

# 'Facet Designer' - Newsletter 01

## 'HEARTS'

Diamond folks talk about 'Hearts & Arrows', which are patterns they like to see in special viewers as an indication of cutting excellence. We showed you the 'Arrows' at Fig.19 in the 'Facet Designer' tutorial.

'Arrows' are seen with crown toward the viewer. 'Hearts' are seen with pavilion toward the viewer.

Both 'Hearts' and 'Arrows' are seen with the light from above and an obstruction in the center. To see the 'Hearts', however, it is also necessary to obstruct light within 60% above the horizon. We can simulate this here using the tri-color illumination option.

The stone used here is a round brilliant diamond per Marcel Tolkmowsky, for which the data are:

*Symmetry* = 8      *Index gear teeth* = 96  
*Girdle Thickness* = 0.031

Table size = 54% (Tolkmowsky 53% was a math error)

CROWN	Row	Split	Shift	Position	Slope
break	1	3	-	0.74	(40.45)
main	2	0	-	0.74	34.50
star	3	0	6	1.00	(21.78)

PAVILION	Row	Split	Shift	Position	Slope
break	1	3	-	0.25	(42.01)
main	2	0	-	0.09	40.75

Fig.1 shows the gem image with 12 reflections. Right-click (green arrow) for message **Reset to Initial Position** and then click on that; this will reset the image to full view looking at the crown, shown in Fig.2.

Per Fig.2, red arrow, left-click twice on the tilt button and the image will roll over to the full view of the pavilion, shown in Fig.3.

Select **Ray Tracing** under **Image** to get **The Map of Illumination** shown in Fig.4. Select the tri-color sphere (blue arrow), then adjust the range of red light to 10° (red arrow) and green light to 40° (green arrow) from the gem axis.

The yellow arrow points to a 'Heart'. An excellent article (unpublished) has been written on how the heart shape is formed and how to modify it.

Slide **Position** of Pavilion Row 1 (black arrows) to see the significance of 'break depth' on this pattern.

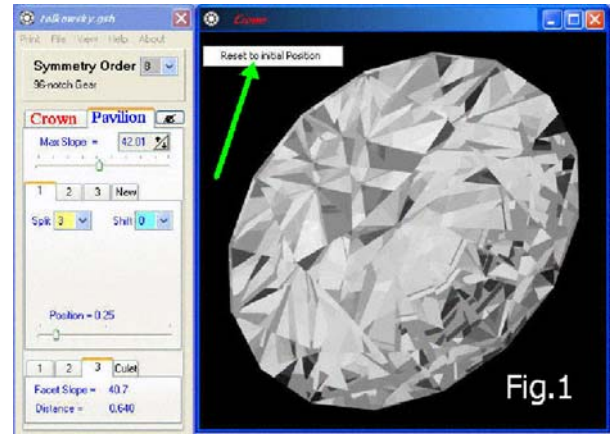


Fig.1

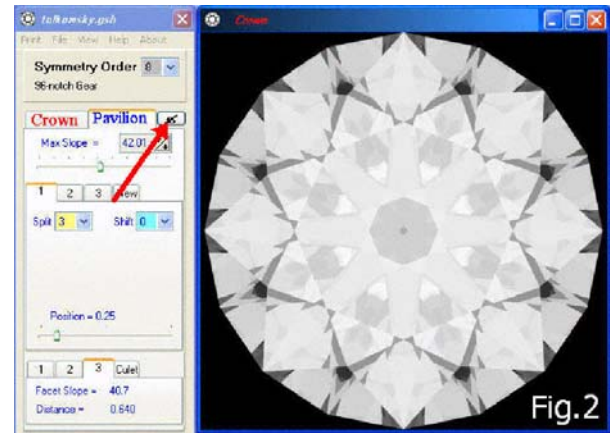


Fig.2

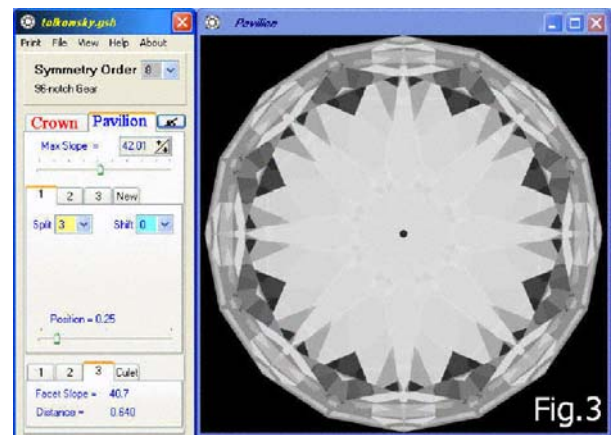


Fig.3

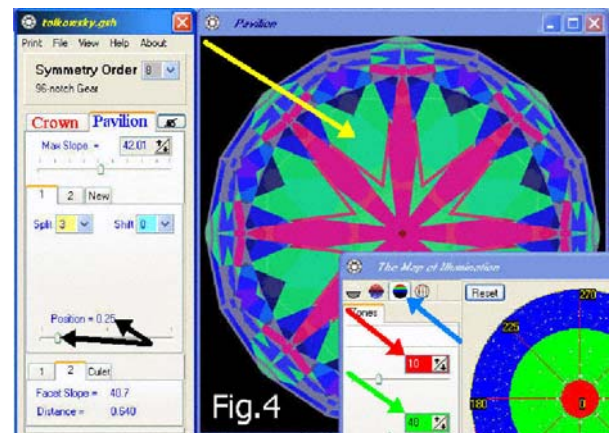


Fig.4

## 'Facet Designer' Tip #2

### PRINT GEM DIAGRAM

#### ALIGN THE IMAGE

As shown in Fig.1, turn on **Edges** (black arrow) and make the gem **Non-transparent** (red arrow) so you can only see the ones on the surface.

You will probably want to align the image in a certain way, such as the side view shown here; this is not an easy task. Try moving the gem to the position you want; it will not move as you think it should. In time you will develop 'tricks' to do it.

The only trick I can give you is that – once you have the girdle level, as shown here – with no 'zaggy' lines in it – then you can rotate the gem about its axis by dragging the yellow dot shown here horizontally; this is the 'center' of the gem in this software.

#### MAKE WHITE ENVIRONMENT

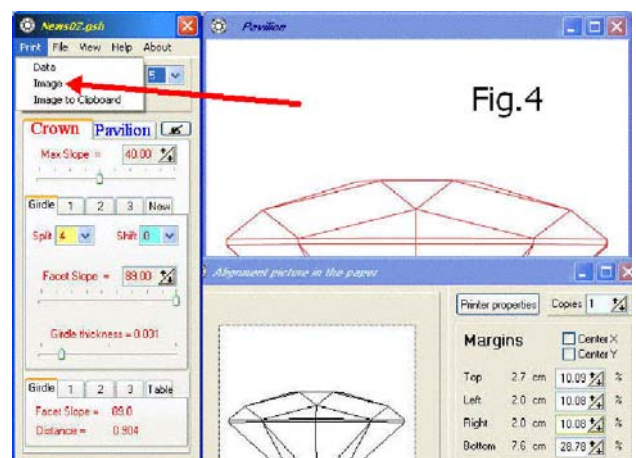
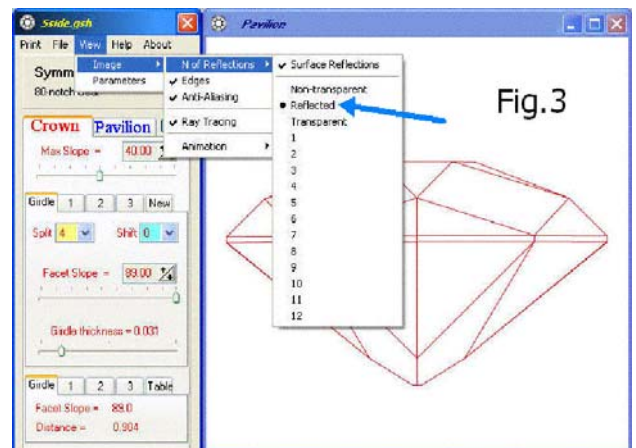
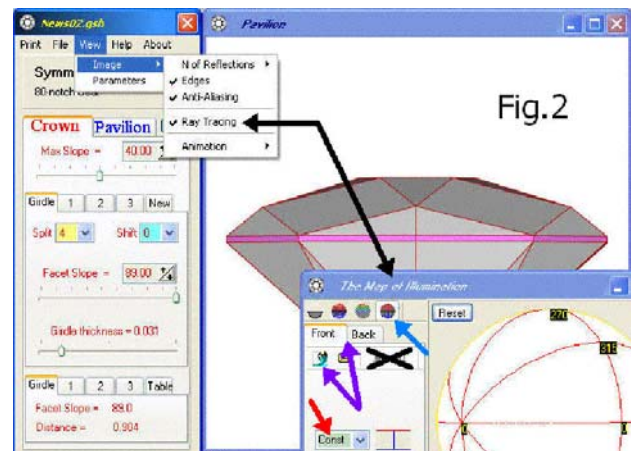
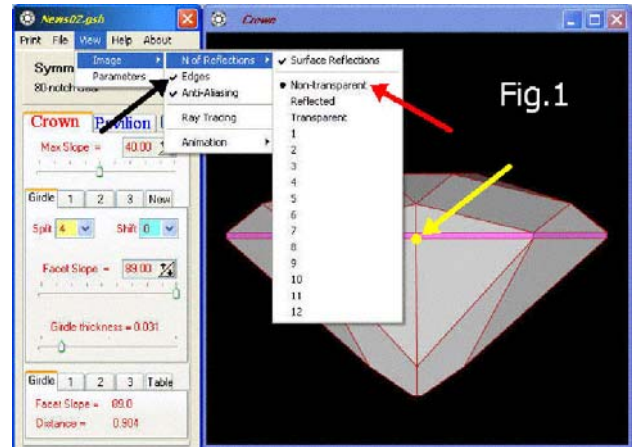
Next, go to **RayTracing** to get **The Map of Illumination** (black arrows) in Fig.2. Select the customizing sphere (blue arrow) and paint both back and front of the sphere white (purple arrows). Then turn on **Const** (red arrow) to make the front be uniform white (no gray grading). Do not turn viewer on (black 'X').

#### TURN GEM WHITE

As shown in Fig.3, turn on **Reflected** to replace the artificial surface shading with the white light source. You have now completed the job except to print it.

#### PRINT THE DIAGRAM

Go to **Print** and select **Image**. You will get the control box partially shown at the bottom of Fig.4 (**Size** controls do not show here). With this you can do all sorts of things to position and size your picture. You will even be able to print several views of the same gem (or views of several gems) on the same piece of paper – by generating a new image and reloading the same piece of paper each time. We may discuss this at another time.





# 'Facet Designer' - Newsletter 03

## WHERE IS LIGHT FROM ?

### 'NORMAL' ILLUMINATION

This gem is Tolkowsky's diamond, as follows:

	Symmetry = 8		Index Gear Teeth = 96		
CROWN:	Row	Split	Shift	Position	Slope
break	1	3	-	0.74	40.45
main	2	0	-	0.74	<b>34.50</b>
star	3	0	6	1.00	21.78
PAVILION					
break	1	3	0	0.25	42.01
main	2	0	-	0.09	<b>40.75</b>

Fig.1 shows the crown with 'normal' illumination (white foreground, with *cos* gradation, and black background), as provided by the left sphere icon (blue arrow).

There was a question, a few years ago, as to what caused the dark wedges at the girdle, indicated here by the lower red arrow. They are almost pure black; looking at the sphere, this light color appears to come from near the horizon.

### SOURCE FRONT or BACK?

To find if light comes from front or back. use the red/blue sphere indicated by the blue arrow in Fig.2. Note that the 'wedges' (yellow arrow) have a blue tone, so the light which causes them is from the back. Here the LIGHT AND GEM are turned to face left to get a side view of the colors. This is done by dragging the sphere along its horizontal meridian (green arrow) with the **LEFT** mouse button until the red equator line is vertical (it turns blue when you pass vertical).

The color of the 'wedges' seems to match that of the sphere at the point indicated by the black arrow.

### WHERE FROM MORE SPECIFICALLY?

To find the range in which the light source lies, select the tri-color sphere indicated by the blue arrow in Fig.3. Turn the LIGHT AND GEM to face left, using the **LEFT** mouse button; as in Fig.2 (not shown here).

Then turn the LIGHT ONLY so that the colors are behind the gem. This is done by dragging the sphere along its horizontal meridian (green arrow) with the **RIGHT** mouse button until the blue/black boundary is vertical.

Clearly the light at the 'wedges' comes from the green zone.

### WHERE FROM EXACTLY?

In Fig.4 the blue/green boundary is moved until the color of the 'wedges' changes from green to blue. This is done by tapping on the 'down arrow' of the green band control (blue arrow). The change is very slow but will go as many degrees as you have tapped, so tap five times to change 5 degrees. The angle from the gem axis to this boundary is shown in the control box (green arrow).

Because the shifting of spheres was not perfect, we see two adjacent wedges with the two colors, as indicated by the yellow arrows. So, in this example, the light came from about 48° off the gem axis. But we don't know by what route through the gem – perhaps another technique will tell us that.

BLH 2004 Jul 20

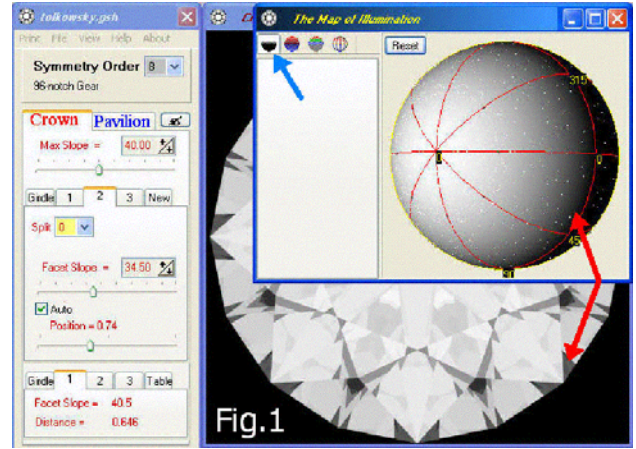


Fig.1

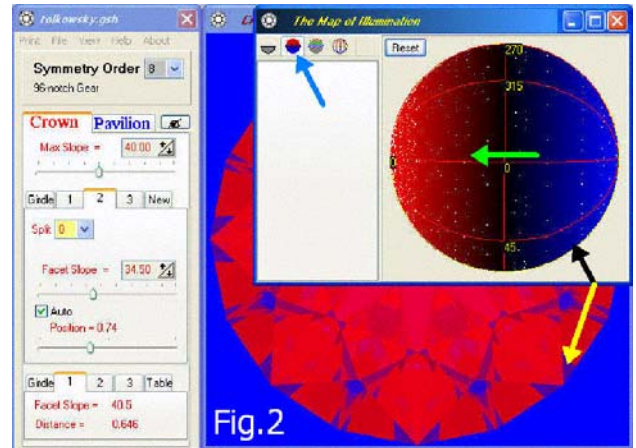


Fig.2

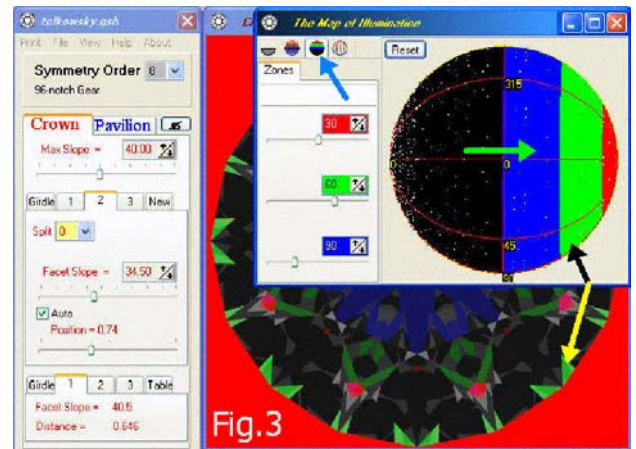


Fig.3

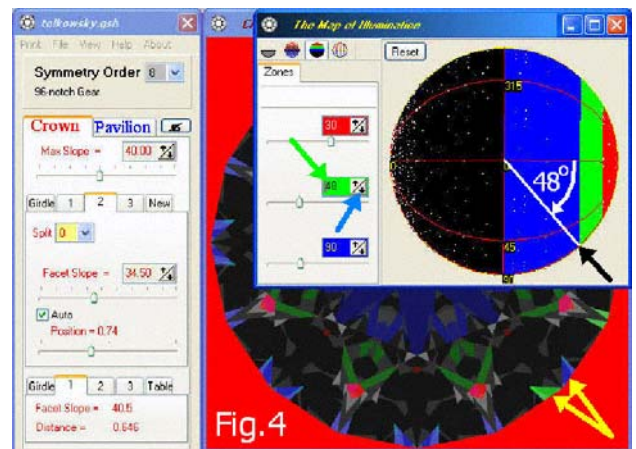


Fig.4

# 'Facet Designer' - Newsletter 04

## WHERE ARE 'BLIKI' FROM ?

### WHAT ARE 'BLIKI' ?

The Russians have copied words from us if they had none as suitable. We should copy one of theirs; it will save time and space in many discussions here. 'Bliki' (pronounced 'bleekee') means 'speck of light'; Anton uses it in his articles.

### MAKE YOUR OWN SPOT LIGHT

Fig.1 is a 'picture' I made with the 'Paint' program. Of the many I made, I like this little spot best because I can select individual light sources on the *Map of Illumination* which correspond to single 'bliki' on the surface of the gem. A more central spot might be better for some studies. I find it necessary to use this picture in bitmap format (\*.bmp).

Again I use the Tolkowsky diamond because it has been the subject of so much detailed interest and discussion.

I have set *Transparent* to only 4 reflections for this study.

Guidelines for this effort were presented in Tips # 03:

- 1) The gem turns in the sphere only if you drag IT directly (right click on gem image to reset it if necessary).
- 2) Use LEFT mouse button to move sphere to a different view.
- 3) Use RIGHT mouse button to move light on the sphere.

### FINDING THE ARROW AGAIN

Fig.2 shows that I have selected the customizing sphere (far right under *RayTracing*), painted the back side of the sphere red, and the front side with my spot picture. Use the RIGHT mouse button to move the spot around the sphere; the gem and sphere don't move - only the light. You will see the spots much better if you maximize the *Light Map* (black arrow).

In Fig.2 the light covers the two brightest spots near the axis of the sphere and gem. These illuminate the two components of the familiar 'arrow', which is normally seen as black when the viewer's head blocks these pairs.

### A DIRECT REFLECTION

In Fig.3 I found a spot near the horizon and on a meridian (green arrow) which is a direct reflection of a 'main' facet (yellow arrow). It is logical that the mains are on meridians; we know that surface reflections come from wide angles.

The reflection is dim because it is only part of the light source; much of this beam is refracted into the gem and passes out somewhere else (perhaps the pavilion). Can you find it?

Surface reflections from the 'stars' should be higher up and halfway between the meridians; you should find them easily.

### A BIGGER SPOT LIGHT

Fig.4 uses a different 'picture' with a bigger spot; the sphere and gem have been turned to see the spots on the pavilion side. With this I was able to cover a pair of spots and show partial exit of light from these at the perimeter of the crown view = the infamous 'wedges' discussed in Newsletter 03.

They are not bright, like the arrows in Fig.2; apparently they are a lower percent of the light that originally entered. Where did the rest of it go? You can spend hours pursuing questions like this = educational and/or fun for some of us.

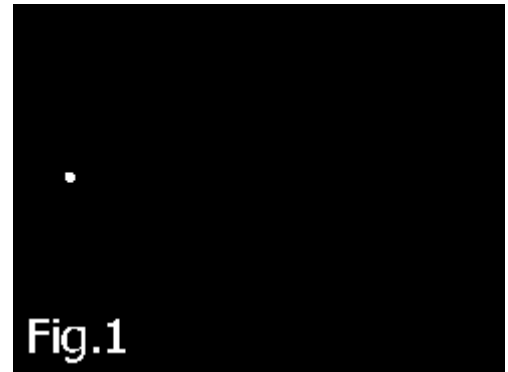


Fig.1

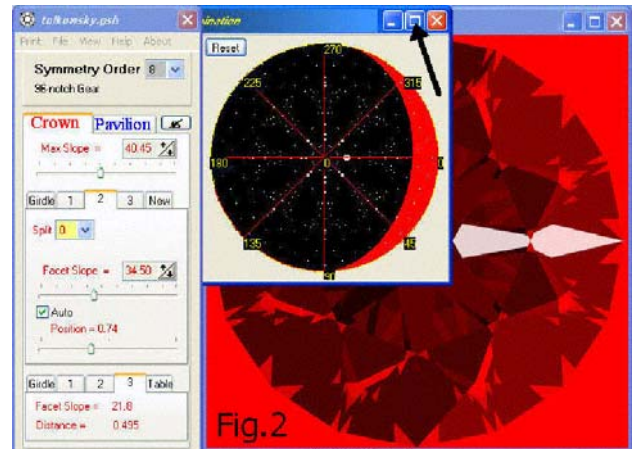


Fig.2

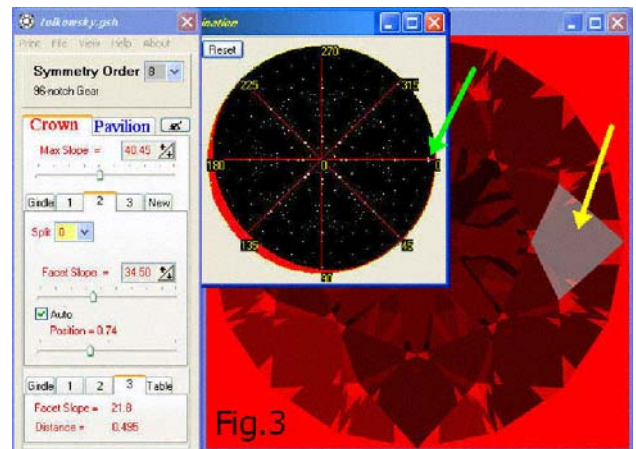


Fig.3



Fig.4



## 'Facet Designer' Tip #5

When trying to relate the location of source spots on the sphere to 'bliki' on the gem, you can get fooled; it is easy to make wrong assumptions. A light source from one side of the sphere may not enter the gem from the same side or produce a light speck on the opposite side of the crown.

### CROSSOVER RAYS

Fig.1 shows examples of 'convergent' and 'divergent' rays, or 'crossing' and 'non-crossing' rays.

Ray A follows the common path of most 2-D rays in a round brilliant, which are bezel-to-table rays or table-to-bezel rays. Note that the entry and exit parts cross each other above the table. This crossover is not visible in such a close-up view of the gem, but they cross immediately above the gem in the big picture of Fig.2; they appear to come from the same spot on the gem, which is of insignificant size in this view – even smaller than shown.

This is why it is important to show both close-up view and observer-length view - both views are required for proper ray analysis.

Note that the 'bliki' seen by the viewer is on the left side of the gem, and the ray enters the right side of the gem but its source will appear on the left side of the sphere.

'Divergent' rays are standard for table-to-table rays but are uncommon for bezel-to-table rays in a diamond, shown as ray B in Fig.1 (note the abnormal main facet slopes).

In Fig.2 the sources of rays A and B, shown on the same side of the sphere axis, actually enter opposite sides of the gem. Sources A produce 'bliki' on the same side of the gem, while sources B produce 'bliki' on the opposite side of the gem. That is, sources side-by-side on the sphere may produce light specks on opposite sides of the gem surface.

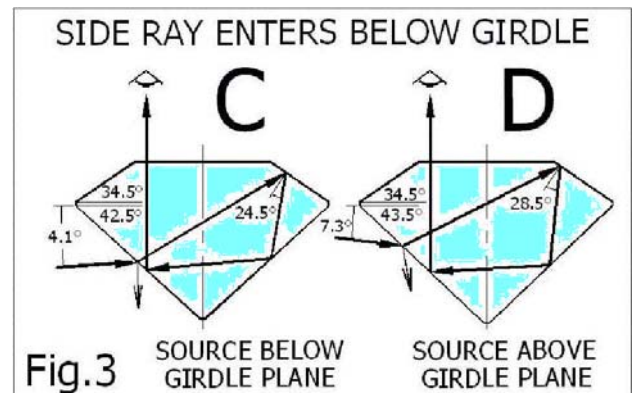
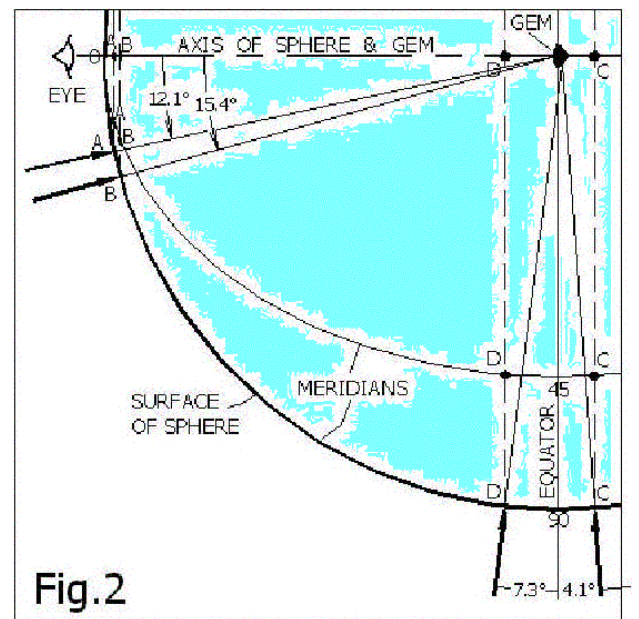
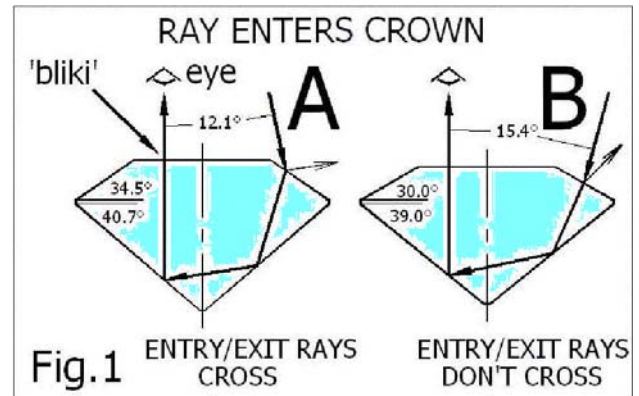
### SIDE SOURCES

Fig.3 shows sources of rays entering below the girdle and exiting the table (3 internal reflections - to be discussed in Newsletter 09 as Garry Holloway's 'NoGo Zone').

Ray C enters the gem from a source that was 'downward' toward the sphere and appears as a spot below the 'equator' of the sphere, which is the same as the gem's girdle plane in the 'normal' view (Fig.1 of tutorial). See Fig.2 here.

Ray D, on the other hand, comes from a source that was 'upward' toward the sphere. It crosses the girdle plane near the gem and its source appears on the sphere ABOVE the equator!

## DECEPTIVE SOURCES



# 'Facet Designer' - Newsletter 06

## LOOKING AT THE 'EDGES'

### OBJECTIVE

Usually we turn off *Edges* because we don't want to see them when viewing the stone's behavior in various lighting. But here we will look at them to see what they can tell us.

### THE 'RETRO-REFLECTOR'

Fig.1 shows a gem which is identical to the Tolkowsky diamond except that we have adjusted *Max.Slope* of the pavilion (break facets) to get 45° mains (red arrow). In Figs 1 & 2 we have selected only 2 reflections to simplify the study.

We have drawn the black outline of a pavilion main facet as you would see it through a flat-top gem (100% table), without distortion by refraction. However, this perfect view is disrupted when the table ends (heavy red line); beyond which this outline appears, distorted by refraction, in the crown main facet just above it.

Because the pavilion main facet slope is 45°, this outline is also that of the far pavilion main being reflected in the near one!

### WITH A PRACTICAL PAVILION SLOPE

In Fig.2 we have the 'ideal' pavilion main slope of 40.75°. Again the direct view of the pavilion main is outlined in black and is undistorted until it reaches the edge of the table (heavy red line). The remainder appears distorted by refraction in the crown main facet just above it (this is the tip of the 'arrow').

The reflection of the opposite pavilion main, in the near one, is shown in green. Both ends of it disappear – the culet end because of the limits of the near pavilion main, and the girdle end because of the table edge.

The thin blue lines show the reflected outlines of the far crown main and stars as they would appear on the plane of the near pavilion main (via the far one) if it was large enough, and seen through the table if it was wide enough.

The area within all of these limits is the 'shaft of the arrow', which is black by certain viewing.

The culet does not show in the bezel – a criterion the author once used to define minimum table size, based on 2D-analysis.

### 3 REFLECTIONS

Fig.3 shows the same stone considering the first 3 reflections. The 'arrow', familiar in diamond, is outlined in black. The 'black hole' (red arrow) now has four parts; Newsletter 07 isolates the sources of this on the sphere.

. Now the culet appears in the bezel (blue arrow) but it is very faint in realistic images.

### INTENSITY vs. EDGES

Intensity is not considered in showing edge reflections; the real image of the culet is barely noticeable because of its low intensity. Fig.4 shows that 2 reflections of the light source reach the viewer's eye at 63% of source intensity, while 3 reflections show only 13% of whatever comes from the culet (which is only 15% of what originally entered the crown)

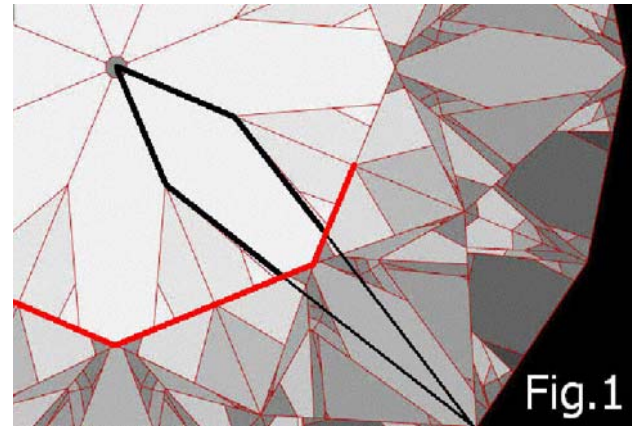


Fig.1

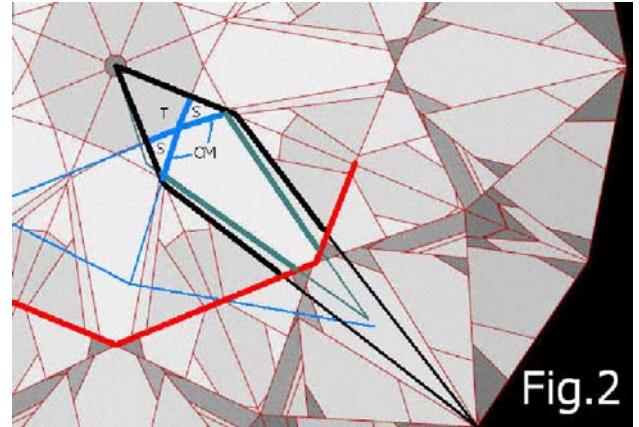


Fig.2

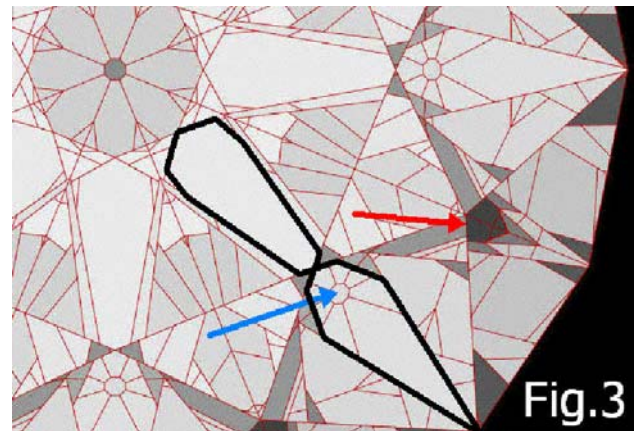


Fig.3

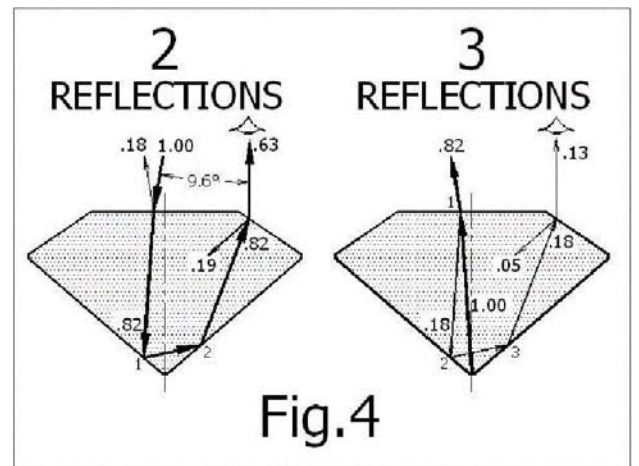


Fig.4



# 'Facet Designer' - Newsletter 07

## EXPLORING THE 'BLACK HOLE'

We continue to study Tolkowsky's diamond, extending the discussion of Newsletter 05 by locating the sources of the 'black hole' we saw there. We saw this very strongly after only 3 reflections, so we use only 3 reflections here to simplify the study (minimum number of light source spots on the surface of the sphere).

We discovered that the 'black hole' has four parts.

### SETTING-UP THE LIGHT SPHERE

To get to the position shown in Figs 1 & 3, we did the following things (as described in Facet Tips # 04):

- 1) At *RayTracing* we selected the custom sphere (far right).
- 2) We colored *back* red and put our spot picture on *front*.
- 3) We turned the sphere 180° by dragging it at its equator (we are now looking at the pavilion side of the sphere).
- 4) We dragged the light 180°, along the equator of the sphere (now you can see the '180' in the middle of the sphere).
- 5) We moved the light spot to various spots on the black surface (maximized) and then looked at the 'normal' image of the crown to see where they appeared on the red surface.

### MAJOR PART of 'BLACK HOLE'

Fig.1 shows the spots that we found which cause the major part of the 'black hole'. The white spot was moved to cover one of a pair of spots; the corresponding 'bliki' on the crown of the stone is shown in Fig.2. It is a large 4-sided area of the 'hole'. The other spot of the pair makes its mirror image.

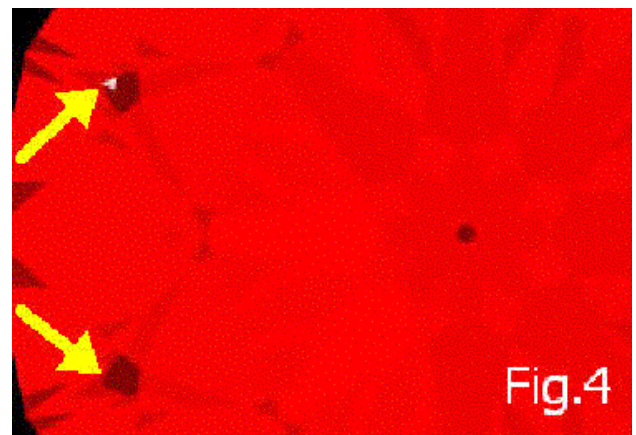
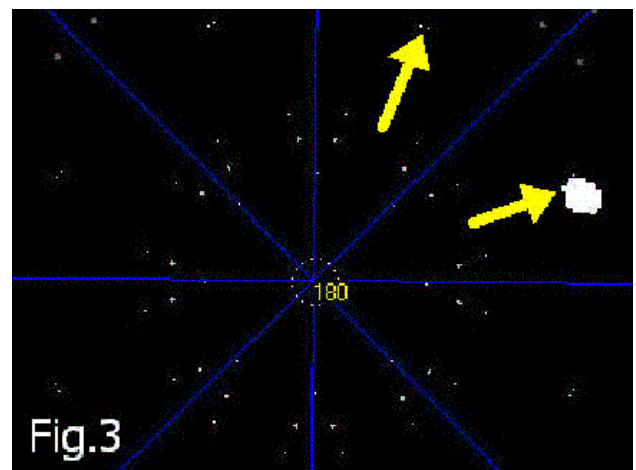
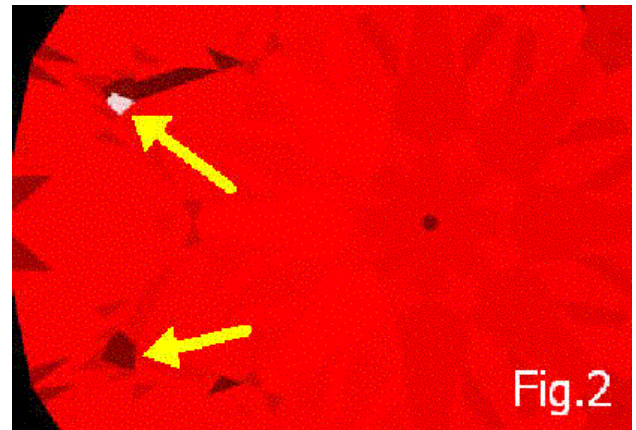
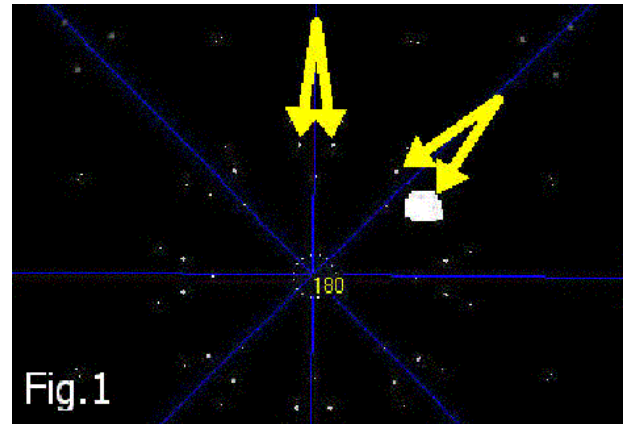
The bliki on the crown is almost directly over the source to the pavilion (straddling the same meridian). What path did this beam follow by 3 reflections?

### THE OTHER PART

Fig.3 shows another pair of light sources on the back side of the sphere; these produce tiny triangular areas on the crown image (Fig.4) to complete the kite-shaped 'black hole'. Here I have lit only one of them. In this case the sources are not directly in line with the bliki, but halfway between the meridians; additionally, the lower light source produces the upper bliki; this is definitely a 3-dimensional path in the gem.

### COMMENTS

This was not an important 'discovery' but it served to show what can be done with this new tool – should it ever be important to do so.



# 'Facet Designer' - Newsletter 08

## YOU CAN GET FOOLED

### THE 'IDEAL STONE'

This is Tolkowsky's diamond again (with 75% pavilion breaks). Fig.1 shows the table-up view in the 'normal' illumination of this software with 34.5° crown mains.

Note the dark areas – the edge wedges and the 'black holes' just beyond the star tips. How can this stone be considered 'ideal'?

Let's see what we can do to improve it

### CAN WE MAKE IT BETTER?

Keeping the pavilion main slope constant at 40.75°, we varied the crown height until we got the brightest view – see Fig.2 – at about 30° crown main slope; many folks assume that bright is good. We did this by holding the *Max.Slope* up/down buttons and watching the picture change; *Auto* stayed on, so the radial proportions were not affected.

Is this a better looking stone? How will we know if there is no viewer?

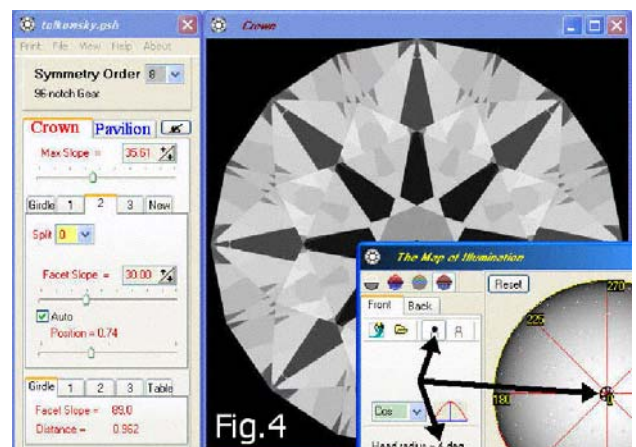
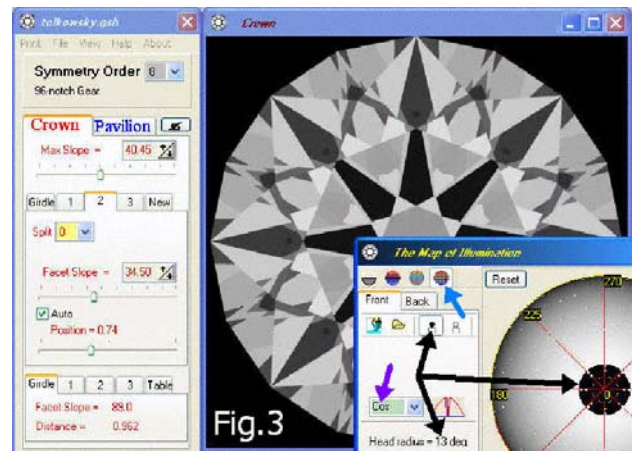
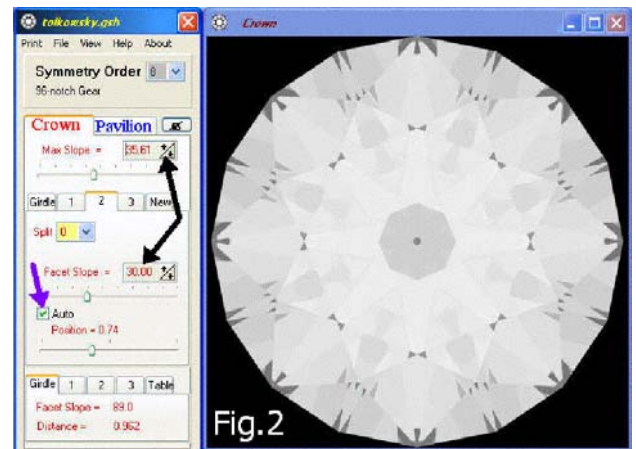
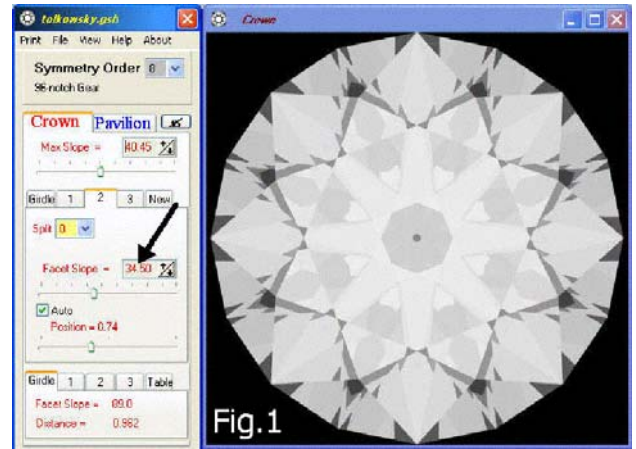
### THE VIEWER'S HEAD

In Fig's 3 & 4 we select the custom illumination (blue arrow) with black *Back* and white *Front* with *cos* gradation; this duplicates the illumination in Fig's 1 & 2. Fig.3 shows the first gem (Fig.1). We increased the viewer's *Head Radius* until the stars appeared in the stone because of the viewer's head – at 13° *Head Radius*; this corresponds to obstruction at **both** eyes when viewing at about 9" inches from the gem. If you look at this gem from 12 inches away, one eye will not see the dark areas which form the star (what does the brain see?).

### IS THE 'IMPROVED' GEM BETTER ?

Fig.4 shows the second gem (Fig.2) with the same illumination as Fig.3 except, increasing the *Head Radius* gradually, the black stars appeared at only 4°. This means that you would see these dark areas with **both** eyes even if viewing them from 2-1/2 feet away!

If you like it, then it's better; if you don't, it's worse. It does have a prettier star. 'Beauty is in the eye of the beholder'.





# 'Facet Designer' - Newsletter 09

## THE 'NO-GO ZONE'

### HOLLOWAY'S 'NO-GO ZONE'

Garry Holloway 'described' what he calls the 'No-Go Zone' = an area of darkness in a diamond.\* These stones look good and are bought by most buyers when they examine them loose, with light coming from the sides; the darkness does not appear until they are mounted. With 'DiamCalc' he showed that these areas are illuminated by rays that enter the pavilion from the side, reflect off the far crown main and then off both sides of the pavilion before exiting the table to the viewer, as illustrated in 'Tips 05'.

Later I showed that, with 34.5° crown mains, this happens, in the 2-dimensional case, when pavilion mains are 42.5° or more\*. Sergey Sivovolenko of Octonus provided ray path illustrations using DiamCalc, and noted that there were actually two ray paths which caused this effect\*.

Here we confirm this and show that there are actually 3 paths! The gem is Tolkowsky's diamond, with the pavilion slopes modified as shown in Fig.1 (black arrows); other data are shown in the inset; it has 75% deep pavilion break facets.

\* 'DiamondTalk', threadid=10892, 11335, 2001 Nov 4, 27

### 'NORMAL' ILLUMINATION

Fig.1 shows the big dark spots within the table limits (red arrow), which were the subject of discussion then; and also some more dark spots outside the table (blue arrow). We chose 3 Reflections because it is sufficient for this study.

### SOURCES of the TABLE SPOT

Using the methods described in Newsletter 04, we identified the sources of the spot in Fig.2, 3, 4; it has 5 pieces.

Fig.2 shows that the big piece is by simple 2-D reflection off pavilion mains in planes parallel to the gem axis (note that '0' meridians line up). The ray comes from about 5° below the horizon. The white arrow shows a little wedge missing and so there are 3 types of pieces making up this spot.

Fig.3 shows that these little wedges also come from about 5° below the horizon. Fig.4 shows that the outer strips come from about 10° above the horizon. These are both 3-D reflections from the sources indicated by the colored arrows.

### SPOT OUTSIDE the TABLE

Fig.5 shows the sources which cause these spots. They come from about 10° above the horizon by 3-D paths. Only the source and spot indicated by the blue arrows can be matched-up within the limits of this picture.

Note that it was necessary to roll the sphere about its polar axis to find the source. This was done by dragging the equator vertically with the LEFT mouse button (white arrow and 'L'). We have labeled the '0', '315' and '270' meridians on the gem image; it is important to note that rotating the sphere about its polar axis does NOT rotate the gem.

### SUMMARY

This shows that this software and 'DiamCalc' are complementary; each does something the other does not.

BLH 2004 Aug 04

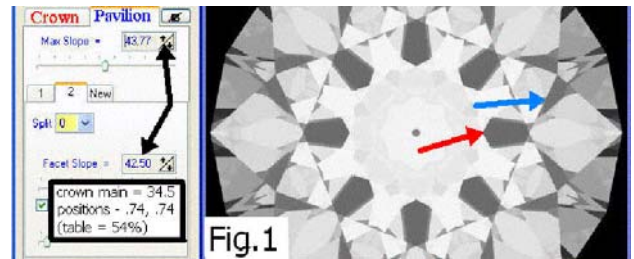


Fig.1



Fig.2



Fig.3

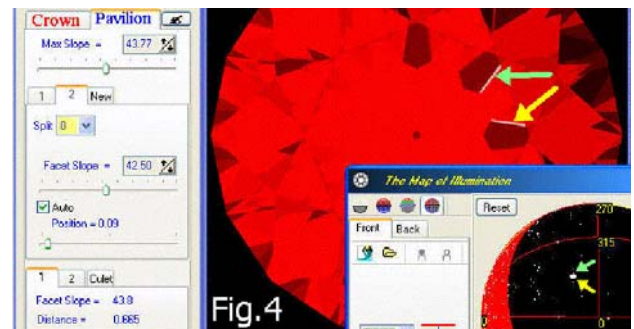


Fig.4



Fig.5

# 'Facet Designer' - Newsletter 10

## ROSE-CUTS

Recall that I said, in Newsletter 05, that setting *N.of Reflections = 1* was 'absurd'. Wrong! Anton read this and reminded me of the 'rose cut' which we never think of anymore. A ray enters one side of the 'crown', reflects off the flat pavilion and exits back out through the crown. When you test the optics of this cut you will see why it was abandoned nearly a century ago!

Drawing the rose cut involves tricks in using the 'Facet Designer'

### THE NORMAL WAY = POINT UP

Fig.1 shows an arbitrary form of the rose cut, where the main facets are perfect squares. To do this use the following data for the crown:

Symmetry = 8		Index Gear Teeth = 96			
CROWN:	Row	Split	Shift	Position	Slope
girdle	G	3	0	0.31	(89)
break	1	3	-	0.77	50.00
main	2	0	-	0.53	(42.97)
star	3	-	6	0.01	(35.71)
PAVILION					
break	1	(3)	-	1.00	(40.00)

Make *GirdleThickness = 0.31* and *Max.Slope = 50°*., which is apparent in Fig.3.

When you flip over to do the pavilion, you will see the breaks already drawn with *Split = 3*, *Shift = 0*, *Position = 0.70* and *Max.Slope = 40°*. If you try to reduce the slope to 0° the program will crash.

Instead, make *Position = 1.00*. The break facets still have 40° slope (theoretically) but they have zero length! – they don't exist! See Fig.2 & 3.

Restore to normal view and select *N of Reflections = 1*; you will see that there are now some images

You can do all the light studies, using *Map of Illumination* and *Animation*; they are not impressive.

### BACKWARDS = FLAT FACE UP

Of course you will turn the gem over and study it the other way around. No problem, using all the tricks we have shown you for turning image, sphere and light. BUT ... if you try to use *Animation* it won't work!

*Animation* always turns the gem back to 'normal view' with the center of the crown facing you at the center of its figure-8 pattern.

No problem – just draw the gem again, but with the crown flat by setting its *Row1 Position = 1.00* and drawing the pattern on the pavilion side as you did before for the crown, as shown in Fig.4.

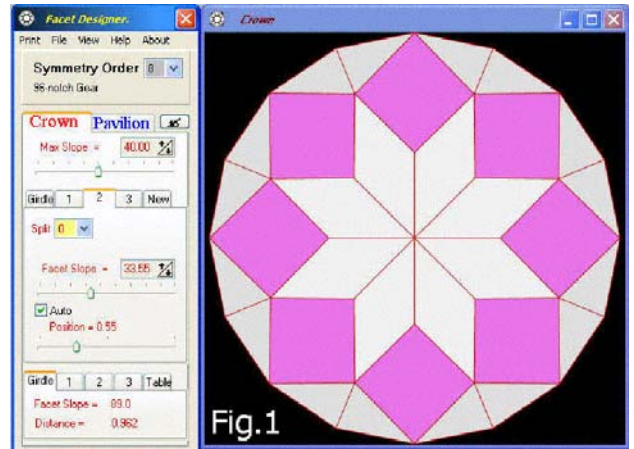


Fig.1

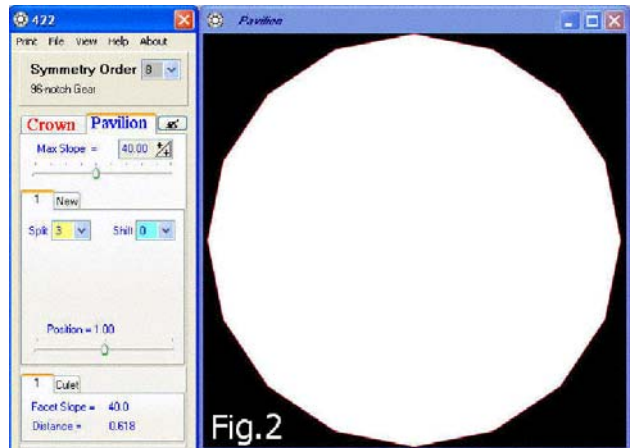


Fig.2

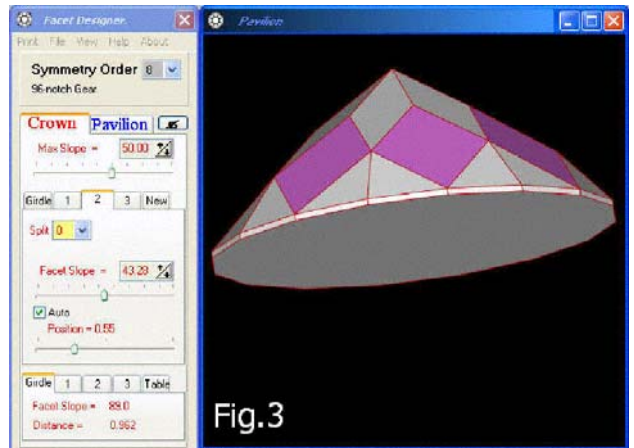


Fig.3

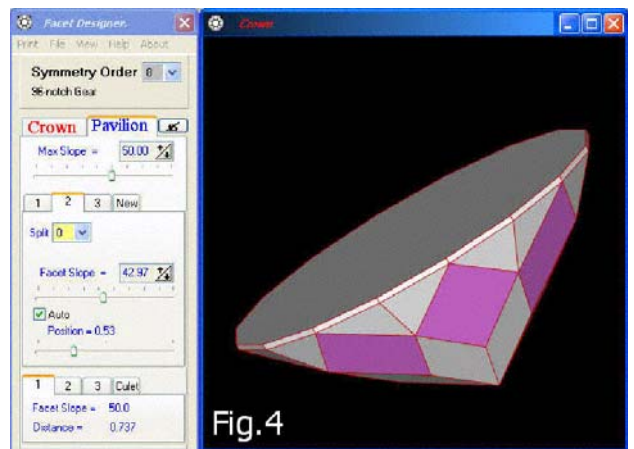


Fig.4