REFLECTIONS / REFRACTIONS

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University Lowbrow Astronomers

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Visit Your Local Planetarium (...or at least remind people they exist!)

By Norbert Vance

I can remember my first visit to a planetarium, Cranbrook, oh so many years ago. It was an exciting experience having gotten a telescope from Santa only a few years before. I was already in touch with the stars. So here I was, in a place devoted to just that... the stars. And planets, and galaxies, and dinosaurs, wow! Then we got to see a telescope in an observatory. As a 13 year old on summer break it was quite the experience. It reinforced what I had already come to love. Too bad the place was WAY the heck over on the other side of Detroit from my Allen Park home. It may as well been the other side of the Milky Way. I had to convince my older brother to drive us there. Turns out, he enjoyed it, too.

The financial closure of the Detroit Science Center should be a reminder that we who get about amongst the public should encourage others to visit these ambassadors of astronomy. When I toured the DSC one day early last fall it was teeming with school kids. Who knew that it was struggling so? All seemed well, at least on the surface. But given the state's economy this news was not terribly surprising... just another sad chapter in the situation we find ourselves. Hopefully that ship can right itself and reopen soon. The center had taken great strides in improving its fare the past couple of decades. Its planetarium director, John Schroer, a devoted employee of the center finds himself in an odd pickle. He also currently serves as President of the Great Lakes Planetarium Association (GLPA). It's disheartening to have the rug pulled from under you while serving such a respected organization. The DSC has to climb out of a pretty deep financial hole.

Fortunately, the state is rich with places to visit... the Exhibit Museum of course, Cranbrook, MSU Abrams, Wayne State, Chaffee in Grand Rapids to name a few. Cranbrook is in the midst of major upgrades and is spending big dollars thanks to some grants. Wayne State in Detroit and Ritter Planetarium at the University of Toledo have new SciDome HD full dome systems. Adrian College's Robinson Planetarium is getting a work over; new seats, paint, repairs, and perhaps a digital dome system to supplement its optical-mechanical projector (note: planetarians do NOT say "upgrade" because the purists insist that computers can't touch the old star balls for nice pinpoint star realism... not yet). Pioneer High School's Argus Planetarium had a nice write up in the Ann Arbor News last month. Forgive me if I didn't mention more! If YOU haven't been to one, I encourage YOU to go. Dig into that jar of nickels and dimes.

Oh yes, EMU will have a modest public schedule ready sometime in the near future as we tweak our program and build a library of programs in our first year of operation. For now, we are quite busy with classes and requests from groups and schools. I personally advertise for the neighbors as much as for ourselves because we all want to see these places thrive. In preparing for the opening of our facility, I was fortunate to have the willing assistance and encouragement of the GLPA membership in design and programming. I got some very valuable ideas and suggestions, plus saw plenty of vendor choices at the three conferences I've attended since joining "Glip-pah". They are pleased to have us in the group, and vice versa. We will host our first state GLPA meeting on March 17th at the sphere. No doubt we will discuss the financial issues that confront planetaria, that's always an issue. But there are new technologies that continue to evolve. New full dome movie experiences to grab the public imagination are released each year. Ideas are shared to make even the veteran star balls new again. It's a time to be positive.

So, I look forward to July when the Lowbrows visit us once more. I trust that's the plan for Charlie and company? We'll have plenty of new stuff to show off. Just wait until you see the night sky shown with our most recent update, the GALACTIC coordinate grid projection, witnessed as the Earth turns. Wow! It gave me goose bumps. Well, OK... I'm into that. But you have to see it!

Machining Optics

By Tom Ryan

Most people who are involved with astronomy for any length of time know that the lenses and mirrors in their telescopes are made by grinding. At the same time, most of the people with whom I've discussed this fact don't have a clear idea of exactly how this grinding process produces a lens or a mirror.

The process can be simply described as rubbing two glass disks against each other with a free abrasive and water mixture between them. The curve necessary for focusing light is produced by the pressure distribution on the two disks when one overhangs the other. When centered, with one disk exactly above the other, the pressure distribution across the disks is uniform, and the disks wear away uniformly. When the top disk is displaced and overhangs the bottom disk, the grinding pressure is greater on the center of the top disk and on the edge of the bottom disk, which tends to make the top disk concave and the bottom disk convex. When the right amount of curvature is achieved, the abrasive mixture is changed for a finer mix, and this continues until the surface is ground fine enough so it can be polished on a pitch lap.

This process is very old, and is easy to do. It is not, however, particularly fast, nor is it easy to arrive at the right curvature and the right lens thickness at the same time. For this reason, most shops that produce lenses or mirrors on a production basis take a slightly different approach. They have diamond grinding machines that grind the rough curve into the glass directly, and they have dedicated tooling (that is, grinding tools with pre-set radii) to fine grind the rough generated curve, and dedicated polishing laps to polish the glass to pre-defined curves. This dedicated tooling makes the process of producing a given curved surface both quick and predictable.

Unfortunately, this tooling is very, very expensive to make, in terms of time and materials, and as a result, every shop publishes a list of the standard curves it can routinely (and cheaply) make, so the lens designer can adjust the curvatures of the lens surfaces in his designs to those available from the shop. Designing a lens system to a set of pre-determined curves is not as restrictive as you might at first expect, because over the years, a shop will accumulate (usually during slow times) an extensive catalog of this tooling. In the process of designing lens systems, shifts in actual radii from their ideal design values can usually be compensated for by shifting the elements with respect to each other.

All this is well and good, but what does one do when one needs a particular lens, with custom radii, and can't wait the six or twelve weeks for a shop to produce that lens? (It is true that there is a shop that specializes in making lenses in one week, but the price they charge is inversely proportional (and often multiplied by an additional factor of three or more) to time.)

It is possible for an individual to make special lenses in a week (I have done this myself), but the one week required may still be longer than is desired, and still involves making a considerable amount of tooling. It would be much better if the lens could be machined directly on a lathe or a milling machine out of a glass blank or rod.

Unfortunately, most optical materials do not lend themselves to this production method. They tend to crack when a tool bit is applied to them. There are materials (mostly used in the infrared) which can be turned on a lathe with a diamond tool bit, but ordinary glass is not one of them.

I was faced with this problem recently. I had designed an optical system that needed to be made fast (fast as in two or three days, at most), and it used lenses with custom curves. I knew I could make the lenses from glass blanks, but I also knew I couldn't make them and their tooling in a couple of days. However, I realized that the lens design simply needed to be verified quickly. Once that was done, special lenses could be ordered and the customer wouldn't mind waiting for them, knowing that the design would work as promised.

And because the proof-of-concept lenses didn't need to be perfect or work over a wide temperature range, I could machine them out of optical grade plastic.

Now, it is true that optical grade plastic has a different index of refraction than most optical glasses, and is different from that of the particular lenses I designed, but I was the lens designer, and if I could design a system made out of glass, I could design a system that was made out of plastic that would work nearly as well. And so I did. The only remaining difficulty was to actually make the lenses.

There are two general approaches one can take in machining spherical surfaces. The first method is to spin the lens about its axis, and then swing a cutting tool through an arc that is centered on the radius of curvature of the desired lens surface. The second method is to, again, spin the lens about its axis, but this time rotate the cutting tool in a circle that contacts the desired surface. This can be envisioned by setting an orange on the top of a drinking glass. The cutting tool's path is defined by the lip of the glass, and when the orange (the lens) is rotated, the cutting tool cuts out a sphere. (That is, if the orange's axis of rotation intersects the edge of the drinking glass. Both of these methods are capable of generating precise, predictable radii, both convex and concave.

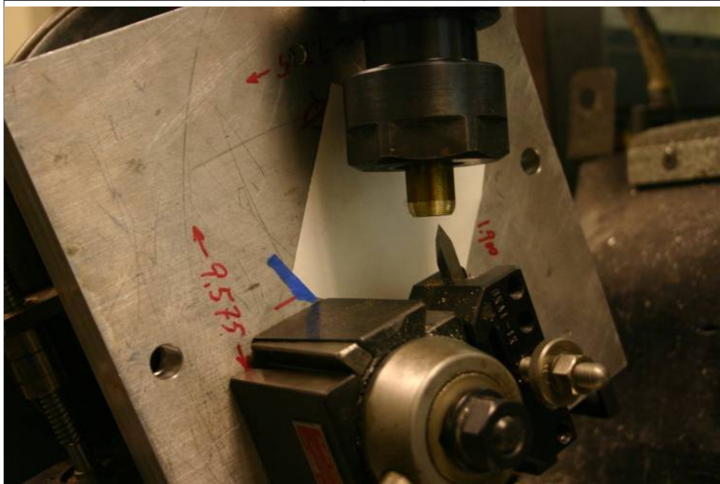
Faced with two approaches and limited time, I, of course, chose the wrong one.

In the first figure, I have a brass blank standing in for the plastic, and a very sharp tool bit mounted on a rotating stage. The tool bit is further mounted on an XY table, so it can be both centered on the axis of the rotary table, and offset from that axis by a distance equal to the desired surface radius.

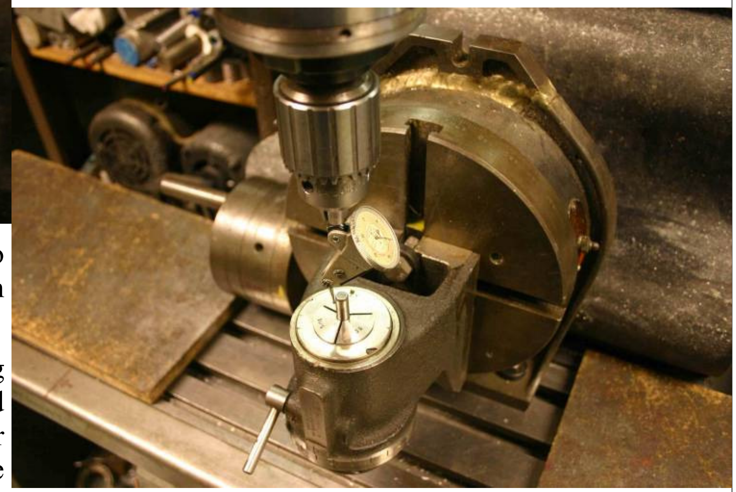
Moreover, the entire assembly is mounted on the XYZ stage of a milling machine, so the axis of the rotary table can be made to intersect that of the lens blank in the machine's spindle. You would think that with all of these adjustments, it would be possible to bring the tool into its exact position and quickly machine the part. And you would be right. It is possible, but not in my lifetime.

The problem is not the number of adjustments, which are sufficient. (No optical designer who can design a system consisting of fifty-seven lenses and can get them all aligned would fear this.) The problem is in determining exactly when the axis of the rotary stage intersects that of the spindle, to within one-thousandth of an inch. Because if the axis do not intersect, the cutter will generate a surface that looks like the top half of a bagel, cut to hold cream cheese. And since we're going directly from machining to polishing, there is no chance to correct any form errors in the machined lens.

Discovering this problem took the better part of a day, leaving only one more day to pursue the second, and as yet untried, method. Fortunately, the second method works.



I should probably mention that the second method is a slight variation on the standard method used to diamond generate lenses, and therefore might seem to be the more sensible approach. The fact that I didn't try it first only proves that Churchill was right about us when he said that “The Americans will always do the right thing...after they've exhausted all the alternatives.”



The key to success in the second method is the ability to easily align the machine's rotational axis. This is done in the figure below using an indicator accurate to 0.0001”.

A sharp tool bit is then placed in a boring head, the boring head is offset and the optical rod is tilted to a pre-defined angle, and then the rod is raised into the rotating circular cutter. If the resulting tool marks aren't symmetric, then the table position is adjusted until they are.

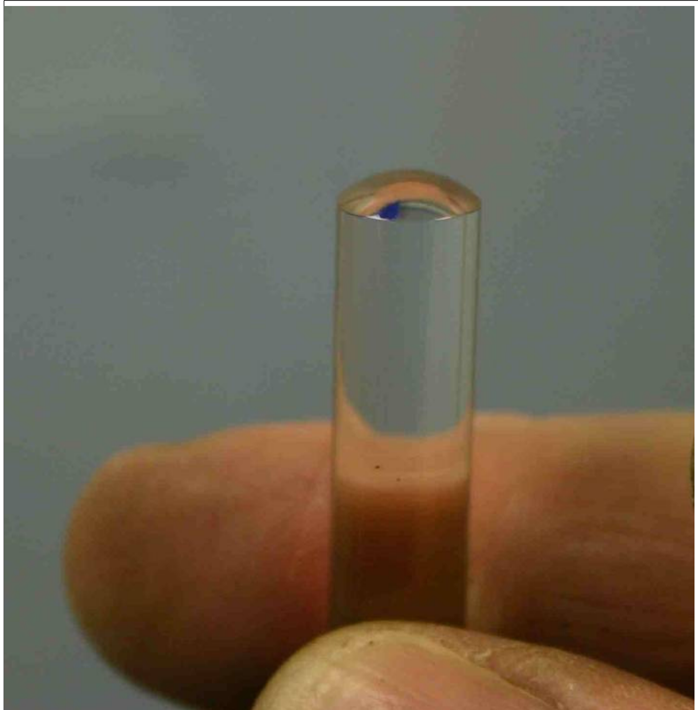
Finally, the end of the rod is polished using a tiny pitch lap, the radius is measured by a traveling microscope in a lathe, and the resulting curve is found to be accurate to a thousandth of an inch.

After this success, a tool holder was made to hold the lenses at a fixed thickness while their second surface curves were generated. More lenses were cut from the rod of optical grade plastic, their surfaces generated, then polished, and finally measured to be within one or two thousandths of an inch of design specifications. Clearly, this is a method that works very well.

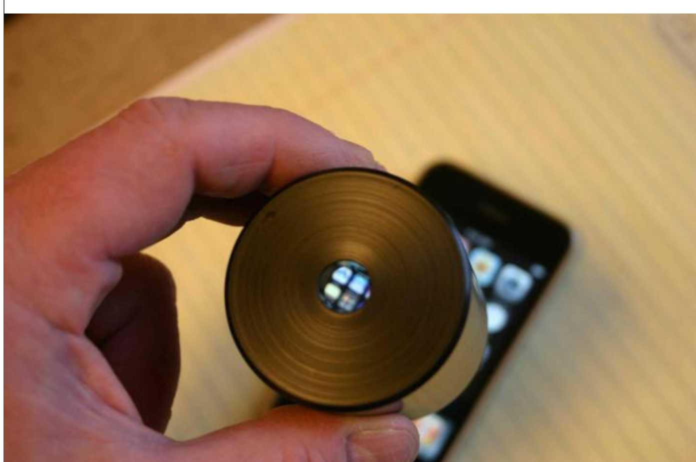
Finally, the lenses, along with their spacers, are assembled into a plastic lens holder using (what else?) black duct tape to hold them in.

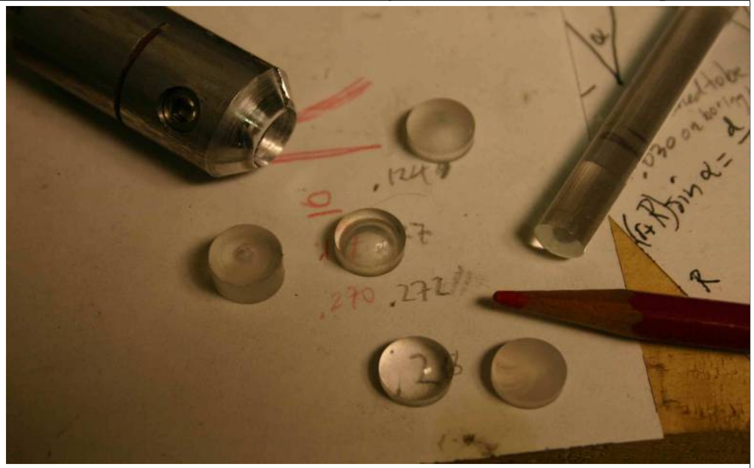
The result is a complete prototype lens system, finished and ready for evaluation in two days.

So I found that this method of machining lenses works very, very well. It is predictable and fast, and I wish every lens could be made this way. But in case you think that everything about this whole process was just peachy, let me add that,



after seeing it, the customer rejected this design. You just can't tell everything about an optical system by looking at a computer, and this is why the late, great editor of the Gleanings for Telescope Makers column in Sky and Telescope magazine, Bob Cox, would never publish a design unless someone had actually built it.





On the plus side, quick rejections make for rapid redesigns, and once I understood exactly what the customer was looking for, my redesign was prototyped (again, by me), approved, and put into production in record time, which saved the customer money and made me happy, as well.

ADVENTURES IN DATA LOGGING: NO SMOKING

By Jack Brisbin

By know most members know we are conducting a data logging project in the Peach Mountain Observatory. We are recording the Temperature, Humidity and Dew point inside the observatory. We will continue to do this until the end of January 2012. On our recent trip to Peach Mountain, myself and Jim Forrester came across a new sign located at the entrance to Peach Mountain. This sign was not there when we did the November download but it's there now at the December 21, download.

For many years now the club has had a no smoking policy when we hold our observing sessions. The smoking is prohibited clause, is located in the "Peach Mountain Guidelines for Lowbrows and Guests". This can be viewed on line on the clubs website. One of the big issues is the possibility of starting a fire on the observatory grounds. Those of you that have visited the observatory in the summer realize how dry the area can get. This causes a fire safety concern that includes the Radio Telescope and other teaching facilities located in the Stinchfield Woods area. There are also other concerns such as; second hand smoke and cigarette ashes on your telescope mirror.

The sign is posted at the entrance to Peach Mountain on the side by the gate entrance. Driving up at night, your headlights should reflect on the sign. The big question is will people pay attention to the sign. The property is owned by the University of Michigan. Those of you that are in disagreement with the policy should review the University of Michigan Smoke -Free-Campus Policy. This can be viewed at: http://www.umich.edu/

The new University of Michigan sign is a welcome addition to Peach Mountain.

Due to the lack of submissions this month, pages 7 & 8 have been removed from this edition.

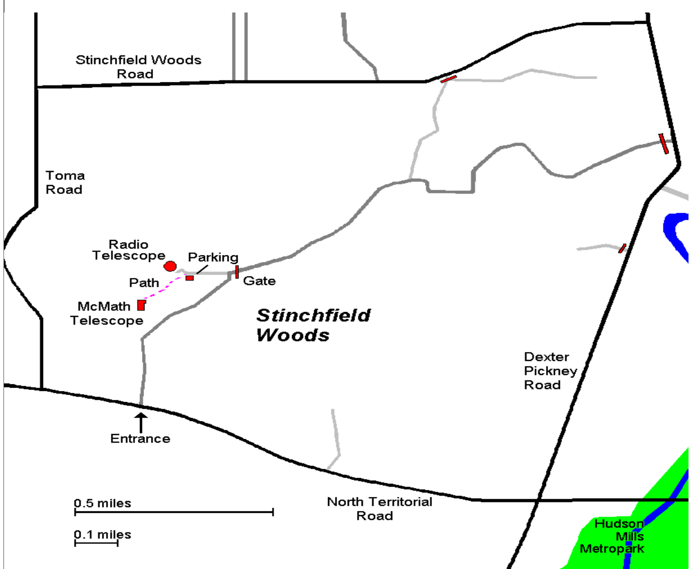
*Remember that this is your newsletter and it should be filled with your words and pictures. Not a reprint of information and articles available on the internet to everyone. Please continue to contribute **your** thoughts and **your** images and help keep this newsletter fresh and pertinent to all the members of the University Lowbrow Astronomers.*

As Editor, I want to thank everyone who has contributed in the past and trust that their example will inspire others!

Places & Times

Dennison Hall, also known as The University of Michigan's Physics & Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. Dennison Hall can be found on Church Street about one block north of South University Avenue in Ann Arbor, MI. The meetings are usually held in room 130, and on the 3rd Friday of each month at 7:30 pm. During the summer months and when weather permits, a club observing session at the Peach Mountain Observatory will follow the meeting.

Peach Mountain Observatory is the home of the University of Michigan's 25 meter radio telescope as well as the University's McMath 24" telescope which is maintained and operated by the Lowbrows. The observatory is located northwest of Dexter, MI; the entrance is on North Territorial Rd. 1.1 miles west of Dexter-Pinckney Rd. A small maize & blue sign on the north side of the road marks the gate. Follow the gravel road to the top of the hill and a parking area near the radio telescopes, then walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.



Public Open House / Star Parties

Public Open Houses / Star Parties are generally held on the Saturdays before and after the New Moon at the Peach Mountain observatory, but are usually cancelled if the sky is cloudy at sunset or the temperature is below 10 degrees F. For the most up to date info on the Open House / Star Party status call: (734)332-9132. Many members bring their telescope to share with the public and visitors are welcome to do the same. Peach Mountain is home to millions of hungry mosquitoes, so apply bug repellent, and it can get rather cold at night, please dress accordingly.

Membership

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, $12 per year for students and seniors (age 55+) and $5 if you live outside of the Lower Peninsula of Michigan.

This entitles you to the access to our monthly Newsletters on-line at our website and use of the 24" McMath telescope (after some training).

A hard copy of the Newsletter can be obtained with an additional $12 annual fee to cover printing and postage. Dues can be paid at the monthly meetings or by check made out to University Lowbrow Astronomers and mailed to:

The University Lowbrow Astronomers

P.O. 131446

Ann Arbor, MI 48113

Membership in the Lowbrows can also get you a discount on these magazine subscriptions:

Sky & Telescope - $32.95 / year

Astronomy - $34.00 / year or $60.00 for 2 years

For more information contact the club Treasurer at:

lowbrowdoug@gmail.com

Newsletter Contributions

Members and (non-members) are encouraged to write about any astronomy related topic of interest.

Call or Email the Newsletter Editor: **Mark S Deprest (734)223-0262 or msdeprest@comcast.net** to discuss length and format. Announcements, articles and images are due by the 1st day of the month as publication is the 7th.

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Reflections & Refractions

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David Jorgensen has made an EQ yoke mount for an 8” f/6 Newtonian, and promises an article soon.

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