the New Mexico Facetor

January-December, 2007

The Official Newsletter of the New Mexico Faceters Guild

NMFG
Show and Tell

An 8mm round aquamarine by Wes Owen. The aquamarine had been set into a gold ring for his wife. Wes does the cutting, while his son does the metalsmithing.

Spessartite garnets by Dylan Houtman.

Large oval peridot from Kilbourne Hole by Nancy Attaway. The ring on the title page is also by the Attaways.

The New Mexico Faceters Guild

Guild Officers 2006-2007

President: Dylan Houtman
Vice President/Programs: Ernie Hawes
Secretary/Treasurer: Betty Annis
Guild Gemologist: Edna Anthony
Guild Mineralogist: Paul Hlava
Workshop Chairman: Ernie Hawes

Newsletter Editors:
Carsten Brandt

Newsletter Production:
Ernie Hawes

Purpose of the Guild: The purpose of the New Mexico Faceters Guild is to bring together persons who are interested in faceting or faceted stones. We promote the art and science of faceting and provide a means of education and improvement in faceting skills. Finally, we provide a means of communication between those persons involved in or interested in faceting as a hobby.

Guild Membership: Dues are $20.00 per calendar year (January through December) for newsletter issues sent by e-mail. Hard copies of newsletter issues sent by US mail are $30. Please see the membership application/renewal form on the last page of the newsletter.

Meetings: The Guild meets now on the second Monday of odd numbered months at 7:00 p.m. at the New Mexico Museum of Natural History, 1801 Mountain Road N.W., Albuquerque, NM. Workshops are generally held in even-numbered months. Date, time, and place are given in newsletter. Also, any change in guild meeting times or dates will be listed in the newsletter.

The New Mexico Facetor

Vol u m e 2 7 , N o . 1, January-December, 2007

NMFG President Dylan Houtman

In This Issue:

New Mexico Faceters Guild Official Website

We invite everyone to visit our website at: www.attawaygems.com/NMFG for interesting and informative articles on gemstones and faceting techniques.

The Prez Sez:
by Dylan Houtman

I have a perverse interest in watching these channels on the television, which sell jewelry and gemstones. One evening someone showed some fresh water pearls that had been faceted; their claim was that there were only two people in the world with the ability to facet pearls. Naturally, I assumed that any time someone claims they are the only one who can do something, they are confused. My personal opinion is, saltwater pearls are too valuable, and the nacre too thin, to risk faceting and damaging these wonderful gems. To experiment on, I chose a cheap dyed pear shaped freshwater pearl. I was afraid of damaging the pearl, so I didn't want to use glue to hold it to the dop. I had just received some sealing wax with a very low melting point that dissolved in alcohol quite well: it works perfectly, the low temperature didn't harm the pearl at all.

The shape of a pearl is conducive to minimum material removal, so I cut a 16-facet girdle with a 1200 grit lap. I wanted to solve the polishing problem before moving on to the next tier of facets. Since a cerium oxide ultralap has worked quit well for me on flourite and calcite, it was my first choice. As soon as the pearl touched the lap I could tell the results were ugly. My next option was 50,000 grit dia-film(the diamond coated mylar sister to the ultralap), but the same dragging, ripping, scratching result as the cerium ultralap. My experience with celestite seemed to indicate that courser grit can produce more satisfactory results and as I still had my master lap on my machine, I slapped on the 8,000 grit dia-film. It was quite aggressive, but left a very nice finish. After finishing the first tier I decided to see how it would work from scratch. The 8,000 grit dia-film does an excellent job of forming the facets without any other steps. So I bought a fine strand of fresh water pearls, 7 to 8 mm. I also made two special dops with a prong in the center, so I could cut the facets about the drilled hole. It took about one-half hour to cut each pearl. The most beautiful feature of the faceted pearls is that the facets appear to be convex, due to the layers of nacre.

Next are two very rare minerals, each of which there must have been a recent discovery, Edenite and Clinohumite.

Edenite is $NaCa_2Mg_5Si_7AlO_{22}(OH)_2$, with a Mohs hardness of 6, and a refractive index around 1.606 to 1.66. The rough I saw was an appealing yellowy green. Like feldspar, it also has perfect cleavage; at first glance the cleavage looks just like that of spodumene. Fear not though, I am sure many of you have cut one form of feldspar or another and edenite cuts almost identically to feldspar. I have cut two pieces and totally ignored the orientation of the cleavage planes with no ill effect. I got an excellent polish using an acrylic lap with cerium oxide. A corian lap with 50,000 grit diamond gave acceptable results, except some fine scratches on the larger facets. This dictated that I had to polish the table with cerium oxide on acrylic. Edenite cuts a brighter stone than feldspars though, and I would advise using pavilion main angle of no less than 43 degrees. My source for this material is selling nice size pieces for $2.50 per gram and all the rough I saw would probably cut a nice stone larger than one carat. I also was informed cut stones had been seen for sale, retail, at $75.00 per carat. This stone is definitely a must for any serious gem stone collector or cutter. And it is definitely an enjoyable experience cutting.

Clinohumite is $(MgFe^{++})_9(SiO_4)_4(FOH)_2$, with a Mohs hardness of 6, and a refractive index around 1.623 to 1.709. The rough I saw was yellow with just a touch of orange except one piece, which I purchased, was mandarine orange. There is no cleavage to be concerned with in this material. This is one of those rare minerals that responds well to cutting and polishing. Using heat in the transfer was not a problem. To polish I used a corian lap and 50,000 grit diamond. From my experience, lead-tin with aluminium oxide should also give an excellent polish. I cut my rough into a standard round brilliant and it was almost as bright as a mandarine garnet. The biggest problem with clinohumite is the cost of the rough, I paid $100 per gram, and my source is renowned for having reasonable prices. These three gems are well worth the effort in my opinion.

Happy Faceting.

Dylan Houtman.

From The Editor's Desk

I hope everyone made it well into the New Year. 2007 has gone by very fast and now it is finally time to get caught up on our newsletters. It appears everybody was busier than usual last year and our newsletters have suffered a bit. Thus we have decided that there will be just one newsletter for the full year, but it is jam-packed with great information and articles. Usually we do not rely much on re-printing articles from other newsletters, but this year you will find quite a few articles that have originated from other guilds' newsletters. Many thanks to all who have contributed and our fellow guilds! For 2008, we hope we will be able to provide newsletters on a more regular schedule again, but the first half of the year may be a bit slow as I will still be in Portland, OR, on a work related training assigment.

May you all have a great 2008,
Carsten

A NEW POLISHING LAP
By Ernie Hawes

Earlier this year I learned about a new polishing lap manufactured by a fellow faceter, Marshall Howard. Marshall is a subscriber to the USFG Faceters Digest and announced in the digest that he had developed this lap, and had arranged with several very experienced faceters to extensively test it before releasing the lap for sale. The reports from these test faceters were glowing, to say the least.

Marshall named it the ***Lightning Lap***, because it polishes facets extraordinarily fast. But from the comments of the test faceters, he might well have called it the ***Miracle Lap***. The test faceters said that it could be used with all of the common polishing agents, diamond, cerium oxide or aluminum oxide. It could even be used with coarser diamond as a cutting lap. And unlike other laps, it could be scrubbed and used with another grit of diamond or a different oxide polish. And it could be used to polish just about any facetable material. If I didn't know Marshall and some of the faceters who conducted the tests, I'd not just be skeptical, I'd say hogwash.

Of course, I had to find out for myself what this lap could do, so I ordered one as soon as I knew it was available. I was cutting a rhodolite garnet when it arrived, and had just finished the 1200 grit step on the pavilion. I put a slurry of aluminum oxide polish on the new lap and started to polish. I made ten swipes on a fairly good sized pavilion facet and looked to see what kind of progress I'd made. Wow! The facet was perfectly polished! I did ten swipes on the next facet, and it was perfectly polished. It went that way with the rest of the pavilion. When I did the crown, it took a few more swipes to polish the table, but that was to be expected with the largest facet on the stone.

I've since used the ***Lightning Lap*** to polish peridot, tourmaline, quartz, topaz and beryl using oxide polishes. Frankly, I haven't cut anything yet that it won't polish. Facets polish flat with fairly sharp edges, and I've had no problem with scratches during polishing. My wife had the experience of going straight from a 600 Dyna lap to polish on a fairly large amethyst, and the polish came up very quickly. In another instance, someone I'm teaching was having problems polishing a synthetic glass-like material. He just couldn't get rid of some scratches. I had him try a new version of the ***Lightning Lap*** that has cerium oxide adhered to one surface. You're still supposed to paint a slurry of polishing agent on the lap, which he did. Running the lap at slow speed, he took a few swipes and the scratches were almost gone. With a few more swipes they were all gone and the facet was perfectly polished. The rest of the stone polished quickly.

Other faceters are using the ***Lightning Lap*** to polish sapphires with diamond, as well as many other faceting materials. In fact, there hardly seems to be a material that the Lightning Lap won't polish. That's not to say some faceters have not always had success with the ***Lightning Lap***. I've read in the USFG Daily Digest of some instances where someone has had a problem. But on the whole, people are having considerable success with this lap. For me, it has replaced my lucite lap and most of my other polishing laps, and I'm using it to polish a greater variety of materials than I would ever have expected to be able to polish on one lap. In fact, in the past several months, the only polishing laps I've used, are the ***BATT*** lap and the ***Lightning Lap***.

The Lightning Lap is made of some high tech resin or polymer material and appears to have fiberglass cloth embedded in it. It is machined to very flat tolerances. The lap can be used on both sides, and is now available with cerium oxide impregnated on one side. It's not cheap. At the moment, the price is $110.00 plus shipping for the 8 inch lap, and is only available directly from Marshall. His website is http://www.lightninglap.com. (He also manufactures the MagDop, a device to aid in dopping stones for greater recovery.)

Article reprinted from *Facets*, Nov 07 (Newsletter of the Columbia-Willamette Faceter's Guild).

1.5 Oval

This is an Oval that is not difficult to cut

Presented by Jim Hoeschen
Columbia-Willamette Faceters Guild, Portland Oregon

Cutting Difficulty: 1-**2**-3-4-5 Medium Easy
Easy--- Medium Easy---Medium--- Medium Difficult---Difficult

Why This Design?

- It is easy to cut.
- Angles are to one tenth of a degree.
- Produces a very nice finished stone with plenty of brilliance.
- Requires less material depth than pointed culet designs.
- All mains are above critical angle.
- No bow tie effect.

Select Rough

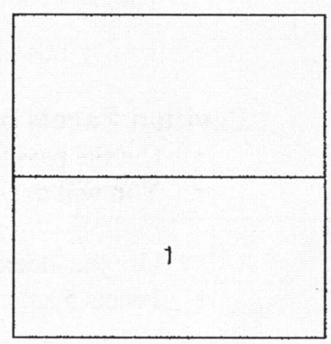
- This cut is a brilliant cut so it is best if you selected a flawless piece of rough that is colorless or not too dark in color.
- This design is for Quartz, R.I. of 1.54 or Sunstone, R.I. of 1.56.

Dop Your Stone

- Grind a flat where the **Table** will eventually be. Use a 260 to 600 grit lap.
- Clean both the stone and dop.
- Use alcohol, acetone or an ultrasonic cleaner.
- Dop the stone using Epoxy or wax.
- Orient the rough so that a flatter side of it will be at index 96.

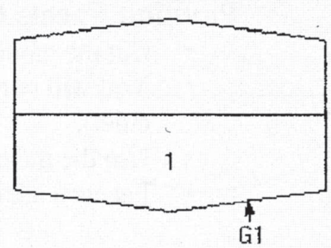
Pavilion Facets 1

- This is a meet-point cutting sequence. No preform steps are needed.
- First, cut the pavilion **1** facets.
- Cut 2 facets at 43.0, degrees using a 600 grit lap.
- Indexes 96-48.
- Facets **1** are cut at the same mast height.
- These facets form the flat portion of the keel culet.



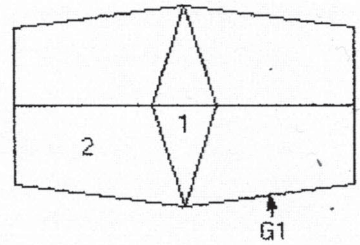
Girdle Facets G1

- Next, cut the Girdle facets.
- Cut 4 facets at 90.0 degrees.
- Use the indexes 02-46-50-94.
- Facet **G1** are cut at the same mast height.
- These facets will determine the width, depth and length of the stone.
- These are shown as **G1**on the Design sheet.



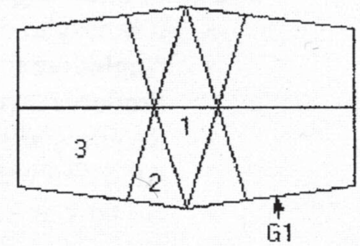
Pavilion Facets 2

- Cut the pavilion **2** facets.
- Cut 4 facets at 44.5 degrees to meet-point **(G1-1)**.
- Use the indexes 02-46-50-94.
- Facets **2** are cut at the same mast height.
- The center of the keel culet will be formed.
- Cut carefully to avoid chipping



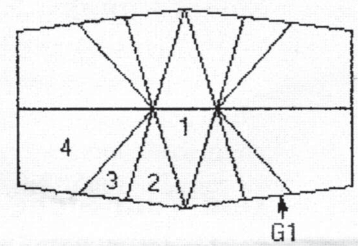
Pavilion Facets 3

- Cut the pavilion **3** facets.
- Cut 4 facets at 44.3 degrees to meet-point (**1-2** at the culet).
- Use the indexes 06-42-54-90.
- Facets **3** are cut at the same mast height.



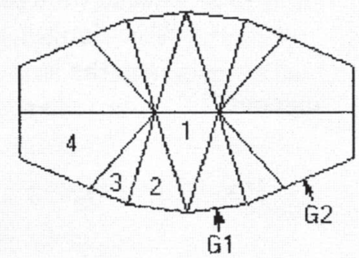
Pavilion Facets 4

- Cut the pavilion **4** facets.
- Cut 4 facets at 43.0 degrees to meet-point (**1-2** at the culet).
- Use the indexes 09-39-57-87.
- Facets **4** are cut at the same mast height.



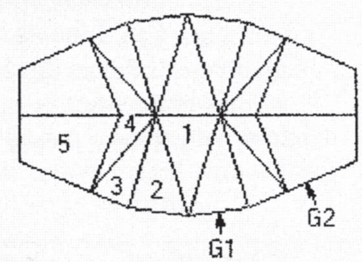
Girdle Facets G2

- Cut the **G2** girdle facets.
- Cut 4 facets at 90.0 degrees to meet-point (**G1-2-3** at the girdle).
- Use the indexes 06-42-54-90.
- Facets **G2** are cut at the same mast height.
- They are cut to form an even, level girdle with **G1**.



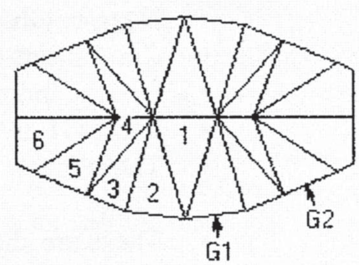
Pavilion Facets 5

- Cut the pavilion **5** facets.
- You will cut 4 facets at 44.0 degrees to meet-point **(3-4-G2** at the girdle).
- Use the indexes 11-37-59-85.
- Facets **5** are cut at the same mast height

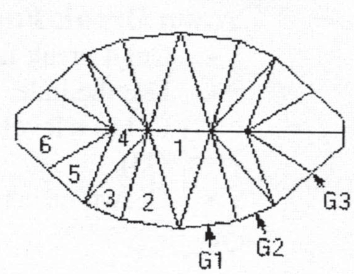


Pavilion Facets 6

- Cut the pavilion **6** facets.
- You will cut 4 facets at 43.5 degrees to meet-point (**4-5** at the culet).
- Use the indexes 19-29-67-77.
- Facets **6** are cut at the same mast height.

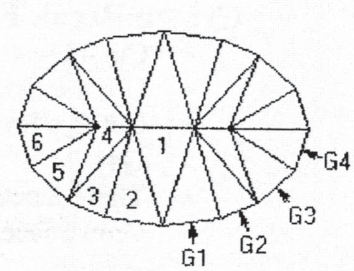


Girdle Facets G3



- Next, cut the **G3** girdle facets.
- You will cut 4 facets at 90.0 degrees to meet-point (**G2-3-4-5** at the girdle).
- Use the indexes 11-37-59-85.
- Facets **G3** are cut at the same mast height.
- They are cut to form an even, level girdle with **G1.**

Girdle Facets G4



- Next, cut the **G4** girdle facets.
- You will cut 4 facets at 90.0 degrees to meet-point (**G3-5-6**).
- Use the indexes 19-29-67-77.
- Facets **G4** are cut at the same mast height.
- They are cut to form an even, level girdle with **G3** and meet each other at the end of the stone.

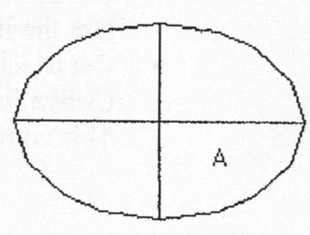
Next Step

- Recut the **Girdle** and **Pavilion** facets, using a prepolish lap such as a 1200 grit.
- Polish the pavilion facets **1, 2, 3, 4, 5 & 6.**
- You can polish the **Girdles** at this time or after you have cut the Crown.
- Optical grade Cerium oxide on your favorite polishing lap would be a good choice.

Transfer the Stone

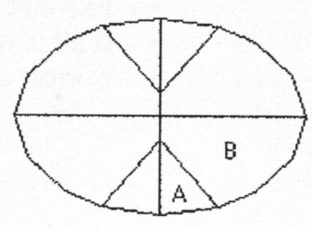
- Transfer the stone using a V dop which is appropriate for a keel culet.
- Be sure to clean the stone and dop with alcohol or acetone.
- Use epoxy, wax or your personal choice of adhesive.
- Transfer alignment of long stones is very important!

Crown Break Facets A



- Cut 4 break facets at 46.4 degrees with a cutting lap such as a 600 grit.
- Use the indexes 02-46-50-94.
- Crown facets **A** are cut at the same mast height.
- Carefully cut down to establish a uniform, level girdle line.
- Use the cheater, if needed, to get a level, even girdle.

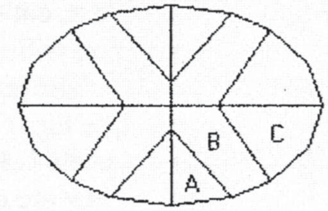
Crown Break Facets B



- Cut 4 break facets at 42.6 degrees.
- Use the indexes 06-42-54-90.
- Cut to a level girdle meeting with the **A** facets at meet-point (**A-G1-G2**)
- Crown facets **B** are cut at the same mast height.

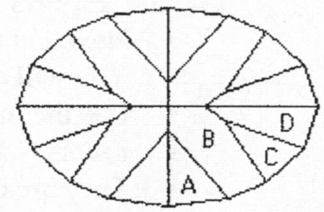
Crown Break Facets C

- Cut 4 break facets at 42.2 degrees.
- Use the indexes 11-37-59-85.
- Cut to a level girdle meeting with the **B** facets at meet-point (**B-G2-G3**).
- Crown facets **C** are cut at the same mast height.



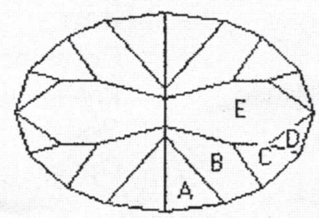
Crown Break Facets D

- Cut 4 break facets at 38.5 degrees.
- Use the indexes 19-29-67-77.
- Cut to a level girdle meeting with the **C** facets at meet-point (**C-G3-G4**).
- These facets also should meet each other at the end of the stone.
- Crown facets **D** are all cut at the same mast height.



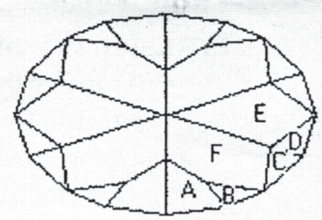
Crown Main Facets E

- Cut 2 end main facets at 30.1 degrees.
- Use the indexes 24-72.
- Cut to meet the girdle at the meet-point (**D-D-G4-G4**).
- Crown facets **E** are cut at the same mast height.



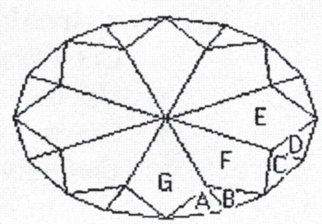
Crown Main Facets F

- Cut 4 middle main facets at 37.0 degrees.
- Use the indexes 08-40-56-88.
- Cut to meet the girdle at the meet-point (**B-C-G2-G3**).
- Crown facets **F** are cut at the same mast height.



Crown Main Facets G

- Cut 2 side main facets at 41.0 degrees.
- Use the indexes 96-48.
- Cut to meet the girdle at the meet-point (**A-A-G1-G1**).
- Crown facets **G** are cut at the same mast height.
- This completes the cutting of the main facets.

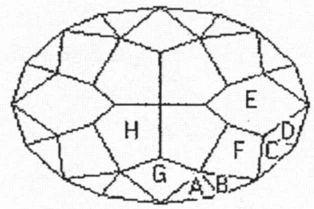


A Good Time to Check

- Examine all of the breaks to see how well they meet around the stone.
- If all is well they will meet the mains and be the same height.
- Correct any errors at this time.

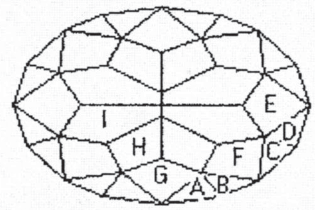
Crown Star Facets H

- Cut 4 star facets at 27.8 degrees.
- Use the indexes 04-44-52-92.
- Cut to the meet-point (**A-B-F-G**).
- Crown facets **H** are cut at the same mast height.



Crown Star Facets I

- Cut 4 star facets at 19.5 degrees.
- Use the indexes 15-33-63-81.
- Cut to meet-point (**C-D-E-F**).
- Crown facets **I** are cut at the same mast height.

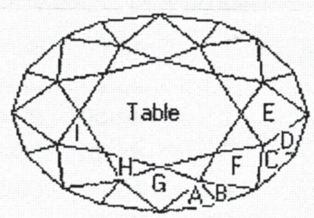


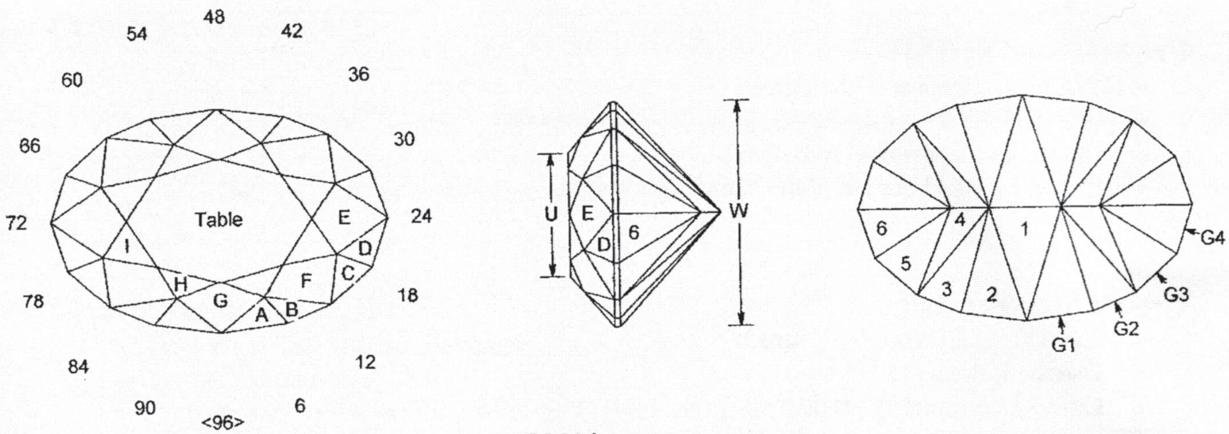
Next Step

- Recut Crown facets **A** thru **I**.
- Use a lap such as a worn 1200 grit or an Amerishine 1200 prepolish lap.
- Polish the crown star facets **H & I** first. Next, polish the **E, F & G** facets, followed by the **A, B, C & D** facets.
- Polish the Girdle facets if they have not yet been polished.
- Optical grade Cerium oxide on your favorite polishing lap would be a good choice.

Table Facet

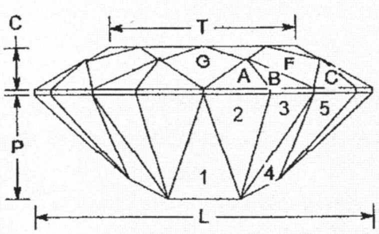
- Use a 45 degree dop. Index at 96.
- Àngle of the quill at 45.0 degrees.
- 600 grit lap.
- Grind **Table** to meet the junction of the star facets.
- Prepolish the **Table** using a worn 1200 lap or an Amerishine 1200 prepolish lap.
- Polish the **Table**. Use optical grade Cerium Oxide.





1.5 OVAL

JAH May 2007
Angles for R.I. = 1.540
55 + 16 girdles = 71 facets
2-fold, mirror-image symmetry
96 index
L/W = 1.510 T/W = 0.831 U/W = 0.547
P/W = 0.466 C/W = 0.197
Vol./W³ = 0.385



PAVILION

1	43.00°	96-48
G1	90.00°	02-46-50-94
2	44.50°	02-46-50-94
3	44.30°	06-42-54-90
4	43.00°	09-39-57-87
G2	90.00°	06-42-54-90
5	44.00°	11-37-59-85
6	43.50°	19-29-67-77
G3	90.00°	11-37-59-85
G4	90.00°	19-29-67-77

CROWN

A	46.40°	02-46-50-94
B	42.60°	06-42-54-90
C	42.20°	11-37-59-85
D	38.50°	19-29-67-77
E	30.10°	24-72
F	37.00°	08-40-56-88
G	41.00°	96-48
H	27.80°	04-44-52-92
I	19.50°	15-33-63-81
Table	0.00°	Table

Dieter Irmesher on using the ceramic lap

There are no publications except what Art Kavan and I have written about this. The concept came form the late Mr. Hetich that passed it on to Ralph Mathewson and to Mr.Dixon in Australia. All the competition faceters use this technique for optimum polish on their stones.

The Norbide dressing stick used by most machinists and tool makers is Boron Carbide. It must be the second hardest substance on earth next to diamond; it is certainly tougher than diamond. Norbide is the trade name from Norton Grinding Abrasive Corp. The stick dimensions are 1/4 " thick X 1/2" wide X 3.00" long. I purchased Norbide sticks from Industrial Tool & Supply 830 E. 22nd Street Tucson, AZ. 85714. Phone (520) 624 - 6656. Latest cost was $ 27.50.

I use the Norbide stick in charging polishing wheels instead of a corundum boule for all my polishing wheels. It works very well on all the ceramic polishing disks.

On tin lead, tin, zinc, copper etc., I use a diamond slurry spray to dampen the lap and then use the stick's 1/2" width. I hold it on about a 45 degree angle and apply moderate pressure and charge the wheel while running at a slow speed. I use the stick like a razor blade to distribute the diamond onto the lap. I work the diamond slurry from the center of the lap toward the outside of the lap. The excess of the diamond slurry that accumulates on the stick I keep there for further charging down the line. I use the same stick for charging all my wheels using all different sizes of diamond. Of course I wipe off the stick from one size of diamond to the next smaller size. When I polish I never use any dripping water. Just keep the wheel slightly damp. When working with diamond less is always best.

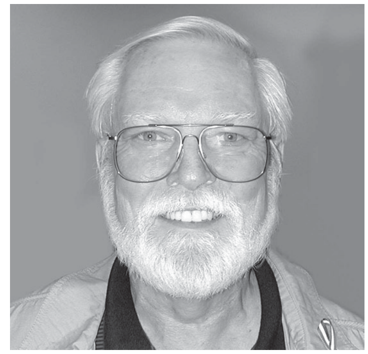
Ceramic laps behave totally different from metal laps. Metal laps are, to some extent, self lubricating while ceramic needs some lubrication. This is why I use synthetic grease with Teflon on my ceramic laps. It is called Permatex Super Lube. It is a synthetic-based lubricant with Teflon. It's a product of Loctite. I believe Radio Shack sells a similar product. I have also used bees wax. It works also, but the Teflon grease works the best. If you tried the ceramic lap without any lube you may able to do a few facets and then there was this terrible scratching and even sparks flying. I have been there and done that. Back to charging the ceramic, first with the lubricant I use about a pea size dab of lube spread it either with my finger or an industrial razor blade. Then I take the stick and work it into the ceramic lap. Take a snippet of paper towel and alcohol and wipe off the excess Teflon grease. Spray on a short spritz of Italdo Diamond and use the stick to work the diamond into the Teflon grease and the ceramic Lap. I charge the lap by running the lap at slow RPM. Last I run the stick from the center of the lap to the outer edge to remove most of the excess. Keep it on the stick for further charging. I use 50k, 100k & 200 K Italdo Diamond spray. I thin the Italdo with about 50% Alcohol. It works for me. Italdo Diamond Spray, Bob-a-Lou Rocks 1833 Gibert, Saginaw, Michigan, 48602 Tele: (989) 793 – 2826. I have no affiliation with any of the above mentioned companies. This works for me when I polish stones either for competition or commercial use. Polishing is a strange thing; what works for me might not work for you. *Dieter Irmischer, Vail, Arizona*

Tip to Align Your Transfer Fixture With Your Machine

Take a scrap piece of window glass 1/4 " or thicker 1/2" to 3/4" wide and 2 1/2 " to 3" long. Take two flat 1/4" keyed dops and place them into your transfer fixture. Clean the glass and the dops so they are free of oil and finger prints. Put a drop of crazy glue on one of the dops. Line up the glass center both ways (height and width). Try to line up the long edge by eyeball as close as possible with the locating device of the dop. Once the glue has set add a drop of crazy glue on the second dop slide the dop on to the glass and you have made a perfect transfer. When the glue has set, remove the glass with the dops opposing each other and insert one dop into the quill of your machine. Adjust your cheater to where you think zero is, using a 96 index gear, with 96 being parallel to your dop keying surface. Mark both long edges of the glass with a magic marker. Set the quill of the machine to the 90 degree girdle cutting position. Grind away to till all the ink is gone. Flip to 48 and cut to the same depth. Make the edges black again. Swap the dops end to end cut a small amount to see where you are grinding. Adjust the cheater slightly and grind again until the ink is gone. Continue swapping the dops from end to end, inking the glass, making slight adjustments of the cheater and grinding the ink away. Once you have reached the point where you're clean of the Magic marker at once after you swapped the dops, your machine is now perfectly lined up and synchronized with your transfer fixture. Grind both sides of the long side of the glass at the same depth setting. Now you can use this as a tool. Loosen your index wheel lock, set your cheater to zero. Place the straight edge of the glass on a flat lap and hold the alignment tool firmly onto the lap and tighten your index lock nut. Use the alignment tool whenever you change index gears. *(ed: or to re-zero the cheater)* This will also help you to cut even girdles (no saw tooth). *Dieter Irmischer, Vail, Arizona*

Editor's Note: For machines that lock the position of the index gear, the position of the cheater when the glass aligns perfectly must be assumed to be the new or correct "zero" position of the cheater.

Facet Designer's Workshop



By Ernie Hawes

As may have already been mentioned elsewhere in this newsletter, due to circumstances beyond our editor's control, we're doing an annual issue ***of The New Mexico Facetor*** for the 2007 membership year instead of our usual bi-monthly publication. So this article will present twelve designs and a lengthy article about them.

I've compiled designs by three different designers, myself, Paul Head, and Danny Hargreaves. Both Paul and Danny, along with myself, are subscribers to the USFG Daily Digest. Thus we are in frequent contact, either directly or through messages in that publication.

Paul is an outstanding faceter, designer and faceting instructor in Tucson, Arizona. I met Paul several years ago at the annual Faceters Hobnob put on by the Old Pueblo Lapidary Club. I've had the good fortune to visit with Paul in his shop and to marvel at his custom mad faceting machine, which he designed and built himself. We all want accurate equipment built to extreme tolerances. As a measure of the tolerances on Paul's machine, when you remove one of his custom made dops from the quill, the fit is so close that you hear a pop as the dop leaves the quill. I don't think it can get any closer than that!

Danny lives in Edinburgh, Scotland where he spends a good deal of his spare time faceting and designing new gem cuts. I met Danny a couple of years ago at the Tucson show, and we've been good friends since. Both of us are Fac-Ette users, and will be sharing a large home in Tucson this coming February with several other Fac-Ette users and the general manager of the Fac-Ette company. I'm looking forward to a great experience sharing ideas and generally having a good time.

On to the designs.

Stephanie's Stone

Our first pattern is called ***Stephanie's Stone*** and was designed by Danny Hargreaves. While there are girdle facets, both the crown and pavilion girdle facets meet at the corners of each side of the girdle. This is quite unusual and will require a bit of skill getting crown and pavilion facets to meet each other exactly all around the stone. Danny accomplishes this crown and pavilion match-up by off-setting the crown and pavilion mains. While this is not totally uncommon, the resulting girdle effect is something hardly ever attempted. Of course, the cutter could decide to enlarge the girdle slightly to avoid the sharp points that would otherwise result at the corners of each girdle facet. Many materials are prone to chipping in such a circumstance, and it might be hard to finish a stone without at least one chipped corner.

Optically, Danny's design is almost uniformly bright except around the edges. In colored stones this should be almost unnoticeable due to the lightening of the stone along the thinner area near the girdle. Danny intended this design to be cut in corundum, but with proper tangent ratioing, I think it would look nice in a number of different materials.

Long Octagon I

Our second design is based upon a pattern I worked out several years ago for Louis Natonek. I call it ***Long Octagon I***, as there are some other derivatives of the basic pattern that I'm working on, but am not yet ready to publish.

Cutting this design looks deceptively easy, but may require some adjustment of angles following pavilion step 2. You might want to skip cutting row 3 until at least after you cut step 4, or even 4, 5 and 6. Then you can come back and cut in step 3, making appropriate angle adjustments to get the meets correctly. On the other hand, if you want to get the design to be absolutely correct, it well could be necessary to go back over pavilion facet step 2 and 3 in relation to steps 4, 5 and 6. In other words, it's not a meetpoint design, and will require some judicious cutting to get everything to turn out right.

I've cut this design in a light blue synthetic spinel, and it looks nice. As with most longer stones, brightness is not altogether even throughout, but there's some nice sparkle. The design works best in stones of light to medium color shades. Even with tangent ratioing, I wouldn't recommend this design for lower RI material unless you're simply trying to darken a stone that is too light.

Niner I

I've commented several times that I have trouble coming up with names for designs. This next pattern is one of those where a good name just couldn't come to mind. Early in the year I was working on designs that used the 72 index, and had nine sides, thus an odd number of mains. I kept referring to them as my "niners" and the name stuck. I'm presenting the first one here, so I'm simply calling it ***Niner I***. The extra row of chevron facets on the pavilion and the split mains on the crown give the design some interesting character, but also make the design one best suited for medium to large stones, at least 10mm in size, if not larger. So far, by calculating different angle combinations, I simply haven't been able to significantly lighten the edges around the girdle. So, this could well be a design you would want to use to darken an exceptionally light stone. Although specifically designed for quartz, I believe it would work well to darken a light colored aquamarine or morganite.

I'm interested in the idea of using an odd number of mains to improve the apparent brightness of a gem. There is considerable argument around this concept, and I'm not positive that it really works. I feel fairly certain that an odd number of mains adds to the sparkle in a stone, and this may be what people see when they think an odd number of mains makes a stone brighter. It may also be that the odd number of mains increases the overall number of facets enough for that to be why a stone appears to be brighter. I've been conducting some cutting experiments in this regard, but so far, I've not been able to come to a definitive conclusion.

Rounded Square 4

Over the years I've created a number of square patterns, most of which have been relatively easy to cut. For a while now, I've been working on squares that have rounded corners. I'm presenting two of them in the newsletter this year. The first is called ***Rounded Square 4***, (once again my old problem with good names).

Rounded Square 4 is a fairly straight forward design that should have few cutting problems. I would not hesitate to ask a beginning faceter to try this design after they have cut a couple of round brilliant. Where a potential problem lies is with Step ***e*** on the crown. If your machine is not aligned properly, one or more sides of this row may be skewed, but it is so small that it should not be noticed unless the alignment is significantly off.

As with any non-round design, there is some slight darkening along the sides. This does not show very noticeably in the finished stone. Personally, I think this type of design is very versatile and can be used for earrings, rings and/or pendants, depending on the size of stone cut.

Brilliant Trillion

One of the most famous faceting designers of all time, Fred Van Sant, commented on various occasions that he did not like triangular designs because they were dark in the corners. Various designers, including myself, have proven this to not totally be the case, but it's not easy to come up with a triangular design with much brightness in the corners.

Earlier this year, Paul Head took an old design that had uneven length girdle facets and reworked it so that the girdles were even, and the design could then be cut meetpoint. Paul also improved on the angles, making the design really attractive. And, while not totally bright, the corners have both brightness and sparkle. But to achieve this in quartz is really remarkable. I cut Paul's design in medium colored amethyst and was extraordinarily pleased with the results. Paul named his design simply, ***Brilliant Trillion***. If you haven't cut a trillion before, this one is an excellent one to try.

Rounded Square 7

Take a close look at both patterns, ***Rounded Square 4*** and ***Rounded Square 7***. While at first glance finished stones in these two patterns might look about the same, there are some differences. First, the corner girdle facets are at different settings, giving a different rounding. Secondly, the pavilion is also quite different. A viewer of a cut stone may notice the sides are slightly darker on ***Rounded Square 7***, and the sparkle pattern will be a little different. Intended for different RI materials, I like characteristics of both designs.

You'll note by the numbers that there are at least seven designs in this series. The two that I'm presenting here are the two that I like best so far. I will continue to try to improve on the performance of both patterns, and may publish revisions later, or perhaps even publish some of the other variations. It's challenging to try to come up with something different, and sometimes what looks on paper to be better than a different variation doesn't always turn out that way when the stone is cut.

Star Flower I

In addition to squares and odd numbered main patterns, I've also been working on a few octagons that are basically simplified rounds. ***Star Flower I*** is the first of them that I feel is finished enough to publish. Simple does not necessarily mean easy. The pavilion mains on this design are very easy to over-cut and the little petal like facets of step ***e*** on the crown take some care to get just right. Consequently, I rate this psttern to be moderate in difficulty and encourage beginners to have several stones completed before undertaking this design.

While designed for corundum, it could be modified for other materials. It is a mixed cut, with step facets predominating on the crown while the pavilion is a brilliant style. I've said this before, but I guess I should repeat it. Having step cut facets on either the pavilion or crown while having the opposite on the other side gives some very interesting optical effects. This is most frequently done with the step facets on the pavilion and the brilliant style facets on the crown, but the effect is similar either way, and can be surprisingly bright with a lot of scintillation. Some cutters may choose to omit the petal shaped facets on the crown. That's fine, but I think they help with the overall appearance of the stone.

Holly's Stone

Danny Hargreaves tends to name his designs after

women or girls; I'm not sure which one or both. Some I do know are family, but others he hasn't told me. But knowing Danny, I suspect there's a romantic connection with some.

When Danny sent me the design for ***Holly's Stone***, I was really quite intrigued. First of all, we don't often see a hexagonal design. Secondly, the arrangements of the facets on the crown are quite intriguing. Third, the angles on both the pavilion and the crown are quite unusual, and all the more so because they result in a very bright stone when viewed straight on. This design probably wouldn't work transposed for lower RI material, but in anything above RI 1.72 should produce a very nice stone. And it appears that this pattern would work very well on relatively shallow material. It should also be noted that on the crown, there are different appearing facets that are actually cut the same. Both steps ***b*** and ***c*** have facets in the same row that don't look like other facets in the row.

I suppose one could call Holly's Stone a novelty cut, but that shouldn't serve to sell the design short. It really does cut a very attractive stone, and it's not often that we come across a design that is both attractive and can be used with shallow material.

Lee-Anne

I have to ask Danny if the ladies he names his designs after know each other. I hope he can keep track of which design is for which lady friend. (Just kidding.)

Although the graphic representation of the light return under different conditions would suggest a series of dark spots near the center of the stone, I doubt that these are especially noticeable in the real thing. Danny designed this pattern for CZ, and with an RI of 2.16, few designs would be likely to show particularly dark areas when cut in this very bright material. Actually, this design has a lot of scintillation and should cut a bright stone with a lot of sparkle. Although I haven't cut this design myself yet, I suspect that the slight twist that occurs at crown step ***c*** also adds to the overall optical effect of this unusual design.

On the other hand, this design is not a true meetpoint, although there are some rows that can be cut in meetpoint style. Judgment is required when cutting the pavilion. Things go easier on the crown, but a watchful eye is needed when cutting crown steps ***a*** and ***b***.

Sadie One of Tew

Many owners of Fac-Ette GemMaster II faceting machines are friends with the company general manager, Johnny Tew, myself, and Danny Hargreaves included. Quite a few Fac-Ette owners also belong to an Internet usegroup sponsored by the company. When we learned that Johnny and his wife were having a new addition to the family, we followed the progress of this blessed event closely. Danny one-upped the rest of us by creating a new design in honor of the new Tew daughter. Thus, we have the name, ***Sadie One of Tew***.

Once again, in creating his design, Danny offset the crown mains. Since they center in the middle of the girdle facets the girdle line in relation to the crown is not level. I'm curious what this does to the light entering the stone at the girdle. Also, stone setters may have to make some adjustments when mounting a stone with a girdle like this. Regardless, it is a very bright design with a lot of sparkle, and I expect the young lady it is named for will have lots of those same characteristics.

Mia's Oval

As most New Mexicans know, Santa Fe counts among its residents some famous, and some not-so-famous but still interesting people. There are artists, writers, musicians, movie stars, outed CIA agents, politicians and other sundry sorts of folks scattered among the population of our state's capitol city. And there just so happens to be at least one real honest-to-goodness princess living there, who also just happens to work with my wife, Rebecca. Mia, (her nick name; privacy considerations preclude my giving her real name) is the youngest daughter of one of the last monarchs in Eastern Europe. Her father's reign was cut short by the communist occupation of their country, and the family had to leave, but Mia still has every right to call herself a princess, even though what was once her father's kingdom is now a modern republic.

Mia loves purple, (what princess wouldn't?), and Rebecca decided that it would be nice if I created a design specifically for Mia that my wife would then cut in amethyst to give to Mia for her birthday. I don't ordinarily create designs for specific individuals. The last time I did that was for our great granddaughter. But my wife prevailed and the result of my undertaking this request is ***Mia's Oval***.

Mia is not a small woman, so Rebecca and I agreed that a large ring stone in medium-dark amethyst would be suitable. Consequently, I decided that I would split the pavilion mains on the side and ends of the design. This allowed for a reasonable amount of both brightness and scintillation. This is a meetpoint design and should not be overly difficult for the average cutter to facet. I would, however, not recommend cutting the design in anything narrower than 10mm.

Becky's Barion II

Having designed a stone for our friend, Mia, I felt that it was probably a good idea to create a design for my wife. What resulted was actually two designs. I'm holding off publishing the first one for now, but decided to finish the designs for this year with the second. It's a barion emerald shape and I have named it simply, ***Becky's Barion II***.

Because of the long emerald shape, it wasn't possible to avoid some darkening in the ends. Consequently, I don't recommend cutting this in anything very dark. However, it should work fine in light to medium toned stones. It looks fine in light citrine and rose de France amethyst. It's even OK in medium citrine and amethyst, but an attempt to cut it in a darker amethyst was not successful.

****

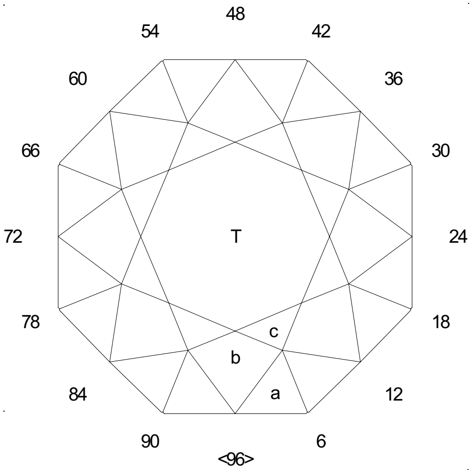
Next Year

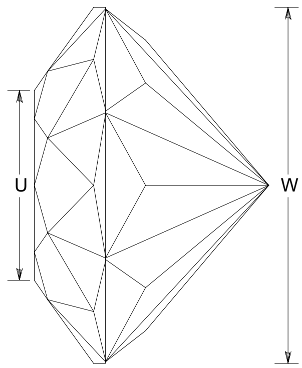
Throughout the coming year, we hope to be able to continue publishing our newsletter, however irregularly it may have to be. Our editor's work will keep him out of state at least for the first several months of the year. Whatever the situation, I will continue my design work and invite other designers to submit designs for publication. It may be that I will put together a few designs periodically and e-mail them to members of the Guild. Any designer is invited to submit their designs for publication. Also, I enjoy hearing from people who have cut designs that we have published. So if you like one of our designs, or even if you've had a problem cutting one, let us hear from you.

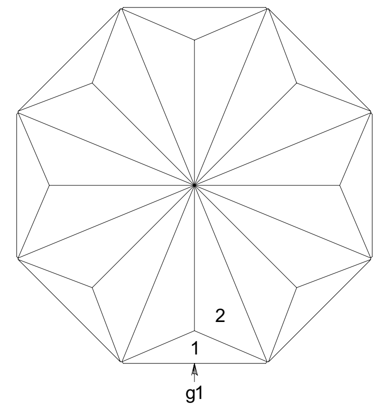
Faceting and the Internet
By Ernie Hawes

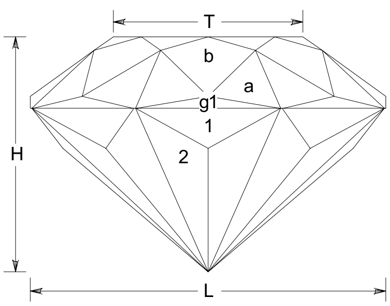
As many of you know, I'm an avid Internet user. Of course, one of the things I especially like to do on the Internet is look up things about faceting. Over the years I've looked at many different sites, some still very active, and some no longer in existence. Some of the sites are vendors of faceting equipment, supplies and rough. Some of these contain very useful faceting information in addition to the vendor's goods. Other sites contain gemological information, gem diagrams, galleries of faceted gems, and other information related to faceting. One very important site is the USFG digest website. I encourage every faceter to subscribe. Below I have listed thirty websites that every faceter should find interesting. There are many more that I haven't listed. I'm sure there are some I haven't discovered yet. You could spend many hours, even days looking at some of these sites. There's a lot to learn, and much just simply enjoy.

EQUIPMENT/SUPPLIESwww.gemcutter.com/getstart.htm
www.mysticrystals.com/faceting.htm
www.gemcad.com/
www.rockhounds.com/rockshop/gem_designs/design_index.html
www.rockhounds.com/rockshop/classifieds/classifieds.shtml
www.gia.edu/gemsandgemology/31265/19341980_back_issues.cfm
www.gia.edu/index.cfm
www.faceters.com/designs/
www.faceters.com/
www.creativegems.com/
www.rockpeddler.com/
www.kingsleynorth.com
www.alpha-supply.com
www.tmsgems.com/store/index.php?cPath=2
www.gemcutter.com
www.facetingmachines.com/machines.shtml
www.gemstoneartist.com/
www.usfacetersguild.org/
www.fac-ette.com/DesignersPage.html
www.usfacetersguild.org/
www.usfacetersguild.org/faceters_list.shtml
www.ultratec-facet.com/Library.htm
www.gemologyonline.com/Forum/phpBB2/index.php
www.morioncompany.com/index.html
www.gemsociety.org/
www.qualitygemrough.com/
www.gearloose.com/
www.theimage.com/
http://www.ukfcg.org/links.htm





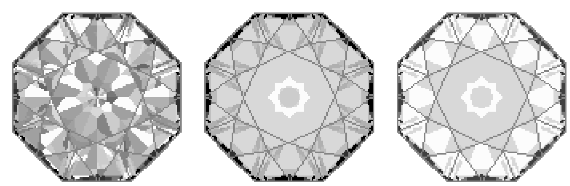




Stephanie's Stone

Copyright Danny Hargreaves

Angles for R.I. = 1.760
57 + 8 girdles = 65 facets
8-fold, mirror-image symmetry
96 index
L/W = 1.000 T/W = 0.537 U/W = 0.537
H/W = 0.663
Vol./W³ = 0.244



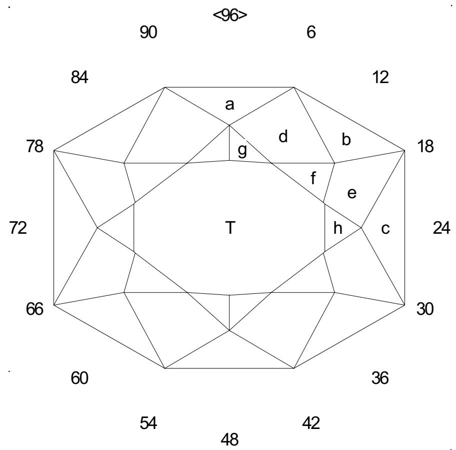
Average Brightness: COS = 79.6% ISO = 87.6%

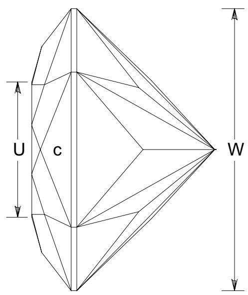
PAVILION

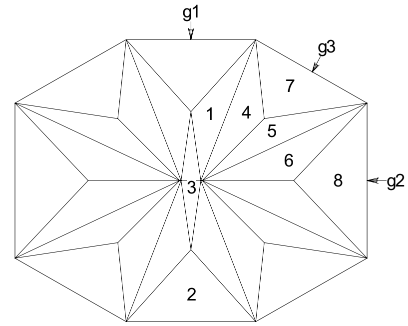
g1	90.00°	96-12-24-36-48-60-72-84
1	51.00°	96-12-24-36-48-60-72-84
2	41.00°	03-09-15-21-27-33-39-45- 51-57-63-69-75-81-87-93

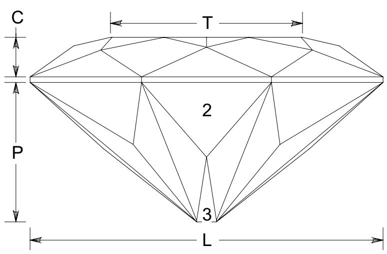
CROWN

a	41.00°	03-09-15-21-27-33-39-45- 51-57-63-69-75-81-87-93
b	36.00°	96-12-24-36-48-60-72-84
c	21.00°	06-18-30-42-54-66-78-90
T	00.00°	Table





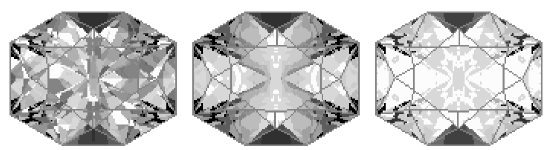




Long Octagon I

By Ernie Hawes

Angles for R.I. = 1.720
53 + 8 girdles = 61 facets
2-fold, mirror-image symmetry
96 index
L/W = 1.250 T/W = 0.676 U/W = 0.483
P/W = 0.495 C/W = 0.137
Vol./W³ = 0.302
Average Brightness: COS = 64.8% ISO = 81.9%

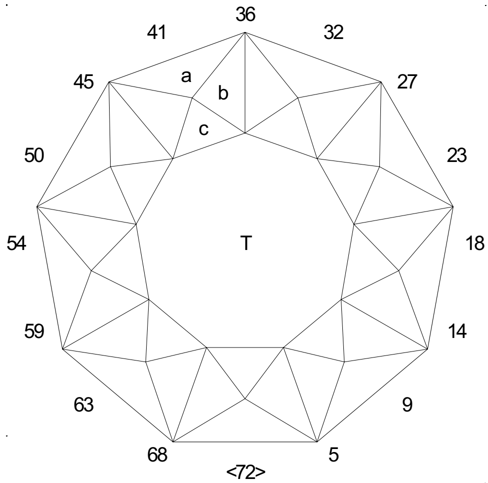


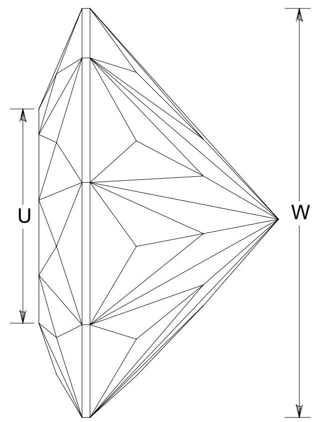
PAVILION

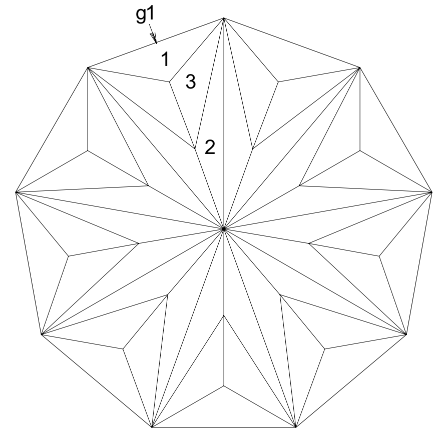
g1	90.00°	96-48	Set width
g2	90.00°	24-72	Set length
1	43.50°	02-46-50-94	Cut to centerpoint
2	46.50°	96-48	Cut to approx.1/3 length at girdle
3	42.70°	96-48	Cut to tip of 2
4	42.75°	07-41-55-89	Meet 2 at girdle
g3	90.00°	08-40-56-88	meet g1 & g2
5	41.75°	09-39-57-87	Meet 1, 3 & 4 at culet
6	38.60°	22-26-70-74	Meet 1,3,4, & 5 at culet
7	44.00°	08-40-56-88	Meet 4 & 5 at girdle
8	42.00°	24-72	Meet 6 facets at girdle

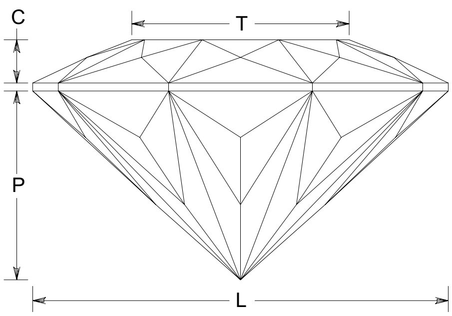
CROWN

a	38.00°	96-48	Set girdle thickness
b	30.60°	08-40-56-88	Cut to level girdle line
c	35.20°	24-72	Cut to level girdle line
d	26.20°	06-42-54-90	Meet a & b at girdle
e	21.90°	16-32-64-80	Meet b & c at girdle
f	17.10°	10-38-58-86	Meet at juncture of b,d & e
g	14.90°	01-47-49-95	Meet at juncture of d & e
h	12.25°	24-72	Meet at juncture of c & e
T	00.00°	Table	





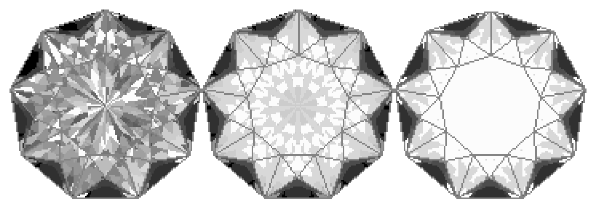




Niner I

By Ernie Hawes

Angles for R.I. = 1.540
82 + 9 girdles = 91 facets
1-fold, mirror-image symmetry
72 index
L/W = 1.015 T/W = 0.535 U/W = 0.527
P/W = 0.461 C/W = 0.108
Vol./W³ = 0.193
Average Brightness: COS = 75.3% ISO = 80.1%

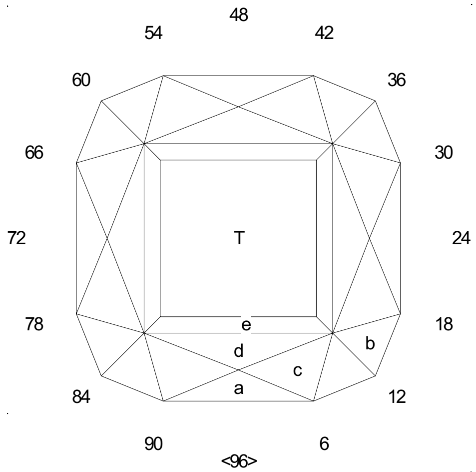


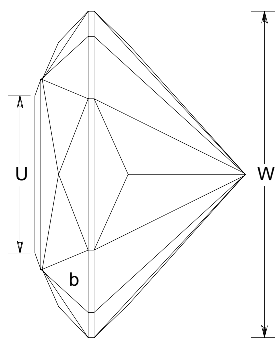
PAVILION

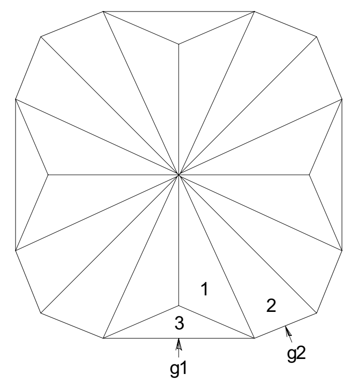
g1	90.00°	72-08-16-24-32-40-48-56-64
1	48.00°	72-08-16-24-32-40-48-56-64
2	41.90°	03-05-11-13-19-21-27-29-35-37-43-45-51-53-59-61-67-69
3	44.00°	01-07-09-15-17-23-25-31-33-39-41-47-49-55-57-63-65-71

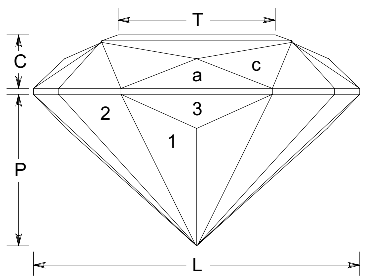
CROWN

a	32.00°	72-08-16-24-32-40-48-56-64
b	24.00°	03-05-11-13-19-21-27-29-35-37-43-45-51-53-59-61-67-69
c	19.00°	72-08-16-24-32-40-48-56-64
T	00.00°	Table





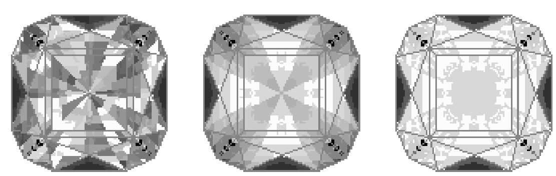




Rounded Square 4

By Ernie Hawes

Angles for R.I. = 1.760
49 + 12 girdles = 61 facets
4-fold, mirror-image symmetry
96 index
L/W = 1.000 T/W = 0.477 U/W = 0.477
P/W = 0.463 C/W = 0.165
Vol./W³ = 0.254
Average Brightness: COS = 71.4% ISO = 85.6%

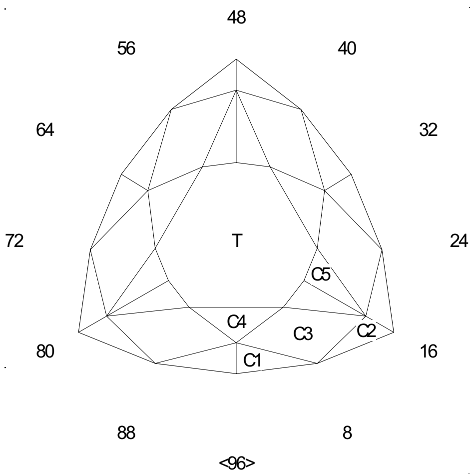


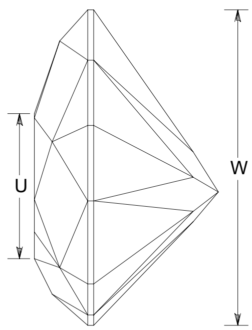
PAVILION

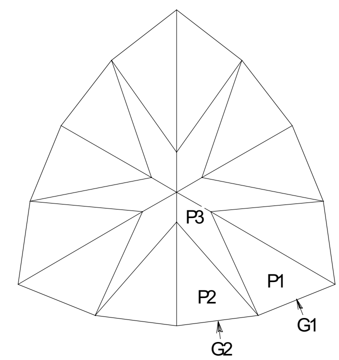
1	42.00°	01-23-25-47-49-71-73-95
2	40.10°	06-18-30-42-54-66-78-90
3	45.90°	96-24-48-72
g1	90.00°	96-24-48-72
g2	90.00°	06-18-30-42-54-66-78-90

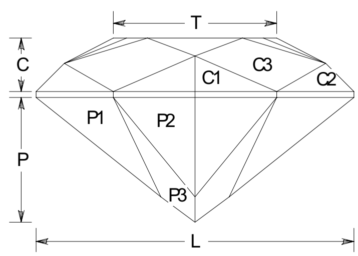
CROWN

a	43.50°	96-24-48-72
b	40.30°	06-18-30-42-54-66-78-90
c	36.00°	02-22-26-46-50-70-74-94
d	25.40°	96-24-48-72
e	21.00°	96-24-48-72
T	00.00°	Table





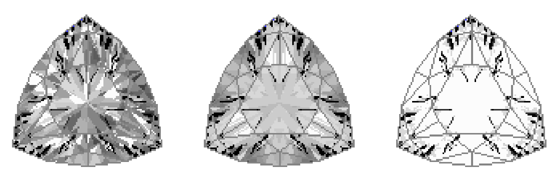




Brilliant Trillion

By Paul Head

ISO 87.4%
Angles for R.I. = 1.540
46 + 12 girdles = 58 facets
3-fold, mirror-image symmetry
96 index
L/W = 1.000 T/W = 0.515 U/W = 0.460
P/W = 0.391 C/W = 0.168
Vol./W³ = 0.178
Average Brightness: COS = 70.2% ISO = 87.6%

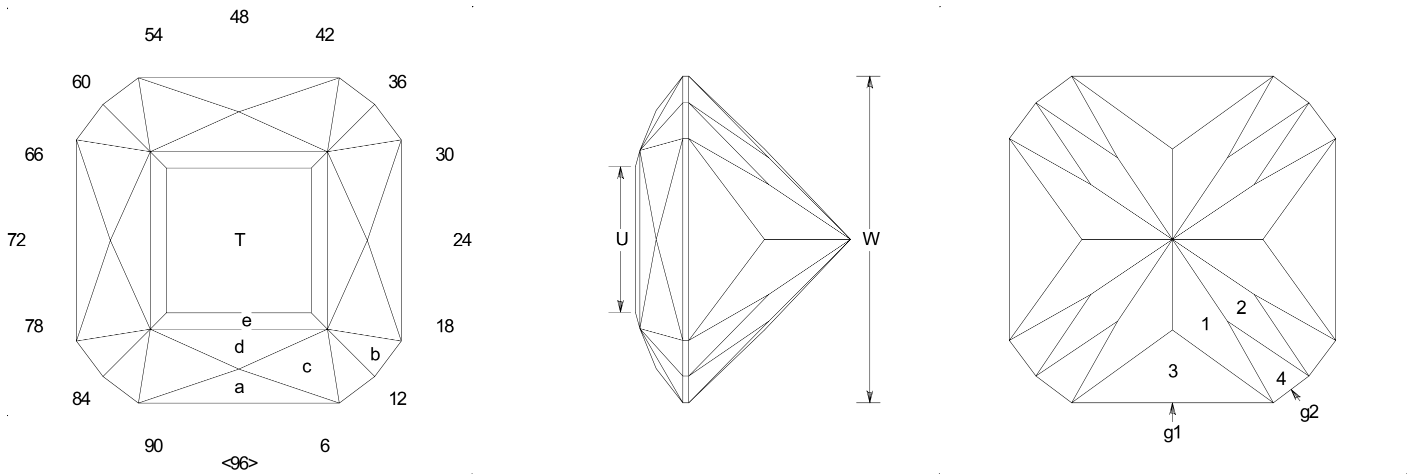


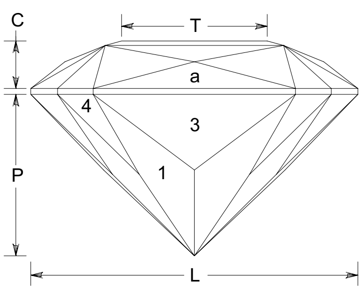
PAVILION

G1	90.00°	06-26-38-58-70-90	Set size (Length L)
G2	90.00°	02-30-34-62-66-94	Level girdle
P1	41.11°	06-26-38-58-70-90	Cut to center point
P2	43.65°	02-30-34-62-66-94	Meet center point
P3	41.50°	04-28-36-60-68-92	Meet G1-G2-P1-P2 at the girdle.

CROWN

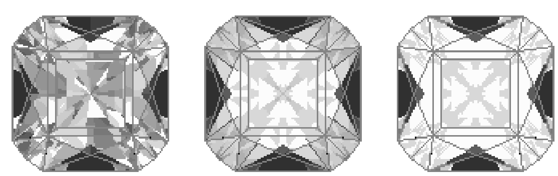
C1	47.86°	02-30-34-62-66-94	Set girdle thickness
C2	47.86°	06-26-38-58-70-90	Meet G1-G2-C1 at the girdle
C3	40.00°	04-28-36-60-68-92	Meet at the same point
C4	27.42°	96-32-64	Meet C1-C1-C3-C3
C5	19.44°	14-18-46-50-78-82	Meet C2-C2-C3-C3
T	00.00°	Table	Meet C3-C4-C5 for the table





Rounded Square 7
By Ernie Hawes

Angles for R.I. = 1.650
53 + 12 girdles = 65 facets
4-fold, mirror-image symmetry
96 index
L/W = 1.000 T/W = 0.449 U/W = 0.449
P/W = 0.494 C/W = 0.148
Vol./W³ = 0.257
Average Brightness: COS = 71.8% ISO = 80.8%

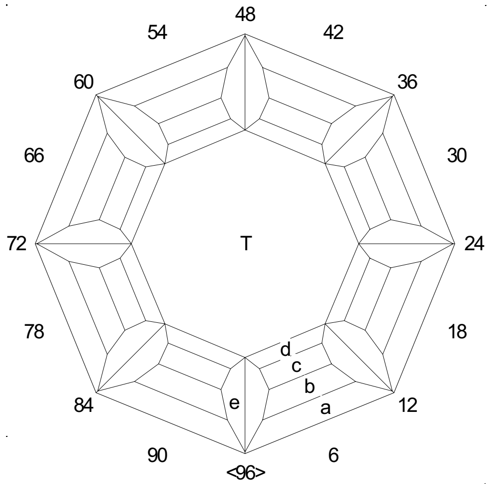


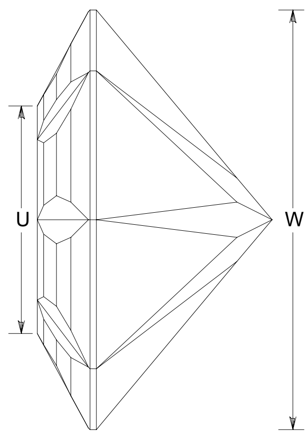
PAVILION

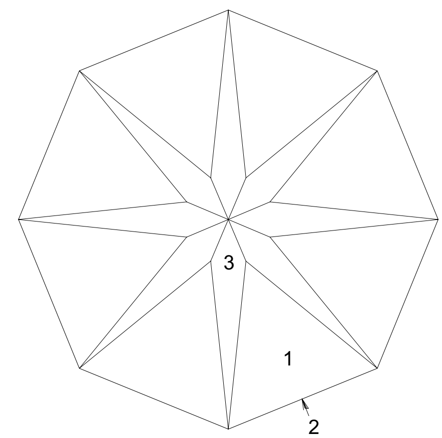
g1	90.00°	96-24-48-72
g2	90.00°	10-14-34-38-58-62-82-86
1	43.60°	01-23-25-47-49-71-73-95
2	40.00°	12-36-60-84
3	46.00°	96-24-48-72
4	41.00°	10-14-34-38-58-62-82-86

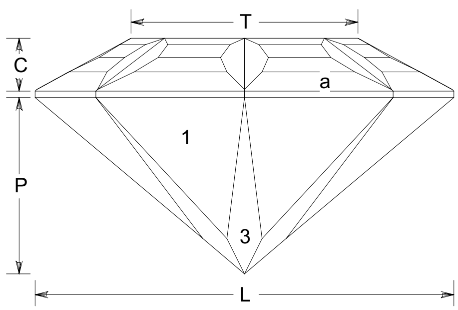
CROWN

a	38.40°	96-24-48-72
b	33.40°	10-14-34-38-58-62-82-86
c	30.00°	02-22-26-46-50-70-74-94
d	22.00°	96-24-48-72
e	17.00°	96-24-48-72
T	00.00°	Table





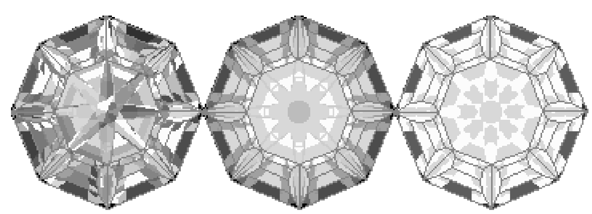




Star Flower I

By Ernie Hawes

Angles for R.I. = 1.760
65 + 8 girdles = 73 facets
8-fold, mirror-image symmetry
96 index
L/W = 1.000 T/W = 0.539 U/W = 0.539
P/W = 0.420 C/W = 0.124
Vol./W³ = 0.169
Average Brightness: COS = 75.5% ISO = 87.2%

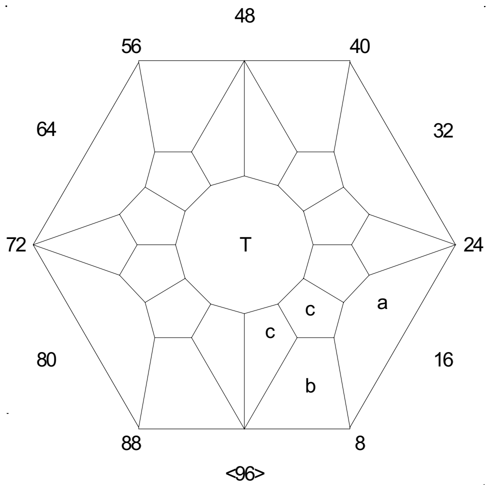


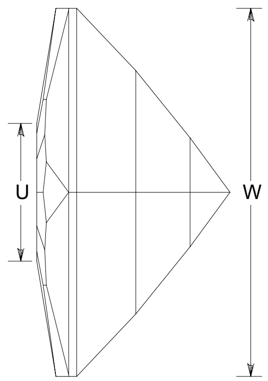
PAVILION

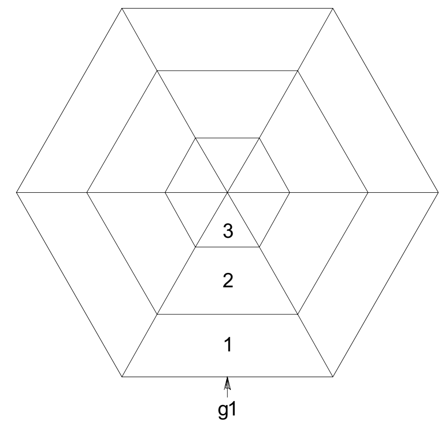
1	43.50°	06-18-30-42-54-66-78-90	Cut to TCP
2	90.00°	06-18-30-42-54-66-78-90	Set stone diameter
3	40.00°	96-12-24-36-48-60-72-84	Meet at girdle; set PCP

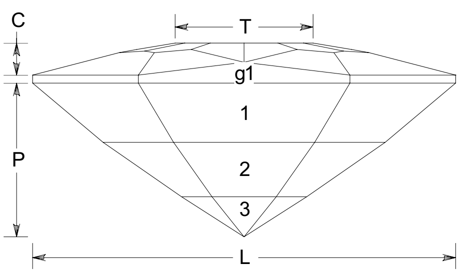
CROWN

a	36.00°	06-18-30-42-54-66-78-90	Set girdle thickness
b	32.00°	06-18-30-42-54-66-78-90	Cut b & c to approx. same size
c	27.00°	06-18-30-42-54-66-78-90	Cut to establish size of b
d	22.00°	06-18-30-42-54-66-78-90	Cut so c is same size as b
e	28.30°	01-11-13-23-25-35-37-47-49-59-61-71-73-83-85-95	Meet at girdle
T	00.00°	Table	Meet at tips of e





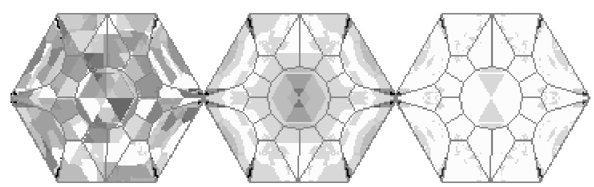




Holly’s Stone

Copyright Danny Hargreaves

Angles for R.I. = 1.760
41 + 6 girdles = 47 facets
6-fold, mirror-image symmetry
96 index
L/W = 1.155 T/W = 0.373 U/W = 0.373
P/W = 0.419 C/W = 0.090
Vol./W³ = 0.194
Average Brightness: COS = 88.3% iso = 95.6%

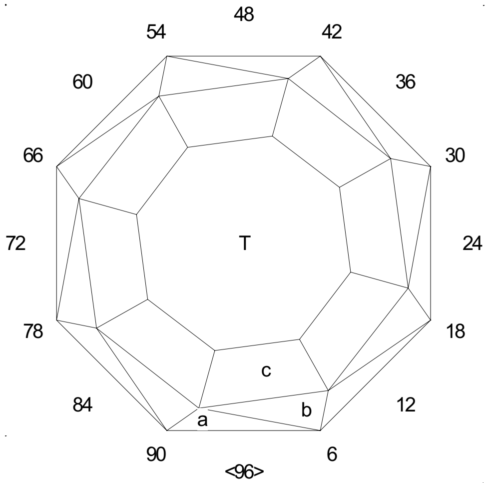


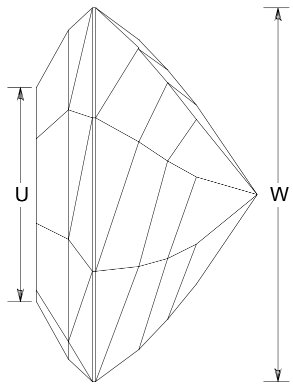
PAVILION

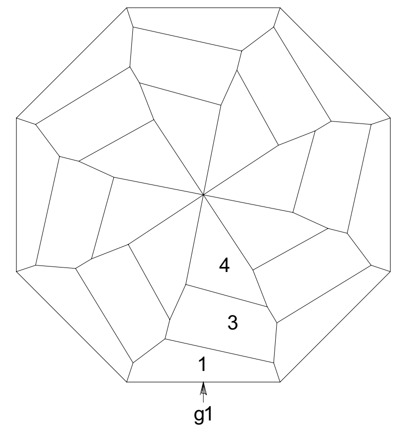
g1	90.00°	96-16-32-48-64-80
1	44.00°	96-16-32-48-64-80
2	39.00°	96-16-32-48-64-80
3	36.00°	96-16-32-48-64-80

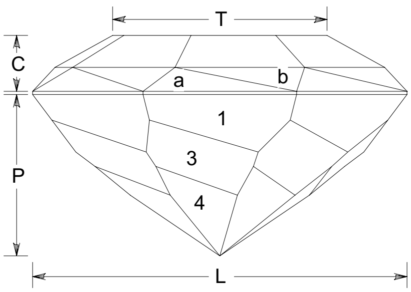
CROWN

a	20.00°	16-32-64-80
b	14.10°	08-24-40-56-72-88
c	10.00°	04-12-20-28-36-44- 52-60-68-76-84-92
T	00.00°	Table









Lee-Anne

Copyright Danny Hargreaves

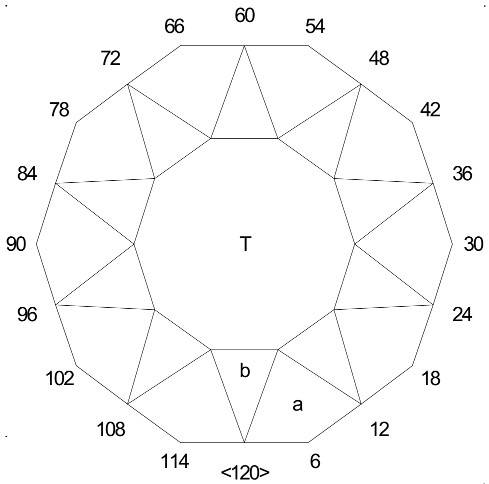
Angles for R.I. = 2.160
49 + 8 girdles = 57 facets
8-fold radial symmetry
96 index
L/W = 1.000 T/W = 0.574 U/W = 0.574
P/W = 0.429 C/W = 0.149
Vol./W³ = 0.231
Average Brightness: COS = 65.2% ISO = 80.8%

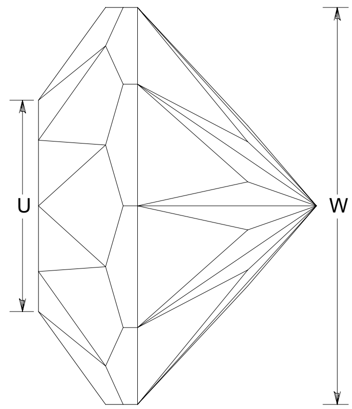
PAVILION

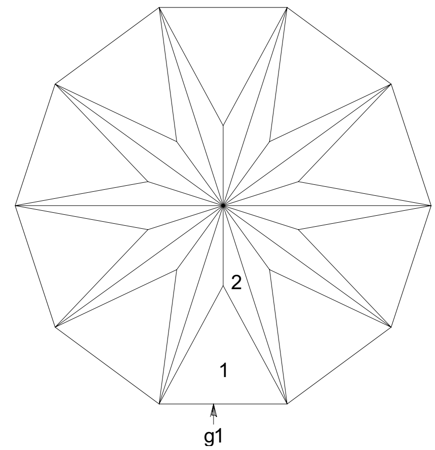
g1	90.00°	96-12-24-36-48-60-72-84
1	52.50°	96-12-24-36-48-60-72-84
3	39.88°	02-14-26-38-50-62-74-86
4	36.00°	03-15-27-39-51-63-75-87

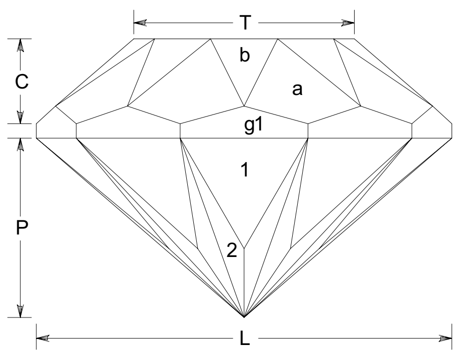
CROWN

a	47.00°	96-12-24-36-48-60-72-84
b	32.27°	02-14-26-38-50-62-74-86
c	30.00°	02-14-26-38-50-62-74-86
T	00.00°	Table





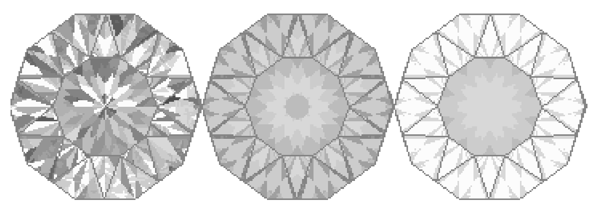




Sadie One of Tew

Copyright Danny Hargreaves

Angles for R.I. = 2.000
51 + 10 girdles = 61 facets
10-fold, mirror-image symmetry
120 index
L/W = 1.051 T/W = 0.562 U/W = 0.534
P/W = 0.451 C/W = 0.213
Vol./W³ = 0.269
Average Brightness: COS = 77.9%   ISO = 91.8%

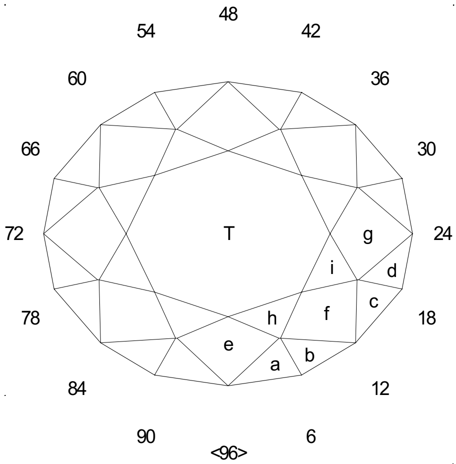


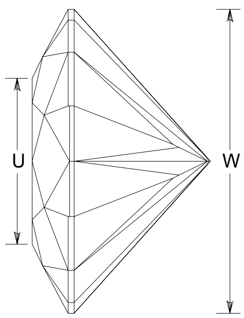
PAVILION

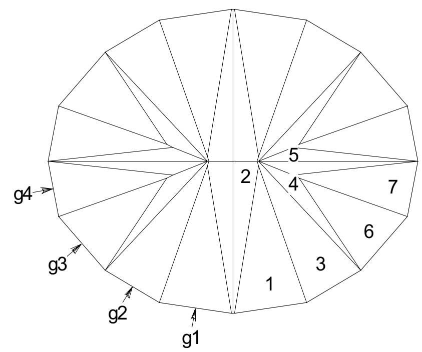
g1	90.00°	120-012-024-036-048-060-072-084-096-108
1	43.00°	120-012-024-036-048-060-072-084-096-108
2	41.00°	003-009-015-021-027-033-039-045-051-057-063-069-075-081-087-093-099-105-111-117

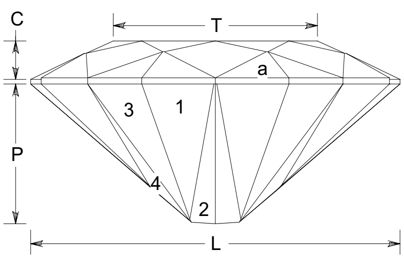
CROWN

a	41.00°	006-018-030-042-054-066-078-090-102-114
b	36.00°	120-012-024-036-048-060-072-084-096-108
T	00.00°	Table





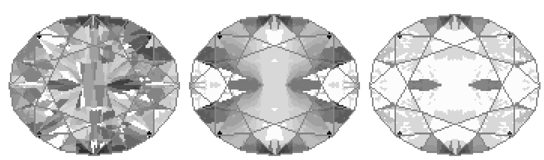




Mia's Oval

By Ernie Hawes

Angles for R.I. = 1.540
61 + 16 girdles = 77 facets
2-fold, mirror-image symmetry
96 index
L/W = 1.249 T/W = 0.683 U/W = 0.549
P/W = 0.459 C/W = 0.126
Vol./W³ = 0.256
Average Brightness: COS = 70.4% ISO = 88.4%

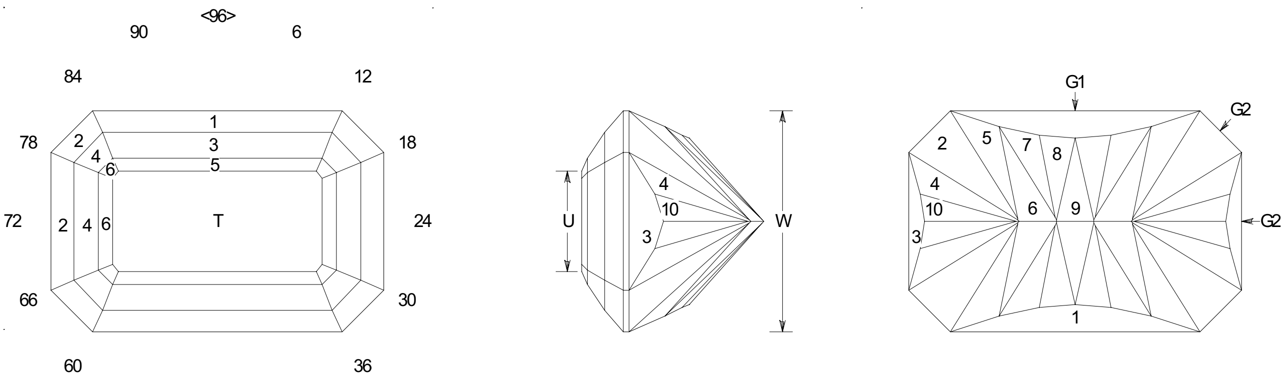


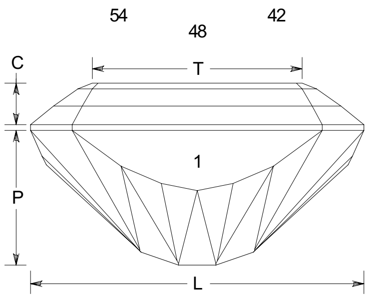
PAVILION

g1	90.00°	02-46-50-94	Establish width
1	43.10°	02-46-50-94	Cut to center line
2	42.60°	01-47-49-95	Cut to centerpoin at girdle
3	42.90°	08-40-56-88	Meet 1 & 2 at culet line
4	42.10°	11-37-59-85	Meet 1,2 & 3 at culet line
g2	90.00°	08-40-56-88	Cut level with g1
5	40.00°	23-25-71-73	Meet 1,2,3 & 4 at culet line
6	42.80°	13-35-61-83	Cut to level girdle line
g3	90.00°	13-35-61-83	Cut level with g1 & g2
g4	90.00°	21-27-69-75	Cut level with g1,g2 & g3
7	40.90°	21-27-69-75	Cut to level girdle line

CROWN

a	33.40°	02-46-50-94
b	31.30°	08-40-56-88
c	31.70°	13-35-61-83
d	28.50°	21-27-69-75
e	29.10°	96-48
f	27.00°	10-38-58-86
g	24.10°	24-72
h	17.90°	05-43-53-91
i	15.70°	17-31-65-79
T	0.00°	Table

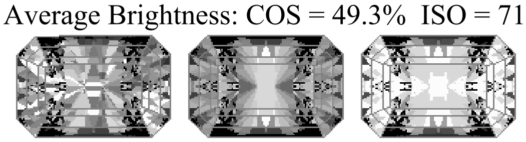




Becky's Barion II

By Ernie Hawes

Angles for R.I. = 1.540
59 + 8 girdles = 67 facets
2-fold, mirror-image symmetry
96 index
L/W = 1.500 T/W = 0.948 U/W = 0.448
P/W = 0.606 C/W = 0.185
Vol./W³ = 0.581
Average Brightness: COS = 49.3% ISO = 71.0%



PAVILION

G1	90.00°	96-48	Set width
G2	90.00°	12-24-36-60-72-84	Cut 24 & 72 to 1.5 width
1	65.10°	96-48	Set girdle line
2	43.80°	12-36-60-84	Cut to even girdle
3	65.10°	24-72	Cut to even girdle
4	43.40°	18-30-66-78	Meet at girdle
5	43.00°	08-40-56-88	Meet at girdle
6	42.00°	06-42-54-90	Meet at juncture 2 & 4
7	42.90°	04-44-52-92	Meet at centerline created by 6
8	42.90°	02-46-50-94	Meet at juncture 6 & 7
9	41.80°	96-48	Meet at juncture 1 & 8
10	43.30°	21-27-69-75	Meet at juncture 2 ,4 & 6

CROWN

1	38.60°	96-48
2	38.60°	12-24-36-60- 72-84
3	33.50°	96-48
4	33.50°	12-24-36-60- 72-84
5	25.30°	96-48
6	25.30°	12-24-36-60- 72-84
T	0.00°	Table

For lighter materials only

Another interesting article, this one is being reprinted from *Facet Talk*, the Australian Facetors' Guild Unlimited newsletter (vol 142 - March/April'05).

TRANSFERRING

BILL HORTON

Taken from ***The Midwest Faceter***

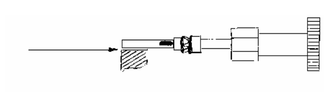
March 2005

Transferring is one of the most difficult skills in faceting. It takes a very good transfer block, as well as a good deal of patience, and some skill.

If you think about the process, visualize the assembly of the original dop, the half completed gemstone and the transfer dop. This assembly is approximately 5 inches in length. There will be some "run-out" in this assembly. A good rule o thumb is to have less than three thousands of an inch. This will enable you to have the crown aligned properly with the pavilion, resulting in a uniform girdle width.

The faceting machine platen has the shaft that holds the laps. It's a very useful tool to check the "run-out" of the assembly. I usually facet the pavilion first, but that's not important. This procedure will work whether you facet the crown or the pavilion first. When I have completed the first half of the gemstone, and I'm ready for the transfer, I use a "sharpie" to mark a spot on the original dop, at the highest index number. I use a micrometer to measure the diameter of the dops. I have several bins in the tool box. The bins are labeled for the diameters of the dops. Dops are made with the shafts .250 inches. Some undersized .001, .0015, .002, etc. Make sure to use the dops of equal diameters. I have used a "centering" drill to drill a very small hole in the dops where the culet will rest I the transfer dop. I place a very tiny bit of "play dough" in this recess. This helps to protect the culet while cutting the other half of the gemstone. Clean the area with alcohol that will receive the glue. Place the original dop and half finished assembly into the transfer block. Attach the transfer dop and glue this to the original. Allow time for the glue to set up.

Place the assembly back into the hand piece with the transfer dop into the hand piece, with the mark from the sharpie aligned to the highest index. Let's assume for this article, it will be index number 96. Place the elevation to 90 degrees, and the hand piece in "free wheeling". Lower the hand piece so the extreme end of the original dop just starts to touch the platen shaft, as in Figure 1.



Rotate the hand piece carefully, and watch the indices of the index gear. Lets assume just for this article, that then end of the original dop barely touches the shaft from index 24 back toward index 96 and releases at index 72. That will tell you that index 96 is the lowest spot of the run out. Stop the assembly at index 96, and raise the hand piece until the end of the original dop just swings free. Rotate the hand piece 180 degrees. This will be index 48. Lock the hand piece at index 48 and read the clearance, using "feeler stock". Feeler stock can be purchased at auto parts stores. I start a data sheet at this point in the transferring process. This is where the make of the sharpie comes into play. If the above run-out is .007 inches, record this in the data bank. Move the assembly so the mark of the sharpie is now at index 48. repeat the above procedure and record the run-out in the data bank. Rotate the assembly so the mark of the sharpie is on the index 24, and repeat the above. Rotate the mark to index 72 and repeat the procedure. If you achieve a run-out of less than .003, breath a sigh of relief. Wet a folded up Kleenex and wet it thoroughly. Wrap the transfer dop and gemstone with the west Kleenex. Heat the original dop at the very end, away from the gemstone. The heat will travel up the dop and allow the original dop to loosen. The wet Kleenex will absorb the heat and protect the bonding of the gemstone to the transferred dop. If you do not find a run-out of .003 of an inch or less, you might be better to try another transfer dop.

96 at 96 = .007
96 at 48 = .006
96 at 24 = .004
96 at 72 = .002

Article reprinted from *Faceters' Stonechat*, vol 58, Nov/Dec '04, from teh UK Facet Cutters Guild.

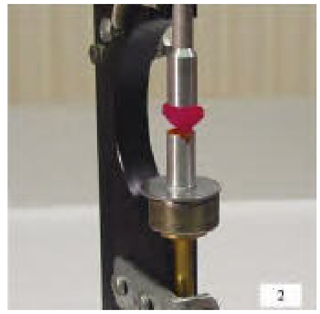
Dopping with a Magnet.

By John Hamer

This is a method designed to give you full control of dopping, so that the stone is dopped in what you consider to be the perfect position first time, and every time. It was designed for dopping with wax, and makes dopping with wax much easier to get right. There is no pre-warming of stones, and no need to ever touch a hot dop, hot stone, or hot wax. It should work equally well with any type of glue or glue/wax methods of dopping, though I have never tried dopping with anything except wax. Having full control, means that it is perfect for getting the maximum yield from expensive rough, dopping a stone for repairing wear and tear, or for re-cutting a native cut stone. The idea will work for every faceting machine if you use a suitable transfer jig, though some of the tools may need to be a little different from those shown; perhaps shorter or a different diameter. The basic idea is simply to temporarily support the stone with the table horizontal, slide it on the magnet so it is perfectly positioned, then transfer dop it, You do need some special equipment for this, but it shouldn't break the bank even if you have to have it made. Many faceters should be able to make something good enough to try it out.

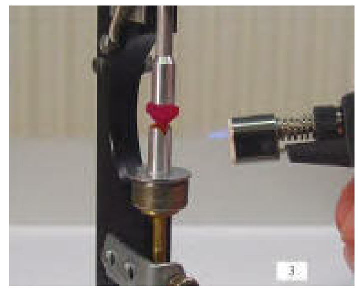
Picture 1 shows the purpose made tools, which were made for the Raytech Shaw faceter. At the top is the magnet, which needs to be quite strong. This one is from an old speaker, it is about 1 inch in diameter, and is glued to a large flat dop. It would work just as well glued directly to a 1/4 inch wooden dowel. Though it doesn't have to be very accurate (centralised), the top surface of the magnet should be horizontal. I have also made several with *1/2* inch diameter magnets, from the 5 lb. telescopic pick up tools easily available from hardware stores. In the centre is a dual tool; a quite large flat dop at one end, and a point at the other. Any suitable sized flat dop will be perfect for use. A 1/16 inch dop (that one you never use because the end is bent), could be filed to a point, so that the point does not move when it is rotated in your transfer jig. This is the only dop that does have to be exactly the same diameter as your normal dops. Mine is only a dual purpose tool because I do not use flat dops, but use cone dops for both crown and pavilion, giving me twice the number to choose from, plus I think that they work better. The short dops at the bottom are the hardest to make. Their steel base needs to be around the same diameter as the magnet, otherwise they tend to easily centralise themselves. These are aluminium riveted to an ordinary washer. I have also made some from solid mild steel bar. They do not need to be very accurate as they are only a temporary support for the stone. Without access to a lathe, the end of an old dop, glued to a small square of steel should work if you keep it cool with wet paper when warming the top.

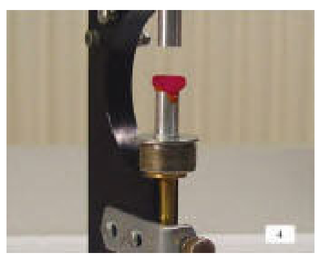
The first step is to prepare the rough, and mark the centre. You can simply grind a flat at the table position, then mark where you think the centre of the stone should be, and dop without further preforming. You could also grind the girdle to a suitable depth, just on the length and width, then you could mark the centre accurately by measurement, giving maximum yield for more expensive rough. You could also completely pre-form the stone before marking the centre if that is your usual method, though this tends to reduce yield.



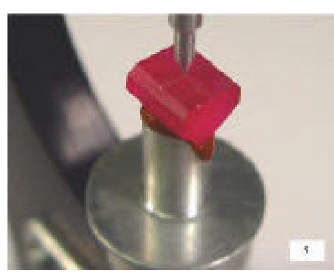
The next step is to support the stone in the short dop with the table horizontal. After cleaning the stone in alcohol, assemble the equipment and stone in the transfer jig as shown in **picture 2.** The stone is held in position solely by friction.

Heat the top of the small dop (not the wax), as shown in **picture 3,** whilst using some downward pressure on the flat dop. As the wax softens, the stone will sink into the wax until it makes contact with the short dop. You are not trying to make a good bond, so the wax does not have to get very hot. This stage should now be complete, with the table held in a horizontal position by the wax, and the stone supported firmly on the short dop as seen in **picture 4**.





Using the pointed dop, the stone can now easily be centred to precisely where you marked the centre, simply by sliding the short dop in the necessary directions on the magnet. For a non round stone, it can also be rotated to line up any side with a pin, groove, or other locating device. The more accurately you can mark the centre, the more accurate the dopping will be.

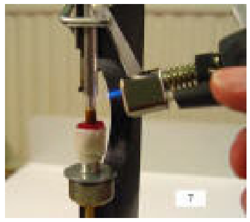


Picture 5 shows the stone centred, and lined up in relation to where the locating pin will be.

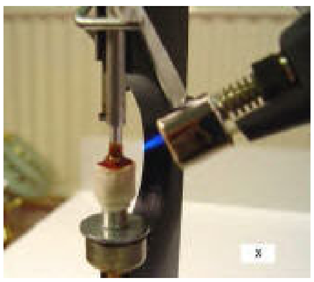
Now it is simply a case of transfer dopping. Carefully wrap wet paper around the short dop, avoiding getting the table wet. Check it is still central, then change the pointed dop for the dop you have prepared for use. I always paint the table with varnish at this stage, though this is optional. I use varnish made with shellac flakes, which dries very quickly

under the torch flame and there is no need to wait for it to dry hard. The varnish makes the centre marking hard to see, as shown in **picture 6,** so be sure it is central before varnishing.

Slide the prepared dop down to just above the stone, and begin heating as shown in **picture 7.**

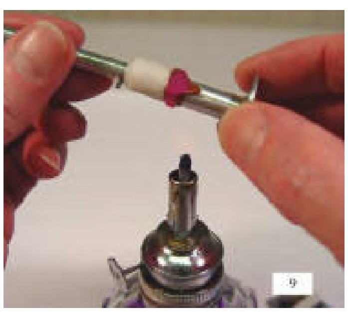


Keeping the flame moving all the time over the stone and the dop above the wax. At first I concentrate a little more on the dop to ensure that the wax softens in the cone of the dop. When the wax begins to slump



onto the stone, press the top dop down until it makes contact with the stone. Now, keeping the flame moving slowly, concentrate the flame onto the stone just away from the wax as shown in **picture 8**, and the wax should flow to the hotter area like soldering. The varnish makes the surface compatible, which also helps. It doesn't have to flow much to make a good bond.

After cooling, wrap the wet paper around the top dop, re-wet the paper if necessary, and remove from the jig. The short dop can now be removed as in **picture 9**.



A steady light pull on the short dop as it is warmed, and it will quickly come off. It can be left on the magnet for this if you prefer. The wax is then cleaned off the stone with a hot knife, and wiped back onto the short dop. This wax doesn't have to be new, as you are not trying to get a good bond on the short dop; old wax can be used and reused many times. You should now be ready for faceting with a perfectly dopped stone.

All this may sound very complicated and time consuming, but it is not. I would not dop any other way, even for cheap rough, partly because the control gives confidence in the bond as well. For professional cutters, the extra yield of expensive rough makes the small amount of extra time, time well spent, while for hobby cutters the extra time is well spent for all rough. There are just 5 easy steps, some of which you have to do anyway. 1, prepare and mark the rough, 2, make the table horizontal with the flat dop. 3, move the stone into the ideal position. 4, dop the stone. 5, remove the short dop.

Measuring and marking the centres of the stones can be awkward and fiddeley, but the more accurately you can mark the centre, the better the possible yield. For the stones oin the pictures I used another simple tool for the very first time. This is shown in **Picture 10**

It is made by drilling a small hole in the head of a 3/4" x 1/4" bolt, to take a short aluminium pointed rod. Brass welding rod or even thick copper wire, would also work. A slight bend in the rod holds it in position. A 1/4 inch thick base is then tapped so that the bolt can be adjusted for height with the fingers. This base is made from an off cut of 3/4 inch foamed PVC, but wood or anything firm will do. To use, adjust the height to the approximate centre and make a small mark. Turn the stone over, and at the same height make another mark above or below the first one. The marker can then be set to the centre of the two marks, and a line scribed across the stone. This can then be repeated at 90 degrees giving an accurate centre.

Small stones are hard to hold, so **picture 11** shows one method to make it easier. Some blue tac is placed on a piece of thin card, then with the side of the stone touching the card, it can be slid up to the blue tac to prevent any getting underneath. The Blu-Tack is then moulded to support the stone vertically. Adjust the marker to the approximate centre, and with the side of the finger supporting the Blu-Tack, a line can be drawn across the stone. Draw another line at the same height from the opposite side, and it will probably make the first line thicker. Repeat this at 90 degrees and you should be able to set the pointer in the centre of the two thick lines. This tool worked well on these first two stones, but it is not really necessary for magnetic dopping. My previous 50 stones were all dopped with a magnet, apart from the very first stone.

The two stones are shown finished in **picture 12**.

The large synthetic corundum in picture 1 was 10.3 x 9.3 x 9.3mm and 11.26cts. it finished at 9.8 x 8.3 x 7.1mm at 5.2cts

The small tourmaline in picture 1 was 4.4mm square x 3.2 mm high and 0.75 ct.

It finished at 4 mm square x 2.9 mm high at 0.37ct.

Both stones could have been larger with more care and cutting experience, but both are probably larger than they would have been without the magnetic dopping.

I am sure many faceters will find these ideas useful

Enjoy your faceting, John Hamer **END**

Program Speaker

Causes of Color in Minerals and Gemstones:
(presented by Paul Hlava 3/06)

The guild had a number of talks and watched several interesting videos on gemstones during the 2007 meetings. Paul Hlava gave his color on gemstones talk during our May meeting. Previously he has given this talk in two sessions, but this year he gave an abbreviated version to fit it into a single evening. The summary printed below is from the 2006 write-up, when he gave his talk during our March and May meetings.

Causes of Color in Minerals and Gemstones:
(presented by Paul Hlava 3/06)

The colors that one sees when looking at a mineral or gemstones are due to the response of that person's eye to the energies of the light, the emission spectrum of the illumination and, most importantly, physical phenomena in the material that cause some colors to be absorbed while others are undisturbed or enhanced. It is beyond the scope of this talk to do more than touch on the physiology of the eye that allows us to see colors. Likewise, we will not dwell on the emissions spectra of various light sources. Rather, we will concentrate on the various ways in which materials, especially minerals and their heights of perfection—gemstones, produce color from white light (1).

Visible light is a form of energy that comprises only a small part of what is known as the electromagnetic spectrum (EMS). Energy in the EMS ranges from long wavelengths with low frequencies such as the radio waves received at the National Radio Astronomy Observatory (NRAO) giant antennas, through microwaves, infrared radiation, the visible light spectrum that gives us color (ROYGBIV), ultraviolet, x-rays, to gamma rays at the short wavelength, high frequency extreme.

What we see is dependent on the biological/ physical structure of the eye. Human eyes contain rods, which see black and white, and three sets of cones (red, green, blue) that produce all the colors by mixing their signals. The eyes of animals contain more rods than do human eyes, to detect movement. When you mix frequencies of light, the human eye perceives only one color. In color blindness, the eye loses its ability to distinguish red, because red light has the weakest and lowest energy. Blue light has a higher energy to stimulate light receptors in the eye. The human eye is most sensitive in the center of the retina, a region called the fovea, that can focus very closely on visual information.

Since the color of light perceived may reflect a mixture of different light frequencies, we need a way of measuring color that is independent of frequency. The 'chromaticity diagram' was established in 1931 (revised in 2000), as an international standard for color measurement. It arranges all colors on three different axes defined by the Commission Internationale de l'Eclairage (CIE). " L" is the black —white axis, "A" is the green—red axis, and "B" is the blue—yellow axis. All colors can be defined for industrial applications with the use of this system in terms of percentage of color along each axis. (http://www.colorsystem.com/projekte/engl/54labe.htm).

According to Kurt Nassau, a mineralogist who has been writing about color for many years, there are five main categories of physical interactions that produce color:

A. Vibration and excitation
B. Ligand field effects/crystal field effects
C. Molecular orbital interactions
D. Energy band theory/color center theory
E. Geometrical and physical optics

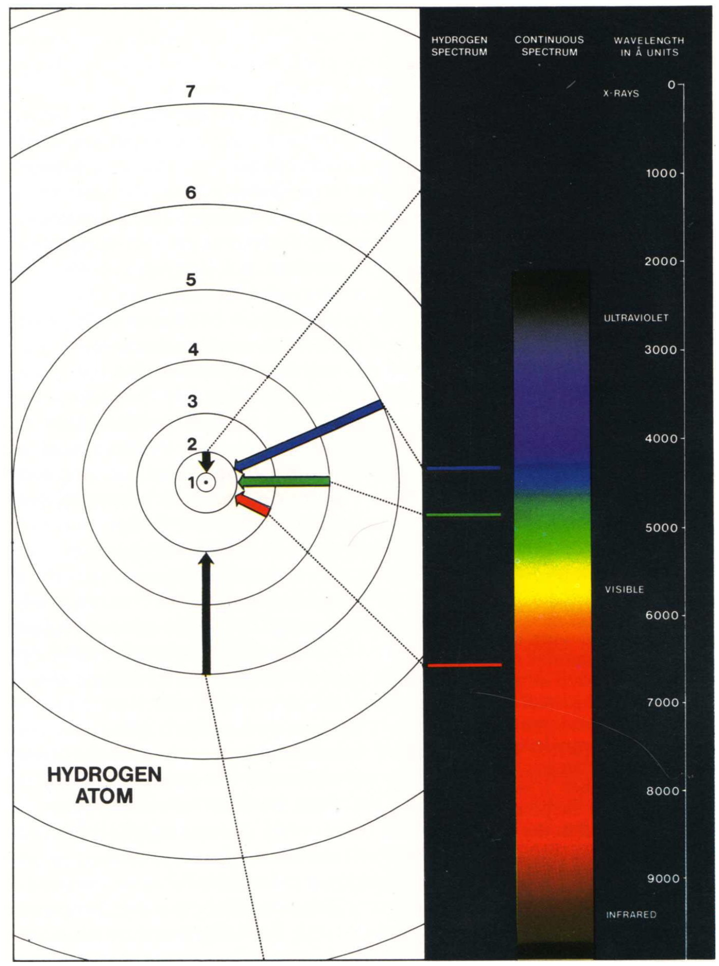
The first category (A) is not relevant to color in gems and minerals but is listed for completeness' sake. Categories B, C and D involve the absorption of certain wavelengths; our eyes see only the colors that are not absorbed. Categories B and C will be discussed in Part 1 in this newsletter. Categories D and E will be addressed in the forthcoming May/June newsletter.

B. Ligand Field Effects/Crystal Field Effects

Color produced by ligand/crystal field effects occurs predominantly in ionic crystals. For example, salt is an ionic crystal formed of positively charged sodium (Na^+) and negatively charged chlorine (Cl^-) ions. Gem minerals are more complex but follow this ionic charge interaction pattern. This type of color requires a partially filled electron shell which will give the ion an overall positive charge if electrons are missing, or an overall negative charge if a surplus of electrons is present. Transition metal elements (most known metals) provide ionic species for the production of color in minerals. Iron is the most plentiful metal in the Earth's crust, and its different valence states (Fe^{2+}, Fe^{3+}) produce a variety of colors.

Transition metals and rare earth elements have complex electron shell layers, many of them partially filled, allowing movement of electrons between them when sufficient energy is supplied. This movement of electrons between shells produces color, and also fluorescence in some cases, when an excited electron falls back to a lower shell.

Emerald, ruby and alexandrite are all examples of ligand/crystal field interactions. Interestingly, a chromium ion (Cr^{3+}) is replacing an aluminium ion (Al^{3+}) in all three gemstones, but because of the surrounding crystal chemistry, different colors are observed. Alexandrite is peculiar in that the field distribution is such that the blue-green and red color absorption bands are in equilibrium, so both colors are transmitted and the color perceived depends on the incident light. In many stones, multiple layers of interactions in color absorption bands result in a great variety of color. Some of the color in tourmaline may be described with ligand/



Spectral lines associated to the various electron orbits of the hydrogen atom (The Cambridge Guide to the Material World, Cambridge University Press, 1985).

Gem	Formula	Color	Cause of color
Alexandrite	Al_2BeO_4	red/green	Cr^{3+} replacing Al^{3+}
Emerald	$Be_3Al_2(SiO_3)_6$	green	Cr^{3+} replacing Al^{3+}
Ruby	Al_2O_3	red	Cr^{3+} replacing Al^{3+}
Garnet	$Mg_3Al_2(SiO_4)_3$	red	Fe^{2+} replacing Mg^{2+}
Peridot	Mg_2SiO_4	green	Fe^{2+} replacing Mg^{2+}
Tourmaline	$Na_3Li\text{-}Al_6(BO_3)_3(SiO_3)_6F_4$	pink	Mn^{2+} replacing Li^+ and Al^{3+}
Turquoise	$Al_6(PO_4)_4(OH)_8 \cdot 4H_2O$	blue-green	Cu^{2+} coordinated to OH

Ionic color sources chart from 'Chemical of the Week' (3) crystal field theory, but it has several color-producing mechanisms which are still being determined (4).

There are two subgroups in ligand/crystal field theory:

—Allochromatic (meaning 'other-colored')
—Idiochromatic (meaning 'self-colored')

Allochromatic colors are the result of transition metal impurities, where a single ion takes the place of another ion. Some examples are the previously discussed ruby, emerald and alexandrite, citrine, peridot, and garnet.

Idiochromatic colors are produced when a transition metal *ionic compound* replaces another ion, or coordinates with hydroxyl or water groups in the mineral lattice. Examples of these compounds are copper carbonate and manganese carbonate. Malachite contains the transition metal ionic compound copper carbonate ($CuCO_3$), rhodochrosite contains manganese carbonate ($MnCO_3$) and turquoise contains a copper phosphate ionic compound ($CuAl_6PO_4$).

C. <u>Molecular Orbital Theory</u>

Molecular orbital theory is used to describe both biological color compounds like porphyrins (and dyes), and the charge transfer compounds more typical of minerals and gemstones. This category involves electrons available through the shared orbitals of covalently bonded elements, which may be metal, non-metal or a combination of both. Examples of minerals that produce color through charge transfer include corderite/iolite, blue sapphire, and kyanite (metal to metal); crocoite (metal to non-metal), and lazurite, graphite, amber, ivory, nacre, and coral (non-metal to non-metal). Charge transfer between molecular orbitals occurs when an electron moves from one ion to another ion. For example, ions of titanium (Ti^{4+}) and iron (Fe^{2+}) in sapphire bounce electrons back and forth to give the blue color we observe. Iolite demonstrates electron charge transfer between divalent and trivalent iron (Fe^{2+}, Fe^{3+}) ions producing a violet color. Aquamarines also show a range of blues from molecular orbital charge transfer between Fe^{2+} and Fe^{3+} in a beryl crystal lattice.

It may seem surprising to some that there is considerable electronic activity in crystals, which appear to be so solid and inanimate. Minerals formed millions or billions of years ago are like flowers in a garden that endures for millennia, offering colors which (almost) never fade, to delight the eye.

D) Energy Band Theory and Color Centers

While, in the previous two categories (crystal field and molecular orbital theories), the color was produced by electrons belonging to ions, defect sites or groups of atoms, in the energy band theory these electrons are considered to be part of the whole crystal.

The energy band theory (or band gap mechanism) contains four subgroups: conductors, semiconductors, doped semiconductors and color centers. Color centers are a special case, and could also be listed in the field effect category.

In conductors (metals and alloys, such as gold, iron or brass), the electrons on the outer atomic shell belong to a common pool for the whole crystal, and are thus free to move within this crystal (some restrictions occur). This basically free movement throughout the crystal is what gives metals their excellent electrical and thermal conductivities. While the electrons are free to move, their allowable energy states are confined by wide bands and specific density states within these bands. Incident light is fully absorbed, as each wavelength can excite the electrons within the energy band into different density states. The electrons immediately fall back into their original state and re-emit light upon this de-excitation. The specific energy states available for excitation and de-excitation vary for each metal and alloy and thus give each metal its specific color and luster.

In semiconductors a band gap exists between two separate energy bands. The valence band, the lower energy band of the two, is completely filled with electrons, while the upper energy band, the conduction band, is devoid of electrons. To excite an electron from the valence band into the conduction band, it needs to traverse the band gap separating the two bands. Semiconductors cannot conduct electricity unless electrons are excited into the valence band; the size of the band gap determines the amount of energy it takes for this to occur. In materials where this band gap is smaller than the energy associated with the visible light range(also called narrow band gap semiconductors) all light is absorbed, as it is very easy to excite electrons into the conduction band. Such materials are often dark grey to black in color, as in galena (PbS), but when electrons drop back to a lower energy state, they can re-emit light and the material will have some color associated with it(e.g. pyrite). If the band gap is of a size within the visible light spectrum, specific wavelength will be able to excite electrons into the conduction band. In this case these specific wavelengths, or colors, are absorbed and only the remaining wavelengths are visible to the observer (cinnabar, sulfur). Finally, if the band gap is larger than the energy of visible light, no wavelength in the visible spectrum is able to excite electrons into the conduction band. This no colors are absorbed and these wide band gap materials appear colorless (pure diamond, sphalerite and zincite).

When impurities, or dopants, are added to semiconductors, intermediate energy states are present within the band gap. These dopants may act as a stepping-stone for electrons moving between the valence and conduction bands. If the energy required for this to occur is within the visible light range, specific wavelengths are absorbed and color is produced.

While we just learned that some materials, such as pure diamond, are colorless because their band gap is larger than the visible light range, we all know that diamond is often not colorless. A typical impurity is nitrogen, which has one extra electron in its outer shell when compared to carbon. This one extra electron exists at an energy state in the bottom quarter of the diamond band gap. Only violet light has enough energy to excite this electron into the conduction band, and as a result the diamond appears yellow. It takes about 10 nitrogen atoms for every million carbon atoms to produce a deep yellow diamond. Another common impurity in diamond is boron. Boron has one electron less than carbon and offers an empty state than can be taken up by one of the carbon electrons (also called acceptor dopant, or electron hole). For boron this empty energy state is only slightly above the valence band, and it takes only low energies to excite valence band electrons into this state. Diamond with as few as a single boron atom for every million carbon atoms creates blue diamonds, such as the hope diamond. Because this specific energy state is so close to the valance band, electrons can even be excited into it from the thermal energy present at room temperature, thus making this type of blue diamond electrically conductive at room temperature. The blue color created by irradiating diamond is created by a different mechanism (color centers) and irradiated blue diamonds are not electrically conductive. For the yellow diamonds discussed above, the gap between the nitrogen state and the conduction band is too wide for the nitrogen doped diamond to be electrically conductive, as room temperature does not provide enough thermal energy to excite electrons into the conduction band. This makes the distinction between doped and irradiated yellow diamonds more difficult.

Color Centers, also known as “farbe” (German for color) or “F” centers, are formed when atoms are oxidized, translated, or removed, usually by radiation, from their normal position in the crystal structure. The resulting hole may be filled by an electron from a neighboring atom. Any unpaired electrons left behind can now be excited and absorb light. Many color centers are unstable and can be destroyed by heat or strong light, such as ultraviolet light.

Many of the colored varieties of quartz (pure SiO_2) are caused by contaminant elements such as Al and Fe. The colors seen in smoky quartz occur when: an electron in an O atom next to an Al atom is knocked out of orbit by radiation and the unpaired electron left behind in the O site can now absorb light and get excited into higher energy orbitals. Fe^{3+} should cause quartz to be yellow but the color is changed to amethyst when 1) the Fe^{3+} is oxidized by irradiation to the Fe^{4+} state, 2) then there is charge transfer of an electron from an adjacent O to the Fe^{4+} turning it back to the more stable Fe^{3+}, and therefore, 3) the unpaired electron in the O can now absorb some colors and leave behind the purple which we see. Green diamonds can occur when C atoms are lost from the crystal lattice due to irradiation: One of the adjacent carbon atoms may lose and electron to the vacancy in the crystal lattice; the remaining unpaired electron is unstable and can absorb light energy to produce color. Color centers for topaz produce blue and brown colors. These result two different and unknown color center processes. The brown color in topaz is unstable. The unstable color of Maxixe beryl is related to carbonate radicals in the crystallographic tubes. Amazonite occurs when Pb^{2-} and OH^{-} are present in microcline feldspar.

E) Geometrical and Physical Optics

There are four basic mechanisms through which crystals can interact physically with incident light waves to create colors. No electrons are involved in these color mechanisms.

In the atmosphere, liquids and solids, color can be produced through **scattering**. Scattering of light is caused by small particles: dust, molecules, clusters of molecules, random collisions of gas molecules, tiny fat globules, and suspensions. Blue light is scattered more than red light. This scattering is also known as the Rayleigh effect. Lord Rayleigh described scattering of blue and red light by a formula where the intensity of light scattered divided by the intensity of the original light is equal to some constant divided by the wavelength of that light to the 4th power. Using this equation we calculate that if the intensity of blue light scattering is set to 100 the red light scattering in the same situation is only 10.7. Scattering of light in our atmosphere by very tiny dust particles, random collisions of air molecules, even small density gradients causes the sky to be blue. The sun appears red as it goes toward the horizon because the blue has been scattered out. As particles become larger, they scatter other colors better and these colors join with the blue until the color fades to the pure white of clouds, fog, mist, bull quartz, etc.

Examples of scattering effects in gemstones include: the milky color of opal (opalescence), ; moonstones, and quartz; cat's eye stones and star stones.

Note: Authorities in the field (Dana, Nassau, Downing, etc.) state that opalescence refers only to the milkiness of stones and not their iridescence (rainbow color), which is discussed under interference effects, below.

Chatoyancy is an optical effect displayed by certain gemstones cut 'en cabochon'. Very narrow linear features (such as needles, inclusions and planes) in the stones scatter light in a plane perpendicular to their length, producing a luminous stripe in the stone that resembles the thin vertical pupil of a cat's eye. These linear features may be needles of another mineral, such as rutile in chrysoberyl, or the tubes/voids sometimes found in aquamarine and tourmaline. The sharpness of the cat's-eye depends upon the density of the needles, their fineness, the quality of their orientation with the symmetry of the crystal, and the roundness of the cabochon.

Stars in stones are produced when multiple orientations of linear features scatter light in planes perpendicular to the lines. When light hits these inclusions, it creates two or more bands of reflected light or 'eyes'. When the stones are cut en cabochon perpendicular to the C-axis, these bright bands intersect at the apex of the cabochon dome and form stars. The effect is also known as asterism. Stones from the hexagonal crystal system exhibiting a six-rayed (rarely a 12-rayed) star include ruby, sapphire, beryl, and quartz. Garnets form in the cubic crystal system and can sometimes show a four-rayed star.

Dispersion is the separation of white light into its specific colors. In 1666, Newton used a prism to separate or disperse the white light from the sun into the component colors of the spectrum. These colors are red, orange, yellow, blue, green, indigo, and violet. Faceted gemstones act as complicated prisms that disperse white light into colors. Because different colors sparkle out of different facets, the result is called 'fire'.

Color due to **interference** mechanisms is produced when a light wave splits upon entering a transparent medium, the various color wavelengths suffer differing retardation, and thus some are out of phase when they try to recombine outside of the medium. Interference often occurs when light rays are split at interfaces. Part of the light is reflected back at the interface, and part of the light is refracted downward. Because the speed of light is less in matter than in a vacuum, the refracted light is retarded. The various colors are dispersed by the medium and so each color follows a different path and is retarded to a different degree. Upon reaching another interface, some of the refracted light is reflected back and eventually exits the medium and tries to recombine with the original reflected part. Constructive interference causes color to be amplified. In this case, light waves traveling the longer path are retarded by an integral number of wavelengths and so they exit in phase, or in step, with the original reflected part. As a result, they reinforce each other and intensify the color. Destructive interference causes colors to be destroyed. Here, light waves on the long path travel so many integral wavelengths and a fraction more. Some are exactly out of phase with the original reflected light and, consequently, cancel each other. Low interference orders (reflected from the top and first, second, etc. interfaces) exhibit brilliant hues while high orders at deeper interfaces (fifth, sixth, etc.) show pale colors.

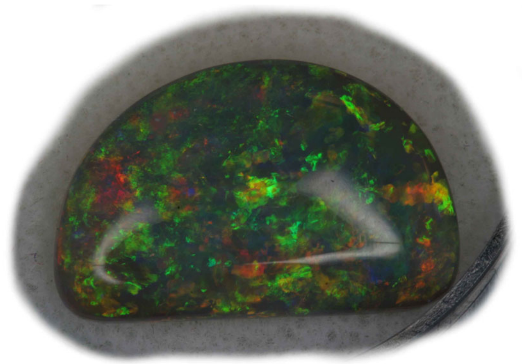
The play of color in labradorite, oil slicks on water, tight stacks of glass or cellophane, thin cracks in minerals, etc. are all examples of interference-produced colors. This is also known as iridescence and can be seen in fire-agate, the wings of some butterflies and the feathers of some birds.

Diffraction is a special case of interference caused by perfectly aligned layers of identically sized spheres of hydrous silica. Diffraction occurs when light waves bend as they pass the edge of an object. Light waves fan out (disperse) and bend through narrow openings between spheres, and they overlap and try to coalesce when there is more than one opening between spheres giving rise to interference.

The origin of the marvelous "play of color" in opal remained a mystery until 1965, when the scanning electron microscope revealed its cause. Two Australian gemologists, Darragh and Sanders, published "The microstructure of precious opal" (*Mineralogical Record* 1971 vol 2 #6 pp 261-268). Their article explained how patterns of spheres of silica interspersed with water, caused color in opal. The color depends upon the diameter of the spheres of silica, the uniformity of the spheres and their alignment, and the angle of incident light. This combination of diffraction and interference causes the varying intensity of color in opals.

This effect also shows how precious opal differs from 'potch'. The perfect layers of identical spheres act like crystal lattice layers in normal interference, but different orientations give rise to differences in spacings yielding different colors. Scattered light from spheres of irregular size, shape, and/or alignment causes the milkiness or opalescence seen in potch.

Colors found in gems and minerals can be caused by many mechanisms, and most (fourteen out of fifteen) of these involve electrons. Many of the important causes of color involve absorption of some energies of light. Some of the mechanisms that cause the most spectacular colors are the result of geometrical physical phenomena, others are due to electronic and quantum physical phenomena. The origin of color in many gems and minerals is still not completely understood. Current research continues to unravel the causes behind the colors we observe daily in our world.



References

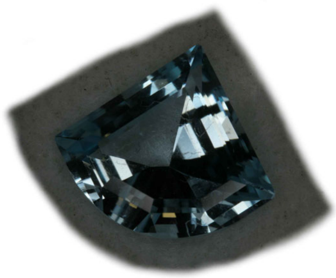
1. http://www.geology.wisc.edu/~johnf/Gem-color-hlava.pdf

2. http://www.colorsystem.com/projekte/engl/54labe.htm

3. http://scifun.chem.wisc.edu/chemweek/Gemstones/Gemstones.html

4. Nassau, K., The origins of color in minerals. *American Mineralogist* 63:219-229 (1978)
html: http://www.minsocam.org/msa/collectors_corner/arc/color.htm

pdf: http://www.minsocam.org/ammin/AM63/AM63_219.pdf



Further reading:

Book review of Theories, technologies, instrumentalities of color, B. Saunders and J. van Brakel, eds. Color Research and Application 28 (2003) 231-232.

A number of wonderful germstones and jewelry by NMFG guild members....

Two pictures by Ernie Hawes from the 2007 Tucsan Gem and Mineral show. The top picture shows a collection of beryls, the bottom picture is a close-up of the stunning center stone.

The New Mexico Facetors Guild

Membership application or renewal form

Dues:

1 year membership, includes electronic copy of NMFG newsletter:........$20.00
1 year membership and mailed paper copy of newsletter..........................$30.00

Please print this page and send it along with a check (made out to NMFG or New Mexico Faceters Guild) for dues to:

NMFG
Betty Annis
11112 Orr Ave. NE
Albuquerque, NM 87111.

Name: ___________________________________
Address: _________________________________
City: ___________________________________
State: ___________________________________
Zip: ____________________________________
e-mail: __________________________________

Amount Enclosed: _____________

Your e-mail address will be needed for you to receive the newsletter on-line.
If you do not have e-mail or access to the web, you can receive a paper copy of the newsletter.

E-mail Addresses:

Edna Anthony .... eba@bwn.net
Nancy and Steve Attaway.... attaway@highfiber.com
Carsten & Margaret Brandt...brandtmeister@comcast.net
Ernie Hawes........................ erniehawes@msn.com
Paul Hlava........................... hpf1@qwest.net
Dylan Houtman....................dhoutman9@aol.com
Mariani Luigi .... ENVMA@IOL.IT
Gary Peters .... albpet@msn.com
Kevin Schwebel.....................kschwebel@zianet.com
Jim Summers: ....commish1@worldnet.att.net
Bill Swantner.........................WSwantner@Comcast.net
Herb and Maria Traulsen ..... htraulsen@mycidco.com
Stephen and Linda Vayna ..... Vayna@transatlantic.com
Elaine and Al Weisman .... almgtcons@aol.com
Scott Wilson......................... swilson@copper.net