.

Phase II of the observatory is estimated at approximately $30k to $50k depending on options. The majority of that would be the installation of external stairs to the roof and a dome to house the 16-inch telescope. (Industrial strength outdoor stairs are surprisingly expensive and constitute a significant fraction of the total cost of Phase II.)

Figure 9. Artist’s conception of the completed observatory.

Conclusion

The use of preformed concrete highway bridge supports resulted in a fairly inexpensive and very robust structure to house our telescopes. The observatory is easy to use and resulted in numerous donations. Public response has been high and the cost of operation has been very low. One of the most important aspects of a project such as this is careful attention to details when choosing the location of the building. Additionally, the unconventional construction method used for this facility is strong enough for a future dome on the top as “phase II” of a project such as this.