

## **ATM Journal: Rough Grinding**

### **By Gordon Tulloch, RASC Winnipeg**

Now that we have a grinding tool, we can proceed to rough grind, the first step of which is commonly referred to as “hogging out the curve”. Hogging out is the process of digging out the center of the mirror blank to reach the desired curvature. So how do we know what depth (or sagitta) we need? We can easily calculate the required depth using this formula:

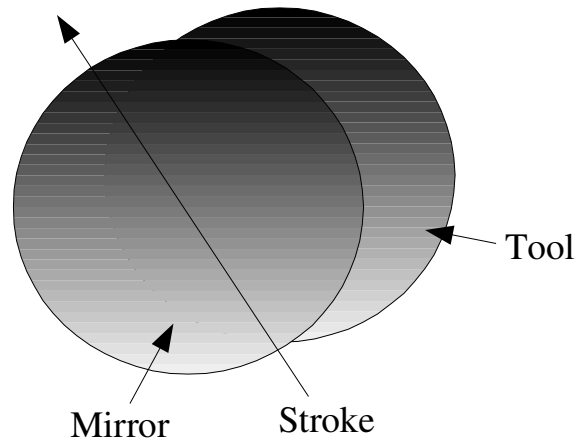
$$S = (D/2)^2 / 4 * F$$

Where S is the desired sagitta, D is the diameter of our mirror (8”) and F is the desired focal length (40” or 80”). Plugging these numbers in we discover that for our f5 mirror, we need to dig out .100” of material from the center of our mirror blank. We need to remove half of that amount (.050”) for the f10 mirror, which makes sense since we want twice the focal ratio. The lower the focal ratio, the closer to the mirror the focus will be so a deeper resulting curve.

Make sure your mirror has a 45 degree bevel on it - not too much (3/32” is fine) but keep an eye on it, as it will likely be ground off during grinding. If the bevel is lost then abrasive might cause the edge to chip, as well as release glass shards into your abrasives, potentially causing scratches. Renew your bevel whenever required by grinding with a corborundum stone under running water around the edge of the mirror.

We begin hogging out as follows: place the tool on the stand and secure it with wood cleats to make sure it doesn't skate around while we grind - not too tight, however, or the surface of the tool will be distorted. Spritz some water from a spray bottle onto the tool, and sprinkle 120 grit on the face of the tool, about a teaspoonful. Place the mirror on the tool, and starting grinding the middle of the mirror against the tool at the edge as seen below. We are essentially passing the center of the mirror over different “chords” of the tool.

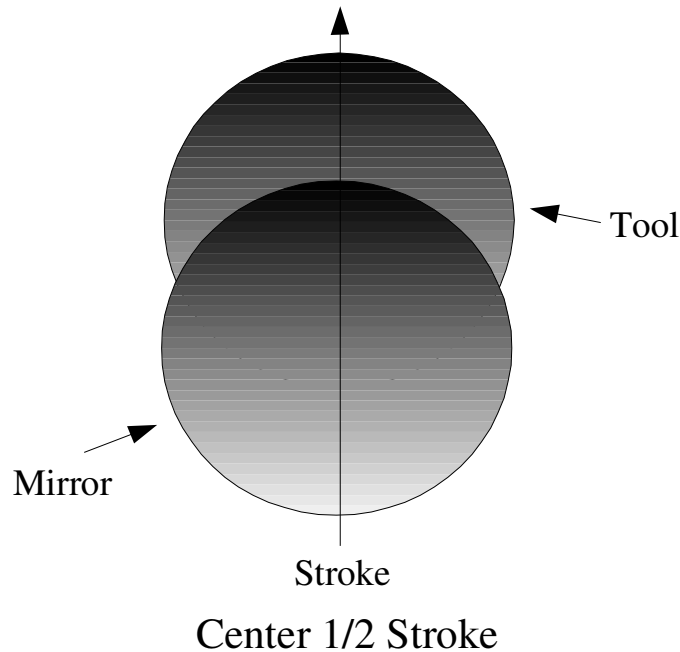
Applying lots of pressure, grind the mirror back and forth 5-8 times (remember, randomness is our friend) then rotate the mirror about an eighth of a turn (more or less) and take a step around the stand. Let the mirror overhang as much as possible without it tipping over the edge of the tool. Repeat until the sound of the crunching grit goes away. The abrasive will break down quite quickly at this point. Rinse off the mirror in a bucket and wipe down the face of the tool with a sponge, then repeat. Each charge of grit is called a "wet".



### Hogging Out (Chordal) Stroke

When you look at the mirror, you'll see the center getting scratched and pitted. This is exactly what we want. After 5 or so wets, get a straight edge and an automotive feeler gage (or some other known thickness) and test your sagitta. The feeler gages adding up to 75% of your desired sagitta should not be able to pass under the ruler - if they can, you're done with hogging out. You will continue to hog out your curve until you're 75% of the way to your sagitta, then change strokes so we can generate matching spherical surfaces between mirror and tool. This might take 20 wets or more.

The new stroke is a center on center stroke where the mirror begins 1/2 its diameter offset from the tool, and the stroke is made to have the center of the mirror pass over the center of the tool, ending with 1/2 diameter of the mirror hang off the end of the tool and coming back the same way. Pressure is not required, the weight of the mirror and the grinder's hands is sufficient.



This stroke is intended to bring the tool and mirror into matching spherical shapes while grinding down the rest of the mirror to match the depth of the center you hogged out earlier. You will continue this stroke until the mirror and tool are complimentary spheres and the mirror has reached the right sagitta as we calculated earlier. As before, every 6 or so strokes (randomly varying) step around the mirror stand and rotate the tool the opposite direction. This will create a nice figure of revolution and avoid astigmatism, where the mirror has a different figure at different places.

I note that all is not lost if you exceed the sagitta! Simply reverse the mirror and tool and grind TOT (tool on top) which will reduce the sagitta of the mirror. In this way we can adjust the sagitta and thus the focal length of the telescope very accurately.

To test the sphere being developed by the mirror and tool, you can use a Sharpie test. Buy a few Sharpie pens since you do not want to use the same pen when you're grinding with large abrasives as you do with small abrasives because a large particle of grit will make a terrible scratch on the surface of your mirror in later stages! That's why you need different sponges for different grits - we must be fanatical about not contaminating our work area with larger grits when we move to finer grits as one particle of rough grit will ruin potentially hours of work. You might want to keep separate Sharpies in envelopes marked with the grade of grit to ensure they stay separate, or mark the pens themselves.

Using the Sharpie, mark an X on each of the tiles on your tool. If you're using some material other than BVC (which is, of course, black and thus makes it difficult to see

a black marker) you can also draw a "bullseye" of concentric circles on the mirror, with particular attention to the edge of the mirror. Let the ink dry a bit, then go back to grinding. After each wet, have a look at the Sharpie marks - if they disappear uniformly, you have a nice spherical surface. If the center tiles still have ink on them, you may have a depression in the center of your mirror still from hogging out, keep grinding. If the edge marks are not disappearing, you have not ground out the curve all the way to the edges. I note that occasionally tiles will be slightly lower than others and the X will stay marked on it for quite a while. As long as not too many tiles are in this state, you can safely assume that the random motions of the mirror will grind the other tiles down to the same depth, or that the tile will have no effect on the final figure. If too many tiles are low, you might wish to cast another tool and ensure that the tiles don't lift.

Rough grinding is considered complete when we have the sagitta exactly where we want it (or perhaps a fraction less, since subsequent grinding will deepen it slightly) and the surfaces are spherical (ie the Sharpie marks all disappear at about the same time). Next, we commence fine grinding to begin removing the scratches and pits left by the coarse grits, and smooth the surface of the mirror.

Next time: Fine Grinding