GemCad for Windows
Version 1.0
User's Guide

by

Robert W. Strickland

September 17, 2002
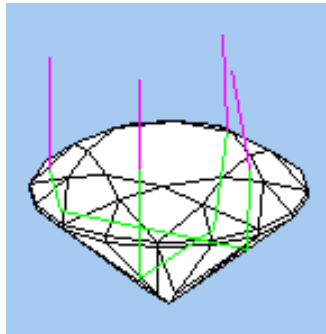
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www.gemcad.com

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In honor of Walter Carss, a world–class faceter, friend and mentor.

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Overview

GemCad is a computer–aided design (CAD) program for faceted gemstones. It runs under Windows 95 or later on PC compatibles with screen resolution of at least 800 x 600. *GemCad* simulates a faceting machine and shows you accurate 3–D views of the stone. *GemCad* understands symmetry, so you typically have to cut only a fraction of the facets to get the full design. *GemCad* can follow paths of light rays through the stone to allow you to optimize a design to minimize light loss. The end product is an accurate faceting diagram that shows several views of the stone with accurate angles, indexes and dimensions.

The program has three main purposes:

1. *Proof–cutting an existing diagram.* Proof–cutting a design on the computer allows you to check the accuracy of the diagram and discover pitfalls before wasting valuable rough.
2. *Editing a diagram.* You can take an existing diagram and modify it to optimize its optical performance for different materials. You can scale a diagram to make it fatter or skinnier to fit a certain piece of rough.
3. *Designing a stone from scratch.* Advanced users can use *GemCad* to create new designs. *GemCad* frees the user from the tedious calculations required to determine angles.

GemCad for Windows can open files made by *GemCad 4.51 for DOS*, and the DOS *GemRay* can open files made by *GemCad for Windows.*

GemCad doesn't model curved surfaces or notches but is limited to convex designs that can be cut on any faceting machine.

If you have the *Datavue II* database of facet designs installed on your system, *GemCad* can access it directly.

You can find current information about *GemCad* at **www.gemcad.com.**

Sample Designs

GemCad's setup program should have installed a number of sample designs on your system. Unless you gave it a different location, these should be located in the folder:

```
C:\Program Files\GemCadWin\Designs
```

## Quick Start Tutorial:Proof–Cutting a Design

Why would you want to proof–cut a design on the computer?

If you have a diagram that you have never cut before, proof–cutting will verify that the angles and indexes on the diagram will produce the design as pictured. This is particularly valuable when cutting designs created before computers. Even for diagrams that are accurate, it is easy to get lost because the design changes drastically as facets are cut. If you are cutting to the wrong reference on the stone or looking at the wrong facet, it's easy to get the cut it and cut it, and the facet is still too big problem. Sometimes the cutting sequence is not specified, or you and the designer have different opinions about the cutting order. Some designs become meet–point designs if the steps are cut in a different order. The bottom line is that proof–cutting on the computer can save you valuable rough and increase your yield.

To summarize, proof–cutting

- • verifies the accuracy of the diagram
- • verifies the cutting order
- • shows how the design looks after every step

Here is a diagram of a Standard Round Brilliant. The tutorial below won't refer to this diagram. It's just for reference to show you the finished product.
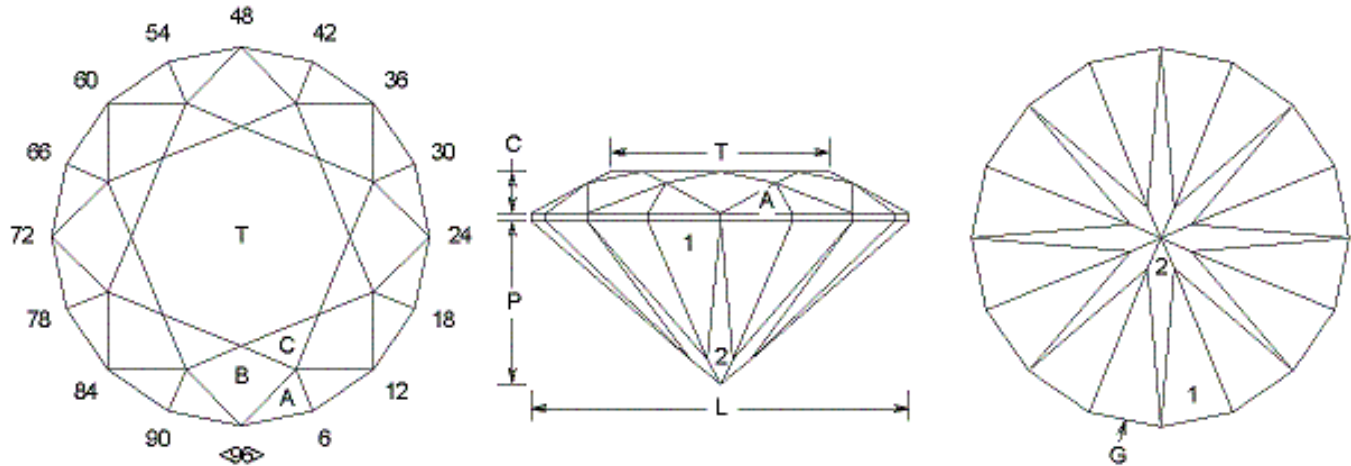
Angles for R.I. = 1.540
57 + 16 girdles = 73 facets
8–fold, mirror–image symmetry
96 index
L/W = 1.000 T/W = 0.584 U/W = 0.584
P/W = 0.442 C/W = 0.111
Vol./W³ = 0.182

PAVILION
G 90.0° 03–09–15–21–27–33–39–45–51–57–63–69–75–81–87–93
1 42.5° 03–09–15–21–27–33–39–45–51–57–63–69–75–81–87–93
2 41.5° 96–12–24–36–48–60–72–84
CROWN
A 34.0° 03–09–15–21–27–33–39–45–51–57–63–69–75–81–87–93
B 28.0° 96–12–24–36–48–60–72–84
C 16.0° 06–18–30–42–54–66–78–90
T   0.0° Table

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First, make sure all of *GemCad's* windows are visible. Your display should look something like the figure on the right. (The colors and window style might vary with the version of Windows and the color choices you have made in the Windows control panel.) If all of these window panes are not visible, move the mouse pointer over the vertical and horizontal separators between the window panes, press the left mouse button, and drag the separators one at a time until your display looks something like the example at the right. If you have trouble with this step, skip down to the **Screen Layout** section.
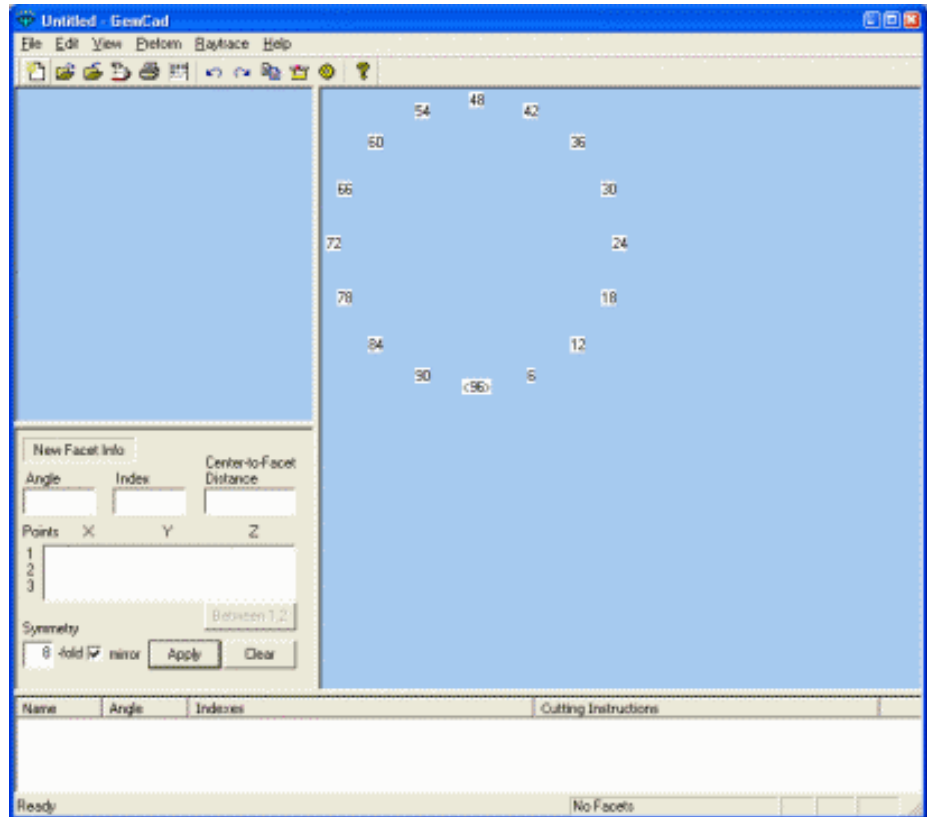
You will enter much of the information for new facets into the **New Facet Info** box. The next step is to set the symmetry to 8–fold, mirror–image. This is the default. If you have changed the symmetry, click in the **Symmetry** box and type in 8. Make sure the **mirror** box has a check mark in it. If you have selected a different index gear, change back to the default 96 index.

Start by cutting the girdle facets. Type 90 in the **Angle** box and 3 in the **Index** box. Then click the **Apply** button (which might be instead labeled **Cut Facet**).

You should then get something like the figure on the right. *GemCad* knows to cut all 16 girdle facets because of the symmetry. The gray facets are the edges of the block of rough. If you don't get this 16–sided shape, press the **Undo** button on the **Toolbar** and try again. Move the mouse pointer as indicated by the crosshairs in the screen shot at the right. Then click with the left mouse button. The **Point on Edge** dialog box will pop up. Click the **Use to Cut** button. This point will establish the plane of the girdle and the depth of cut for the break facets. Enter an angle of 42° and in index of 3 and click the **Apply** button. *GemCad* will cut 16 break facets, making a cone.
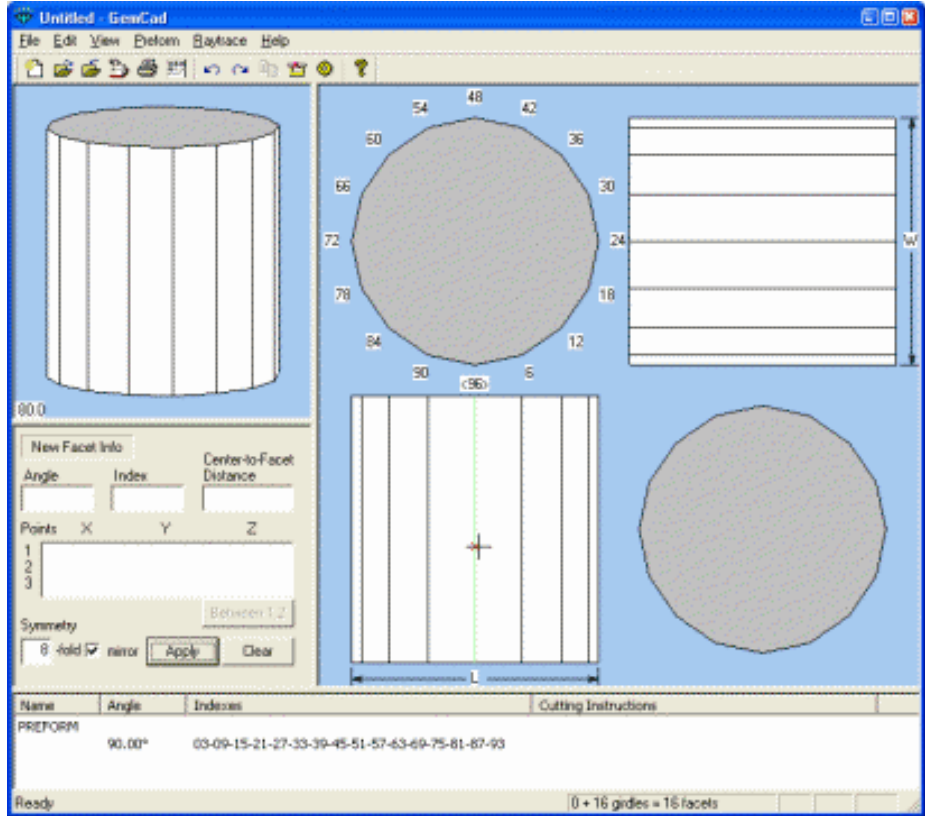
Next, move the cursor as shown in the figure at the right, as indicated by the crosshairs and the small red circle **o**. Once the pointer gets close enough, the red circle will appear under the crosshairs. Click with the left mouse button and click the **Use to Cut** button. Enter an angle of 41° and an index of 96. Click the **Apply** button, and *GemCad* will cut 8 main facets. This completes the pavilion.

Use the **Edit/Transfer** menu command or click the transfer block button on the **Toolbar** to transfer the stone.
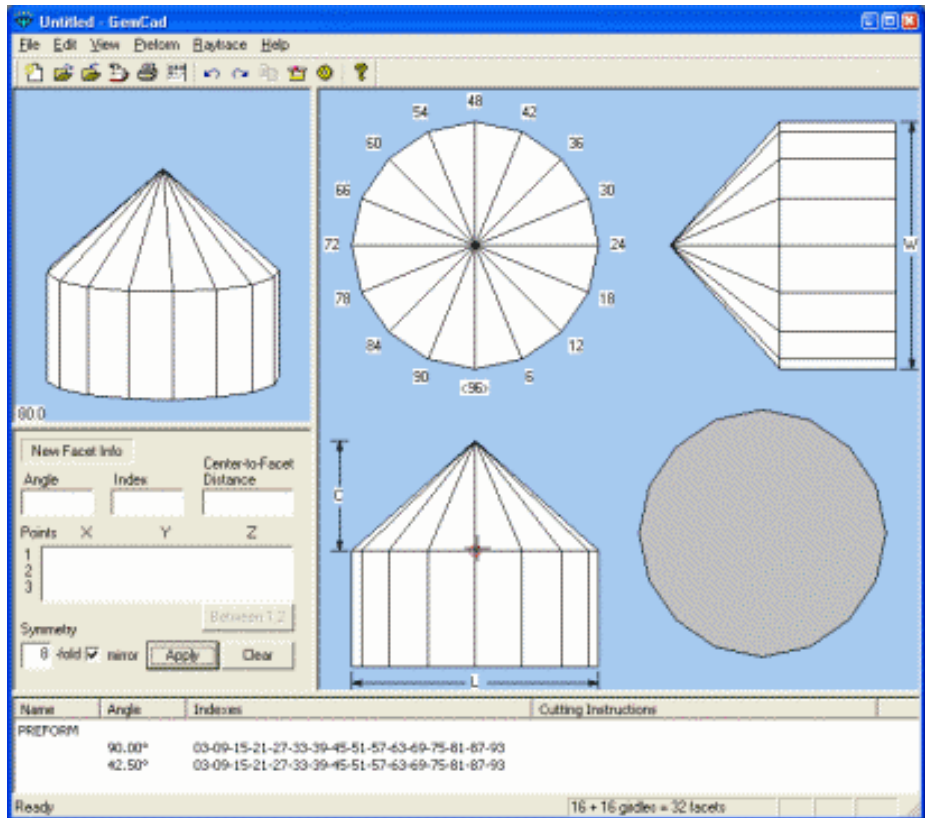
Your stone should look like the figure on the right. Now we are ready to cut the crown break facets and establish the girdle thickness. Move the mouse pointer as shown in the screen shot to the right, just above the girdle line. The whole girdle facet should be highlighted in green. If only a single edge is highlighted, move the cursor away from the edge until the facet is highlighted. This point will establish the girdle thickness. Click with the left mouse button and click the **Use to Cut** button. Enter an angle of 34° and an index of 3, click the **Apply** button and *GemCad* will cut 16 crown break facets:
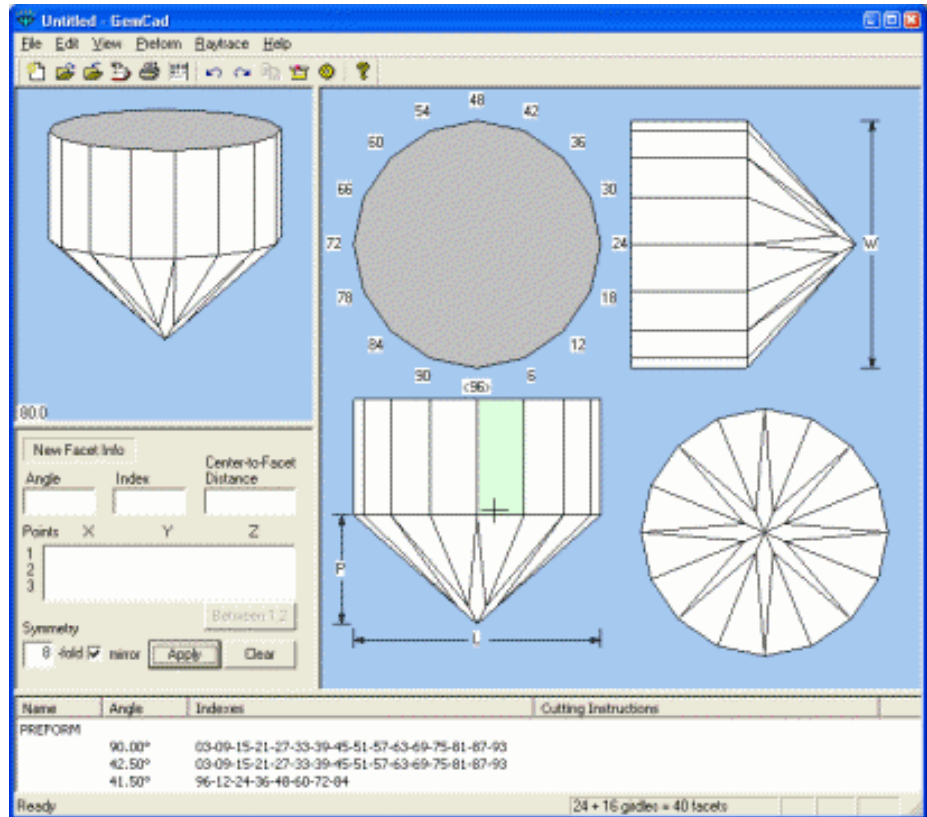
Now we are ready to cut the crown main facets. Move the mouse pointer as shown by the red circle. This should be at the crown girdle line. Click with the left mouse button and click the **Use to Cut** button. Enter an angle of 28° and an index of 96, click the **Apply** button, and *GemCad* will cut the 8 crown main facets.

Now we are ready to cut the star facets. Move the mouse pointer as shown by the red circle at the tip of the break facets along the edge at the 6 index position. Click with the left mouse button and click the **Use to Cut** button. Enter an angle of 16° and an index of 6, click the **Apply** button and *GemCad* will cut the 8 star facets.
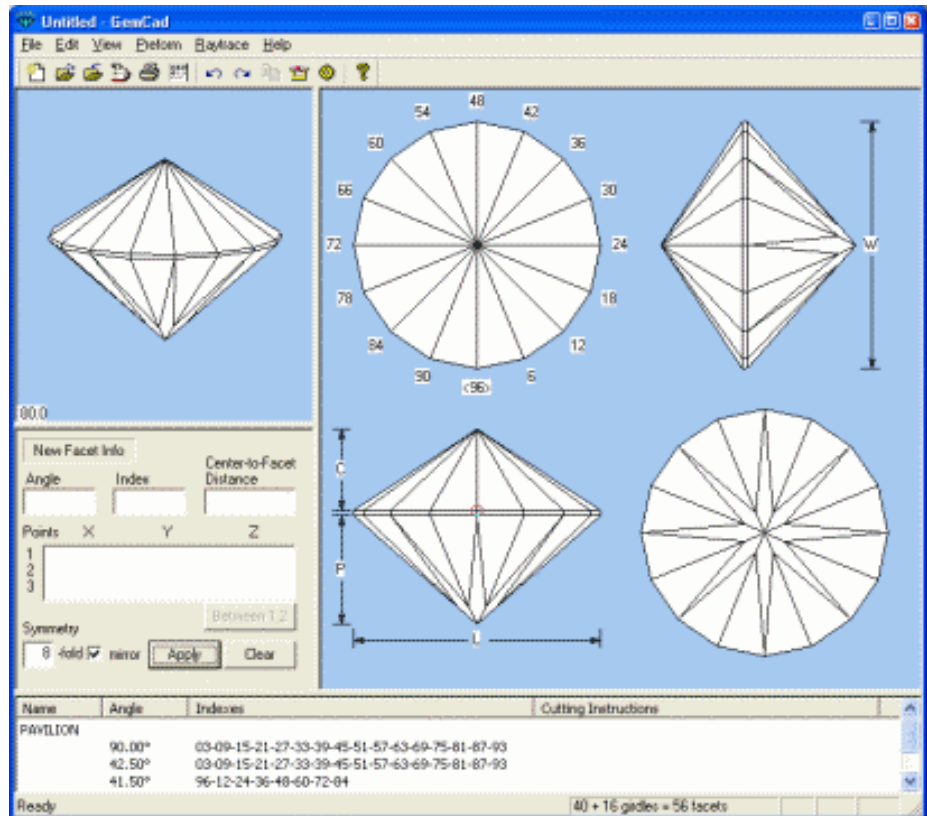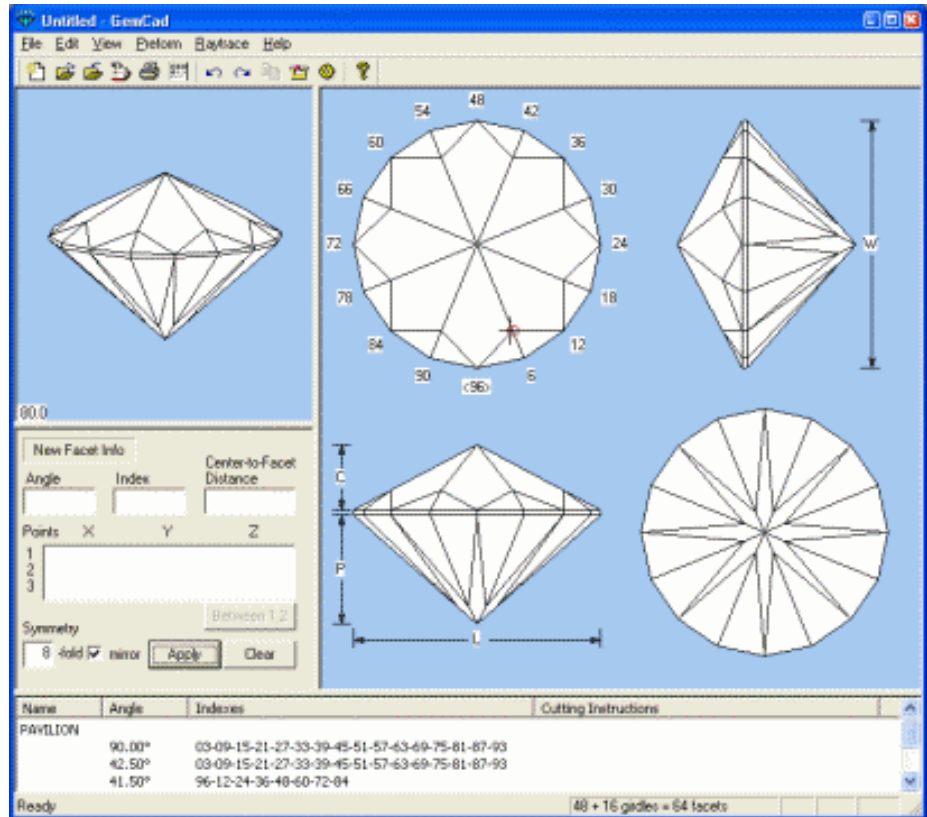

Move the mouse pointer as shown in the figure at the right. You should see a red circle **o** around the meet point. Click the left mouse button and click the **Use to Cut** button. Enter an angle of 0° and click the **Apply** button. *GemCad* will cut the table facet. This completes the faceting.
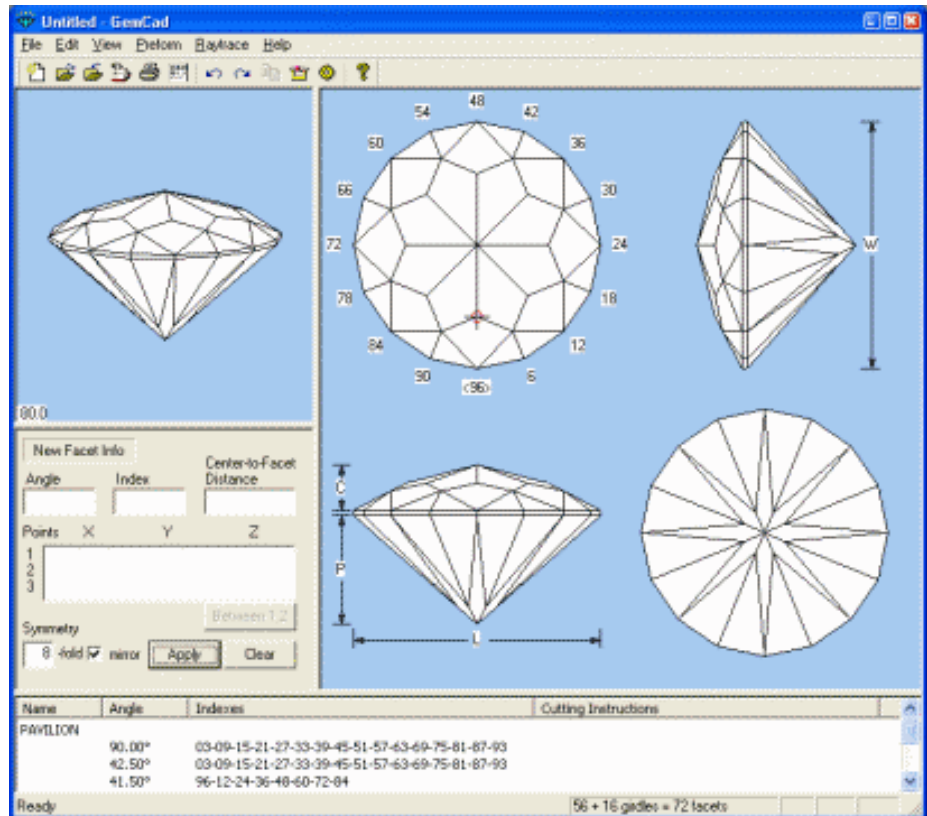
The next step is to name (label) the facets. Move the cursor as shown at the right. There should be a little red dot **.** on the outline of the stone, not a red **x**. If not, move the mouse away from the edge slightly. Click the left mouse button, and the **Facet** dialog will pop up. (If you instead get the **Edge** dialog, click **Cancel** and try again.) Click in the edit box labeled **Name** and type in **G**. Click the **Apply** button, and *GemCad* will label the girdle facet with an arrow and **G** as shown in the next figure.
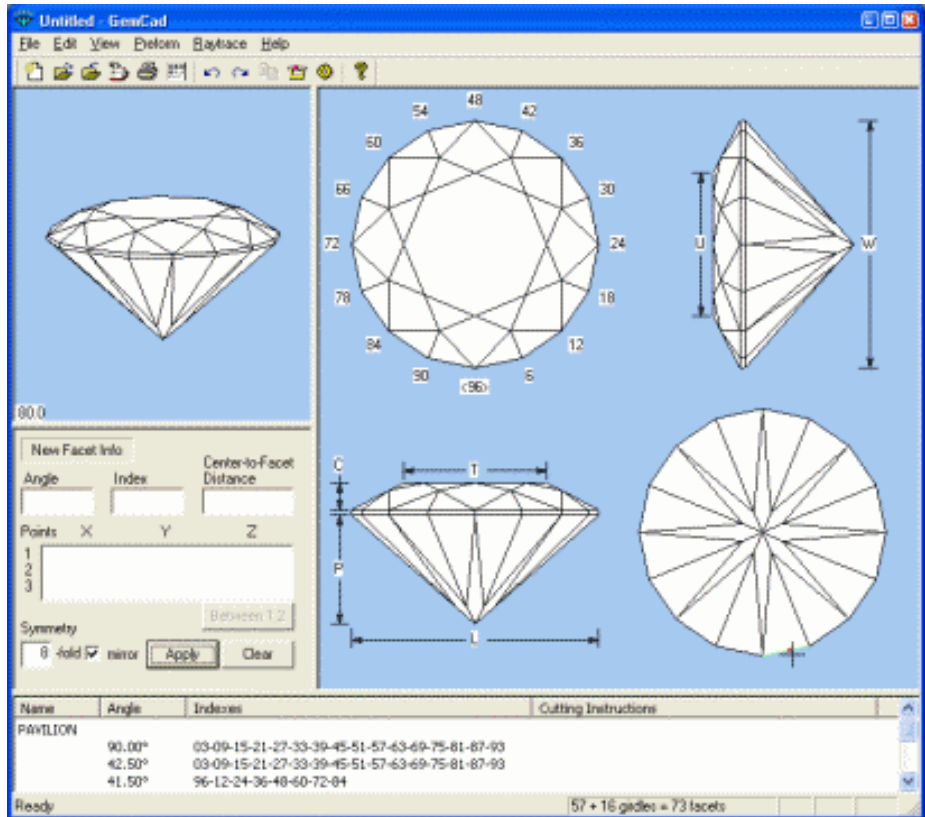
Next move the mouse pointer inside the facet labeled 1 at the right. *GemCad* will highlight the facet in green. Click with the left mouse button, click in the **Name** box and type in **1** and click the **Apply** button. You will see a the **1** label appear inside the facet. Continue clicking in the facets, one at a time, and naming them, as shown at the right. You will notice that the facet names also appear in the *Name* column of the cutting instructions at the bottom.
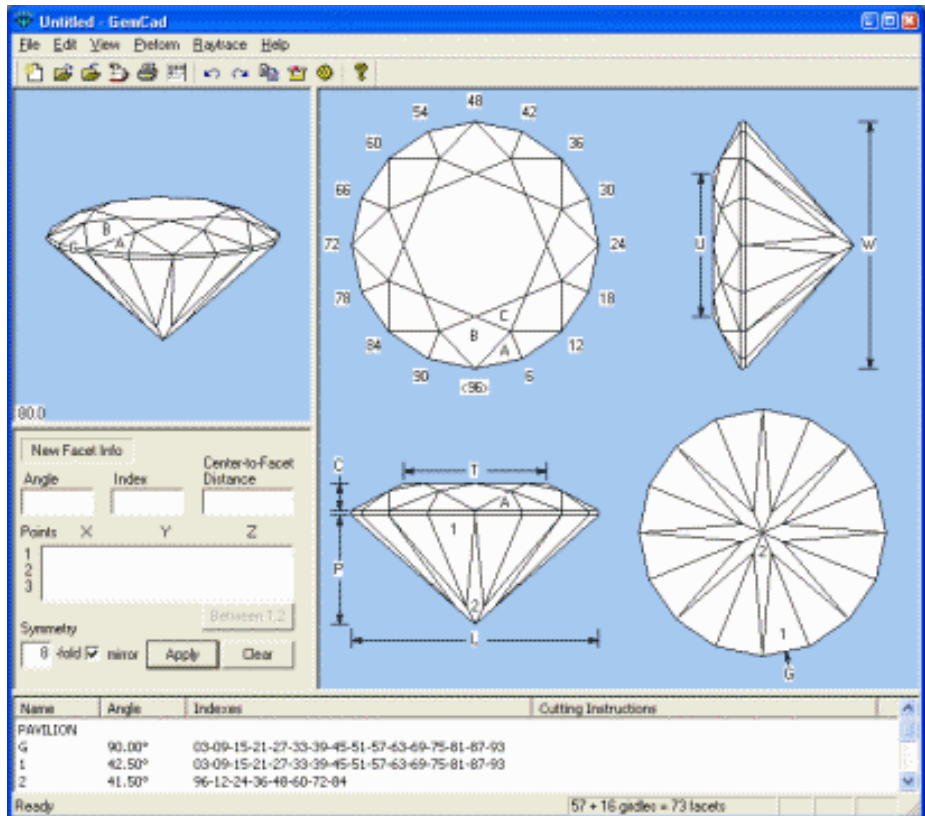
This concludes the round brilliant. You can save the design with the **File/Save** menu command. Take a look at the diagram with the **Edit/Print Preview** command.

After practicing this tutorial a couple of times, try cutting the design from the faceting diagram above without referring to this tutorial. If you can do this then you are ready to try proof–cutting other diagrams.

Here is a summary of what we have learned:

- You can resize *GemCad's* window panes by dragging the bars that divide the panes.
- *GemCad* simulates a faceting machine.
- *GemCad* shows what the stone looks like after every step.
- You tell *GemCad* how deep to cut a facet graphically with a point.
- Like using a faceting machine, you cut one side of the stone and then transfer to cut the other side.
- To specify a meet point, a point on an edge, or a point inside a facet, just click on the point with the mouse and click the **Use to Cut** button.
- *GemCad* takes advantage of a design's symmetry to cut several facets at once.
- Enter the angle and index of a new facet in the edit boxes in the **New Facet Info** box.
- When *GemCad* has enough information to cut a facet, the **Apply** button caption will change to **Cut Facet**. Clicking this button will tell *GemCad* to cut the facet and all of the facets related to it by symmetry.
- Facet names appear as labels inside the facets. Girdle facets are labeled outside the outline of the stone in the bottom view.
- To select a girdle facet, move the mouse pointer just outside the outline of the facet in the bottom view.

Screen Layout

GemCad's basic screen layout is shown at the right. The colors and window style on your system might differ from those pictured because of the particular version of Windows and the color choices you have made in the Windows control panel. *GemCad* uses a special type of window called a *splitter window* that is divided into four *views* or panes separated by small bars. These bars are resizing gadgets that you can drag with the mouse to change the size of the individual views. To drag a sizing bar, move the mouse pointer over a bar, press the left mouse button, and hold it down while moving the mouse in the direction of one of the arrows. Any one of the four panes can be enlarged to fill the entire window. When one of these panes is hidden, you will still find its sizing bar along the edge of the neighboring pane.
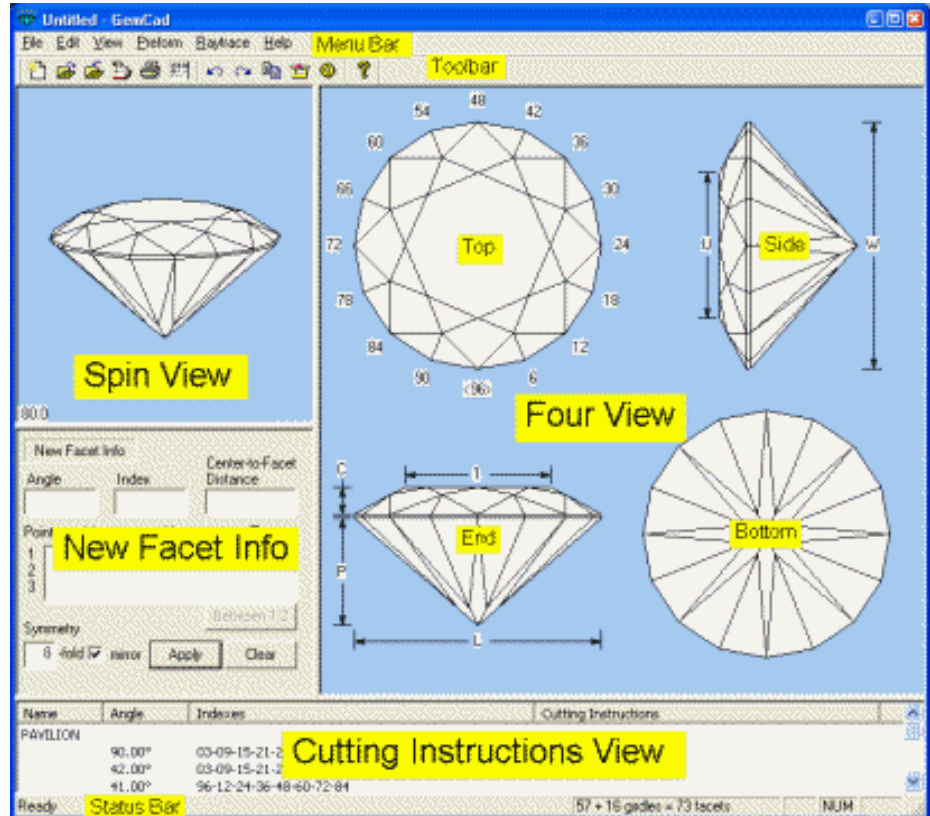
In the picture above, you can click on the different sections to jump directly to the corresponding section in this manual.

The Four View

The **Four View** shows four views of the stone from different points of view, or just a single view depending on the setting of the **View/Zoom** switch. Besides displaying the stone, it is used to select points for cutting a new facet. In general, at least one point is needed to establish the depth of cut for a new facet.

Selecting Points: The Point Dialog Boxes

As you move the mouse pointer around in the **Four View**, *GemCad* will highlight different parts of the stone. When you click with the left mouse button in the **Four View**, a dialog box will pop up. Which dialog box depends on what is highlighted when you click. If the mouse pointer is near a meet point of three or more facets, *GemCad* will circle the meet point in red. If the mouse pointer is near an edge, *GemCad* will highlight the edge in green. If the mouse pointer is in the interior of a facet, *GemCad* will highlight the entire facet. Clicking with the left mouse button will pop up one of several dialog boxes. All of the boxes have three buttons in common:

- **Use to Cut**
- **Zoom In/Out**
- **Cancel**

Clicking the **Use to Cut** button will place the *xyz* coordinates of the point into the **New Facet Info** box. This point will be used as one piece of information to determine the plane of the next facet to be cut. This button is the default, so the space bar or the *Enter* key ⏎ can be used instead.

The **Zoom** button affects how the **Four View** displays the stone. The view surrounding the mouse pointer can be enlarged to fill the entire window. If the view is already zoomed in, then clicking this button will zoom back out so that all four views are visible. The **Zoom** button's label will toggle between **Zoom In** and **Zoom Out** accordingly**.** The **Zoom** button toggles between the two magnifications, so there is no way to further zoom in on the stone. If you need more magnification, you can enlarge the **Four View** so that it fills the entire *GemCad* window. You can also try maximizing the *GemCad* window so it fills the entire screen. The magnification can also be changed by the **View/Zoom** menu command. You can enlarge the window slightly by hiding the toolbar and status bar with the **View/Toolbar** and **View/Status Bar** menu commands.

One of four different dialog boxes will pop up when you click in the **Four View**. Which dialog depends on what is highlighted as you move the mouse. The four dialogs are:

- **Meet Point**
- **Point on Edge**
- **Facet**
- **Outside Stone (Pierce)**

The Meet Point Dialog Box

The **Meet Point** dialog pops up when you click with the left mouse button when the mouse pointer is near a meet point of three or more facets that is circled in red **o**. When you place the mouse pointer in the **Four View** near a meet point, the meet point will be circled in red. When you click the left mouse button, the dialog shows the *xyz* coordinates of the point and allows you to use the point.
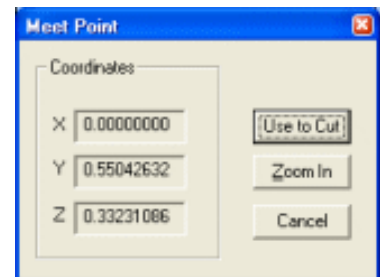
The Point on Edge Dialog Box

The **Point on Edge** dialog pops up when you click with the left mouse button near the edge of a facet when that edge is highlighted in green with a red **x** on the edge near the cursor. The coordinates of the end of the edge nearest the mouse pointer are the **Near End**, and the other end is the **Far End**. The box labeled **Length of edge** shows the length of the edge as a fraction of the stone width. Likewise, the boxes labeled **Difference** show this length projected on the *xyz* coordinate axes. The box labeled **Angle between facet normals** gives the difference in angle between two vectors normal (perpendicular) to the two planes that share the edge. This angle is the dihedral angle between the two facets that share the edge. In general, angles less than about 5° make it difficult to polish without getting a single rounded facet instead of two facets with a sharp edge.
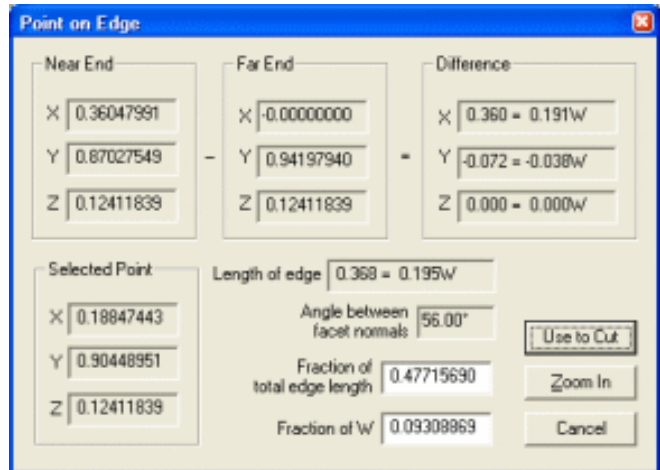
There are two edit boxes that allow you to enter not just the point at the mouse pointer, but *any* point along that edge. The box labeled **Fraction of total edge length** is intended to take a number between 0 and 1. The fraction 0 gives the near end of the edge, and the fraction 1 gives the far end. The fraction 0.25 selects a point on the edge a fourth of the way from the near end to the far end. Similarly, the box labeled **Fraction of W** give the length from the near end to the selected point in units of fractions of the width of the stone (the dimension labeled W). Let's say you have cut the pavilion of a design and have transferred and are preparing to cut the first crown facet. To make the girdle thickness exactly 2% of the width of the stone (W) click on the corresponding edge and change the **Fraction of W** number to 0.02 (2%). As you change the numbers in either of these two white boxes, the coordinates in the **Selected Point** box change accordingly.

A similar dialog box pops up if you have entered two points and press the **Between 1,2** button in the **New Facet Info** box. Point 1 will be the near end and point 2 will be the far end.

If you want to select a point on an edge near a meet point, but *GemCad* wants to select the meet point instead, there are a couple of tricks. One is to select a point on the edge further away from the meet point and then use the **Fraction of total edge length** edit box and type in a smaller number. The other trick is to hold down the *Ctrl* key. This will allow you to get closer to the meet point before *GemCad* changes from highlighting the edge to highlighting the meet point.

The Facet Dialog Box

The **Facet** dialog pops up if you click inside a facet in the **Four View** when a facet is highlighted. The point is indicated with a red plus **+** under the mouse pointer. The entire facet will be highlighted in green. The **Facet** dialog has three purposes, as indicated by the three groups of controls:

1. To enter a point in the interior of a facet.
2. To edit a facet or tier of facets.
3. To copy information about the facet for cutting a new facet.
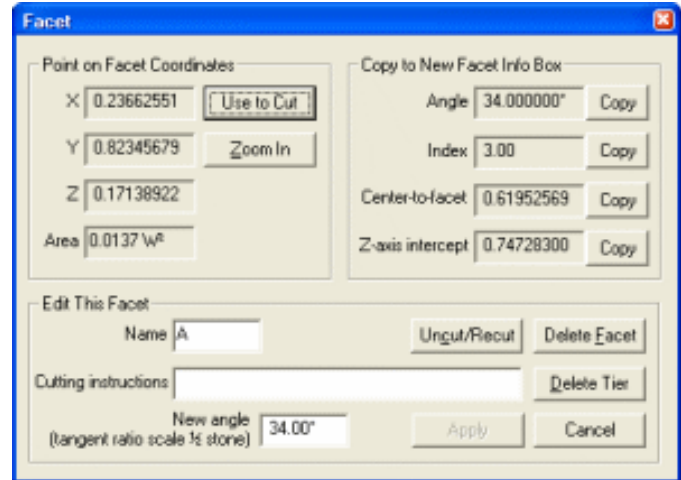
The group of controls labeled **Point on Facet Coordinates** is similar to the other point dialogs. The **Area** of the facet is given as a fraction of the square of the width of the stone.

The **Edit This Facet** group has several choices. The **Name** of the facet gets placed inside the facet to label it. Also, the name is placed in the first column of the cutting instructions. The **Cutting Instructions** are placed in the right column of the **Cutting Instructions View**. This is intended as an annotation to describe a reference point or information about the cutting depth.

The **Uncut/Recut** button un–cuts all of the facets in the tier that have the same area and then rounds off the index to the nearest notch (if needed) and places the index in the **New Facet Info** box. This is used to edit an existing facet. Before you click the **Uncut/Recut** button, you will probabably want first to select one or more meetpoints on the facet. This is because uncutting the facet makes some of the meetpoints disappear.

The **Delete Facet** button will delete the facet. The **Delete Tier** button will delete all of the facets on this tier whose area is equal to the selected facet. If this tier has facets of different shapes, and you want to delete *all* of the facets in a tier, click on the line containing the facet in the **Cutting Instructions View** at the bottom of the screen to get the **Edit Tier** dialog box.

The **New angle** box is used to tangent–ratio scale the side of the stone containing the facet. Just type in a new angle and click on the **Apply** button to use this feature.

The **Copy to New Facet Info Box** group of static text boxes and the corresponding **Copy** buttons are used to display information about the facet and copy information from this facet to cut a new facet. For instance, the **Copy Index** button is used to copy the index of the selected facet to the **New Facet Info** box. This comes in handy if you are cutting a step cut and want to make another tier with the same index positions as the first. Likewise, the **Copy Angle** button will copy the angle of the selected facet to the **New Facet Info** box. The **Center–to–facet** box gives the distance from the plane of the facet to the origin, the point (0,0,0). The corresponding **Copy** button comes in handy for making ECED (Equal Center–to–Edge Distance) designs. The **Z–axis intercept** box gives the distance from the origin to the point at which the plane of the facet hits the dop axis. This comes in handy for editing facets that meet at a TCP (Temporary Center Point), even if other facets have already cut off that TCP.

The **Facet** dialog also pops up if you click just outside the outline of the stone in the **Four View**. This selects the facet that shares the outside edge with the outline of the stone. The easiest way to select a girdle facet is to position the mouse pointer in the Top or Bottom view just outside the margin of the stone along the edge of the facet that shares an edge with the girdle facet. There will be a small red dot

or square ▪ near the cursor. If there is instead a red **x**, the mouse pointer is too near the edge and needs to be further outside the margin of the stone.

The Outside Stone Dialog Box

The **Outside Stone (Pierce)** dialog pops up if you click in the **Four View** outside the stone. It selects a point under the mouse pointer. One of the coordinates will be zero. For instance, in the top view, the *z* coordinate will be zero as in the example to the right. This is most commonly used when cutting a girdle outline.
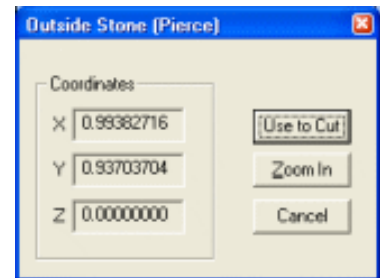
The Ctrl Key

Sometimes it is difficult to select a small facet because *GemCad* wants to select an edge or meetpoint instead of the facet. It is also sometimes difficult to select a point on edge near a meetpoint. If you hold down the *Ctrl* key while moving the mouse in the **Four View**, *GemCad* will allow you to select a point on a facet closer to one of its edges. It will also allow you to select a point on edge closer to a meetpoint. A trick for remembering this is that the *Ctrl* key gives you more *control*.

Sometimes it is easier to select a small facet in the **Cutting Instructions View** instead of trying to select it with the mouse in the **Four View**.

The Shift Key

The *Shift* key is used for making edges that are exactly horizontal or exactly vertical. If you hold down the *Shift* key while moving the mouse in the **Four View**, *GemCad* will anchor the marker to the previous point so that it aligns vertically or horizontally with the previous point. *GemCad* remembers the location of the previous point whether or not you clicked **Use to Cut**. When you click the left mouse button while holding down the *shift* key, *GemCad* selects the point indicated by the marker instead of the mouse pointer. A trick for remembering this feature is that the *Shift* key allows *GemCad* to *shift* over horizontally or vertically from the previous point.

Raytracing

The **Four VIew** also allows you to do raytracing. Clicking the right button will shoot in a single ray of light at the point of the cursor. The ray will be displayed in all of the views. If you hold down the right mouse button while moving the mouse, *GemCad* will shoot in a continuous stream of light rays.

Copy to Clipboard

The **Edit/Copy** command copies the **Four View** to the Windows Clipboard.

The New Facet Info Box

Cutting New Facets

This dialog box collects and displays the information that you give *GemCad* to cut the next facet or tier of facets. When you have given *GemCad* enough information to cut a new facet, the **Apply** button's label will change to **Cut Facet.** Clicking the **Cut Facet** button will tell *GemCad* to cut this facet or facets. The **Symmetry** settings control how many facets are cut and how they are spaced around the index gear.
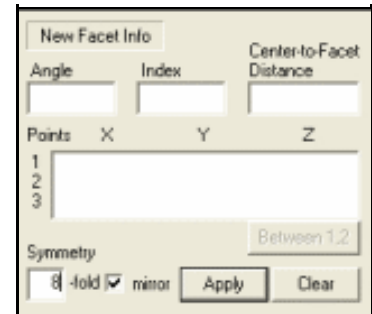
To enter an angle or index, click in corresponding box and type the number into the box. You can change an angle or index number by double clicking on the number and typing over it. Likewise, you can type in or change *xyz* coordinates into the **Points** box, but this is seldom needed. After you enter an angle or index, you might find it helpful to press the *Tab* key. This will update the status of the **Apply** button.

If one of the edit controls has the focus (as indicated by a blinking cursor), pressing the *Enter* key works the same as the **Apply** or **Cut Facet** button.

To cut a facet, *GemCad* needs three pieces of information. You might remember from geometry that three points determine a plane. The most common combinations are:

- Angle, index and one point
- Index and two points
- Three points
- Angle and two points

The combination of angle, index and one point is the most common when proof–cutting an existing design. The remaining choices are used in the design process. If you specify an index and two points, *GemCad* will calculate the angle. If you then change the angle by changing the number in the **Angle** edit box, *GemCad* will discard the second point and keep the first one. When you give *GemCad* three points, it will calculate the angle *and* the index. The index of the new facet is not likely to fall on a whole number, but will probably fall between index notches. You can edit the index and/or the angle before you press the **Cut Facet** button. If you do this, *GemCad* will discard the second and third points.

The **Center–to–Facet Distance** is the distance from the plane of the facet to the origin, the point (0,0,0), the point at the center of the four views of the stone. This distance is measured perpendicular to the plane of the facet. There are two situations where this distance comes in handy. The first one is when cutting an Equal Center–to–Edge Distance (ECED) design. These designs have an outline formed by cutting girdle facets at 90° at a variety of index positions but at the same mast height. To do this using *GemCad*, you can cut one girdle facet and then click in it. When the **Facet** dialog pops up, press the **Center–to–Facet Copy** button. Then give *GemCad* the index of the next girdle facet and an angle of 90°. You can use the **Angle Copy** button to save some keystrokes. Another use of the **Center–to–Facet Distance** is in designing spherical cuts. If you cut a bunch of facets at varying angles and indexes but with the same center–to–facet distance, the result is a spherical shape.

The other way to get information into the **Angle, Index** or **Center–to–Facet Distance** boxes is to use the **Copy** buttons in the **Facet** dialog. These buttons copy bits of information from existing facets.

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Symmetry

The **Symmetry** edit control and **mirror–image** checkbox are located in the lower left–hand corner of the **New Facet Info** box. *GemCad* understands two types of symmetry: *radial,* and *mirror–image* symmetry. Both types of symmetry are common in nature and everyday life. Flowers and spokes on a wheel are common examples of radial symmetry. A design with radial symmetry will have the same appearance if rotated by some fraction of a revolution. The degree of radial symmetry is the number of steps required to rotate the design one full revolution.

The other type of symmetry is mirror–image symmetry, or *bilateral* symmetry. A design with this type of symmetry can be flipped about a vertical axis without changing the design. Common examples of this are the human face, body and many tree leaves. With such a design, you can place a mirror on edge through the center of the design, and the reflected half will be identical to the half hidden by the mirror. *GemCad's* axis of bilateral symmetry is always vertical like the human body. If you want to cut a pear shape with *GemCad,* you will find it easiest to orient the axis of symmetry vertically. (You can rotate the index gear so the ID position is on the side to make the indexes line up with an existing diagram.) If you need to make the symmetry axis horizontal, you can rotate the design after cutting it.

Some designs have both radial and bilateral symmetry or just one or the other. To figure out the degree of radial symmetry, you can count how many identical pie–shaped pieces that you can cut the design into. The suffix *–fold* should be thought of as *parts* or *times,* not like *folding* a piece of paper. The pie–wedge analogy works fairly well for 3–fold or higher radial symmetry, but for 2–fold symmetry, the concept takes a bit of getting used to. *GemCad* considers designs such as ovals, emeralds, and marquises to have 2–fold, mirror–image symmetry. Designs that have only bilateral symmetry, such as hearts, shields, and pears, have 1–fold, mirror–image symmetry, and the axis of symmetry must be vertical. To *GemCad,* a design without any symmetry has 1–fold symmetry.
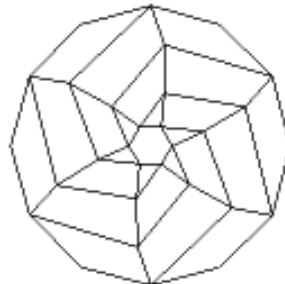
The best way to explain *GemCad's* concept of symmetry is with a lot of examples. Each example below was created with the symmetry setting in its caption.
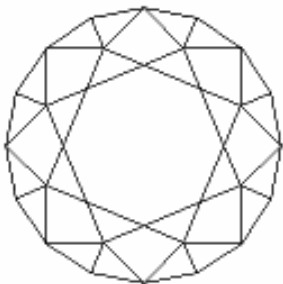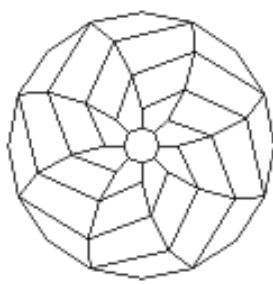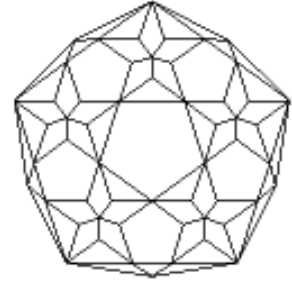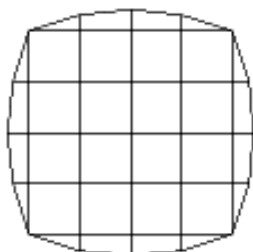

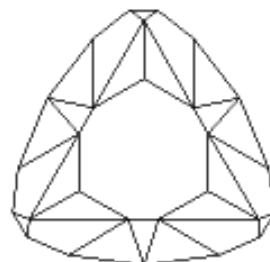| *8–fold, mirror–image* | *8–fold, not mirror* | *6–fold, not mirror* | *5–fold, mirror–image* |

| *4–fold, mirror–image* | *4–fold, not mirror* | *3–fold, mirror–image* | *3–fold, not mirror* |
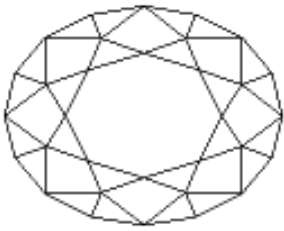
2–fold, mirror–image   2–fold, mirror–image   2–fold, mirror–image   2–fold, not mirror
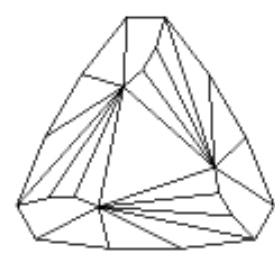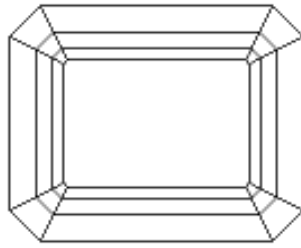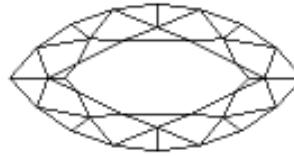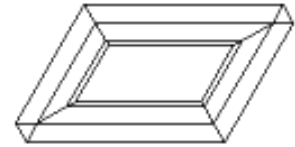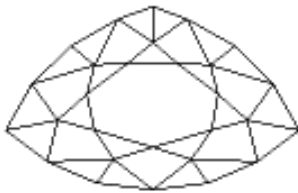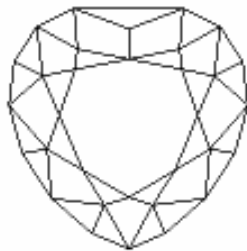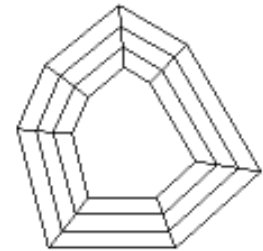

1–fold, mirror–image   1–fold, mirror–image   1–fold, mirror–image   1–fold, not mirror

You can change the symmetry in the middle of a design if your design has mixed symmetry. When you save a design, *GemCad* saves only the current symmetry settings.

The Between 1,2 Button

The **Between 1,2** button is used to select a point along the imaginary line segment that joins point 1 and 2 in the **Points** box. A dialog box very similar to the **Point on Edge** dialog will pop up. The point labeled **Near End** is point 1, and the point labeled **Far End** is point 2. If you click the **Use to Cut** button the new point *replaces* points 1 and 2. This feature is seldom used.

The Clear Button

The **Clear** button is used to discard all of the information in the **New Facet Info** box. This has no effect on the symmetry.

The Spin View

The **Spin View** allows you to view the stone from any angle. To rotate the stone, put the mouse pointer inside the **Spin View** and press and hold down the left mouse button as you move the mouse. Moving the mouse horizontally will spin the stone about the dop axis as if spinning the index gear. Moving the mouse vertically will tilt the stone as if changing the protractor. If you hold down the *Shift* key while moving the mouse, the entire view will rotate. You can use the spacebar to round all of the view angles to the nearest 10°. *GemCad* will display the tilt (protractor) angle in the lower–left–hand corner of the view.

The **Spin View** also allows you to do raytracing. Clicking the right button will shoot in a single ray of light at the point of the cursor. If you then rotate or tilt the stone, you can see this ray path in three

dimensions. If you hold down the right mouse button while moving the mouse, *GemCad* will shoot in a continuous stream of light rays.

The **Edit/Copy** command copies the **Spin View** to the Windows Clipboard.

The Cutting Instructions View

The **Cutting Instructions View** displays a table of the angles and indexes for each facet. Each line of information corresponds to a *tier* of facets. All of the facets in a tier have the same angle and mast height and are usually related by the stone's symmetry. At the top of this view, there is a title bar with the column headings *Name, Angle, Indexes,* and *Cutting Instructions*. You can adjust the column widths (like tab stops) by holding down the left mouse button while dragging the little vertical bars that separate the columns.

The Edit Tier Dialog Box

As you move the mouse pointer over this view, the line under the mouse pointer will be highlighted in blue. If you click on a line in this view with the left mouse button, the **Edit Tier** dialog box (shown at the right) will pop up. This box allows you to edit the highlighted tier of facets as a group. The **Move Up** button moves the tier up one position in the cutting instruction list. Likewise, the **Move Down** button moves that tier down one position. The **Delete Tier** button deletes that line and deletes those facets from the other views as well. This is the easiest way to get rid of a tiny facet that is too small to select in the **Four View**. Unlike the button in the **Facet** dialog with the same name, this one deletes all of the facets regardless of their size. The one in the **Facet** dialog deletes only facets in the tier that have the same surface area.
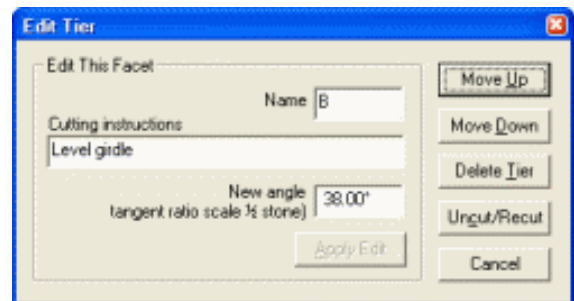
The **Uncut/Recut** button also deletes that tier. However, before deleting it, it copies the smallest index number into the **New Facet Info** box. The next tier of facets cut will be positioned in the same spot in the cutting instructions instead of at the end. It is similar to the **Uncut/Recut** button in the **Facet** dialog, but it applies to all of the facets in the tier regardless of their size. The one in the **Facet** dialog only applies to facets in the tier that have the same area.

The group of controls labeled **Edit This Facet** allow you to edit properties of that facet. The **Name** is placed in the first column and the **Cutting instructions** are placed in the right column. It is possible for more than one facet in a tier to have a name. If you change the name of the tier, *GemCad* will change the name of every facet that has one to the new name. If none of the facets in a the tier have a name, the new name will be placed in the facet that has the smallest index number.

The **New angle** box is designed to tangent–ratio scale either the pavilion or crown. To use this feature, type in the new angle and click the **Apply Edit** button. This changes not only the tier you clicked on but scales all of the facets on that side of the stone. This process stretches or shrinks the stone along the dop axis but does not change the appearance of the stone from the top or bottom.

The **Edit/Sort** and **Edit/Rename in order** menu commands affect the order and names in this view.

The Toolbar
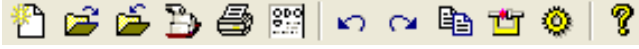
The toolbar provides shortcuts to frequently−used commands. Click on the buttons on the toolbar image above to jump to the corresponding description. The **View/Toolbar** switch hides the toolbar if you need a bit more screen real estate.

The Status Bar

The status bar keeps track of the number of facets. It tells you how many non−girdle, girdle, and total facets. It also gives help text for the toolbar and menu commands when you move your mouse pointer over the toolbar and menu. The **View/Status Bar** switch hides the status bar if you need a bit more screen real estate.

The Menu Bar

File Edit View Preform Raytrace Help

You can click on the image of the menu bar above to jump to that section of the manual.

The File Menu

You will recognize many of the file menu commands as standard Windows fare. *GemCad* is a single−document application. This means you can have only one design open at a time. (You can, however, run several copies of the program opening a different design in each copy.)

The New Command

The **File/New** command deletes all facets and starts a new design. *GemCad* will prompt you to save your modified work. The shortcuts to this are the [icon] button on the toolbar or the standard Windows shortcut, *Ctrl*+N.

The Open Command

The **File/Open** command opens an existing design file. There is a drop−down list labeled **Files of type** that lets you choose the file type. The shortcuts to this are the [icon] button on the toolbar or the standard Windows shortcut, *Ctrl*+O.

The Save Command

The **File/Save** command saves the existing design to a file, writing over the previous version. If you haven't given the project a name yet, this works like the **File/Save As** command. The shortcuts to this are the [icon] button on the toolbar or the standard Windows shortcut, *Ctrl*+S.

The Save As Command

The **File/Save As** command saves the existing design to a new file, prompting you for the new name. There is a drop−down box labeled **Save as type** that lets you choose the file type.

GemCad File Types

GemCad's native file format is the `.GEM` file. The `.GEM` file format is proprietary. The `.GEM` files made by *GemCad for WIndows* are fully forwards compatible with the old DOS *GemCad 4.51*. *GemCad for Windows* can open any file made by the DOS *GemCad 4.51*. If you save a design with *GemCad for Windows*, you can generally open it with *GemCad* or *GemRay* for DOS with no problems. The exceptions are as follows:

- *Line length.* The DOS programs are limited to 79 characters on the heading and footnote. If you have longer lines, these will cause an error message in the DOS software, but the facets will be OK.
- *Preforms.* The DOS programs will ignore any preforms.

These limitations apply to the *GemCad* and *Datavue II* `.ASC` file format as well. The `.ASC` format has some additional limitations regarding preforms. CAM preforms will be included but the preform height might change. Other types of preforms that have a TCP or OMNI type with no facets cut off will not retain the preform. However, the **Preform/Copy to Preform** command can be used to regenerate the preform.

Here is an example of a `.ASC` file for the Standard Round Brilliant above:

```
GemCad 5.0
g 96 0.0
y 8 y
I 1.54
H Standard Round Brilliant
H 9/5/02
a -90.000000 1.02653281 93 n G 87 81 75 69 63 57 51 45 39 33 27 21 15 9 3
G 16-sided outline
a -42.500000 0.61819401 93 n 1 87 81 75 69 63 57 51 45 39 33 27 21 15 9 3
a -41.500000 0.61701256 96 n 2 84 72 60 48 36 24 12
a 34.000000 0.68444470 3 n A 9 15 21 27 33 39 45 51 57 63 69 75 81 87 93
a 28.000000 0.60896430 96 n B 12 24 36 48 60 72 84
a 16.000000 0.50613241 6 n C 18 30 42 54 66 78 90
a 0.000000 0.36450932 96 n T
F GemCad for Windows Manual
```

The first line is always **GemCad 5.0**. The **g** line gives the index gear. The **y** line gives the symmetry. The **I** line gives the refractive index. The **H** lines give the heading, up to four lines total.

The facet data are found in lines beginning with **a**, one line per tier of facets. After the **a** is the angle (negative for pavilion facets). Next comes the center–to–facet distance. This number will be positive unless the facet is a culet (0° pavilion) facet. Next comes the list of index numbers. Facet names are given after the **n** character after the corresponding index number. Cutting instructions follow the **G** character and extend to the end of the line. You can break long lines of facets, or the **G** and cutting instructions can be at the end of the **a** line.

The **F** line is the footnote. There can be up to four **F** lines.

These files are text files, and you can edit them with a text editor such as Windows Notepad to do dirty tricks and extend the capabilities of *GemCad*. For instance, you can merge the pavilion of one design with the crown from another design.

The Export Command

The **File/Export** command saves designs in several other non–native file formats:

- Autodesk DXF format. This divides the facets into triangles and uses the `3DFACE` primitive. This format is supported by a variety of 3D CAD and rendering packages.
- VRML(<u>V</u>irtual <u>R</u>eality <u>M</u>arkup <u>L</u>anguage) `.WRL` world file format.
- Long and Steele B3D format. This format is used by Robert Long's *RayWin* program and other software.
- THB format. This is the low–resolution thumbnail sketch format used internally in *Datavue II*. Only the *Datavue* database administrator needs this format.

The Search Datavue Database Command

The **File/Search Datavue Database** command interfaces directly with the *Datavue II* database of faceting designs if you have it installed on your computer. *Datavue II* was originally published by Robert Long and Norman Steele. Most recently, it has been maintained by John Franke of the Facet Shoppe, www.gemcutter.com. If *GemCad* finds the database, a search dialog pops up. If not, a standard Windows *File Open* dialog box pops up that lets you browse for the database file `dlist.dbf` on your hard disk. If you find this file, *GemCad* will remember its location and not ask again. The only time that you need to do this is if you have already installed *Datavue* but have put it somewhere other than its default folder, `C:\DVUE2`. The next time you run *GemCad,* it will remember the location of this file automatically.

If you have installed *Datavue II* and *GemCad* has found it, the **Search Datavue Database** dialog will pop up. You can type a, *search pattern,* a word or phrase for which to search in any of the white edit boxes. In this example, the *Design Name* box has the search pattern tribble in it. When you click the **Find Next** button, *GemCad* will search for designs that match the search pattern If you type several search patterns in different boxes, *GemCad* will search for designs that match *all* of the search patterns.

If there is a design that matches, *GemCad* will fill in all of the boxes. If a thumbnail sketch is available, *GemCad* will show a picture of the design. If you press the **Find Next** button again, *GemCad* will search for the next design that matches your search criterion. If you pass the design you wanted, press the **Previous** button to back up. When you get to the last design, *GemCad* will pop up a dialog box that shows how many designs it found that match the pattern.
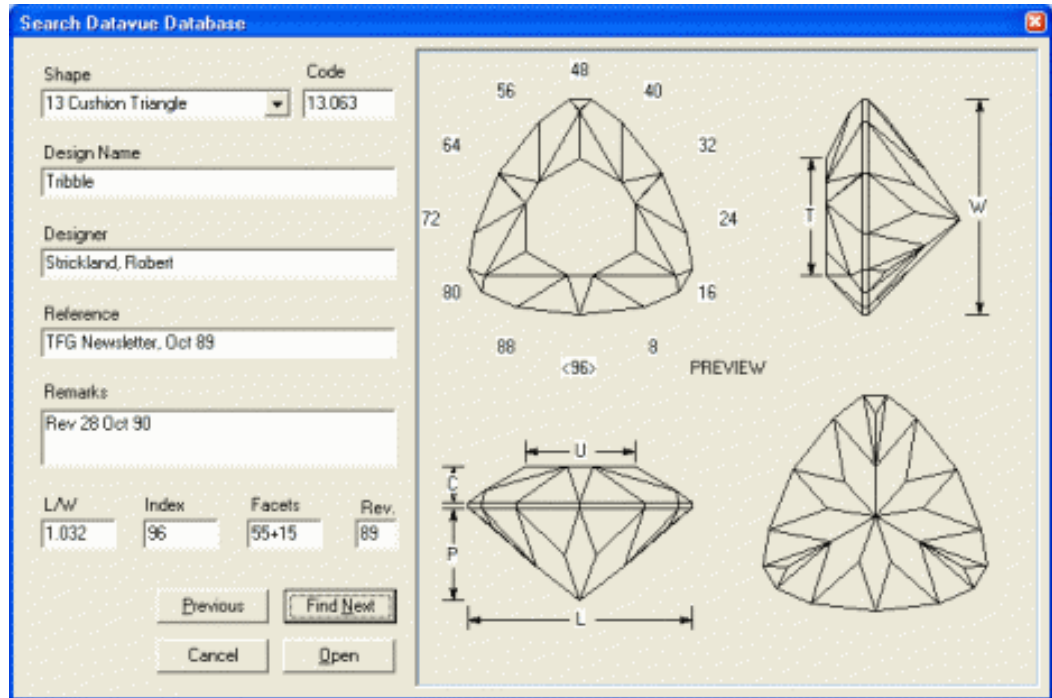
If the **Open** box is not disabled, then the design is also available in *GemCad* format. Pressing the **Open** button will open the design in *GemCad*. If the **Open** button is disabled (grayed) then you probably do not have the full version of *Datavue II* with the designs in *GemCad* format. At the time of this writing (9/02), the version of *Datavue II* did not have any designs in *GemCad* format because some designers had requested their designs be removed from the database. If you are in doubt, search for the file GASC0101.STO and record its size. If it is only a few bytes long, then this file is merely a placeholder, and you do not have the files in *GemCad* format. If this is the case, check www.gemcutter.com periodically to find out when these files will become available.

In the *Datavue* database, each design is assigned a unique number. There is a two digit number, a period and a three digit number. The two digit number is a code corresponding to the shape of the outline of the design. The 3 digit number after the decimal is a sequence number for that shape. The **Shape** control is a drop–down list box. You can click the little triangular down arrow to drop down the list of shape categories. To search using a different search criterion, type over one of the edit boxes, and all of the other edit boxes will be cleared.

There is a button for this command in the toolbar.

The Print Command

The **File/Print** menu command prints the design through the Windows print system. You can use the toolbar button 🖨 or the standard Windows *Ctrl*+P shortcut. *GemCad's* page layout is shown on the right. Text size and layout are adjusted to fit the diagram on a single page. For complicated designs, *GemCad* might choose a two–column layout if it will help the diagram fit on the page. If you are not satisfied with the page layout chosen by *GemCad*, you can use the **Edit/Copy** command to copy the diagrams and cutting instructions to the Windows Clipboard so you can copy them into your favorite word processor. For complicated designs, you can print on larger paper. Select the paper size with the **File/Print Setup** command.

You can input the title, author and date in the heading with the **Edit/Heading/Footnote** command. The first line of the heading is set in bold–face and in a larger font.

After the heading comes the refractive index, facet count, symmetry and index gear.

TRIBBLE: A Triangular Brilliant
by Robert W. Strickland
Sep. 28, 1989; Rev. Oct. 28, 1990
Angles for R.I. = 1.540
55 + 15 girdles = 70 facets
3-fold, mirror-image symmetry
96 index
L/W = 1.032 T/W = 0.553 U/W = 0.508
P/W = 0.430 C/W = 0.171
Vol./W³ = 0.201

PAVILION
1   46.00° 14-18-46-50-78-82 Cut to TCP
2   43.00° 10-22-42-54-74-86 Meet TCP of 1
3   90.00° 14-18-46-50-78-82 Cut to final size
4   90.00° 10-22-42-54-74-86 Meet 1-2-3 (level girdle)
5   44.50° 16-48-80 Meet 1-1-3-3
6   42.96° 12-20-44-52-76-84 Adjust to meet culet and 2-3-4
7   42.10° 09-23-41-55-73-87 Meet 2-2-6-6. Sensitive to angle!
8   47.00° 96-32-64 Meet 2-7-4
9   90.00° 32-64-96 Meet 2-7-4-8
CROWN
A   45.50° 14-18-46-50-78-82 Leave some girdle
B   38.00° 10-22-42-54-74-86 Level girdle
C   44.00° 16-48-80 Meet 3-3-A-A
D   30.94° 08-24-40-56-72-88 Meet A-B-C
E   52.20° 96-32-64 Adjust to meet B-B-D-D and girdle
T   0.00° Table Meet A-B-C-D

The designer expresses his gratitude to Walter Carss
for proof-cutting the design and making several
valuable suggestions.
C:\GemCad\TRIBBLE.GEM

Next comes the table of dimensions described below.

Next comes the table of facet names, angles, indexes, and cutting instructions.

Finally there is the footnote and file name.

The Print Preview Command

The **File/Print Preview** command is used to preview the printout. It's also the only way to see the table of dimensions without printing the diagram. You can also use the toolbar button 🔳 or the standard Windows *Ctrl*+R shortcut.

The Print Setup Command

The **File/Print Setup** command lets you select the printer and paper size.
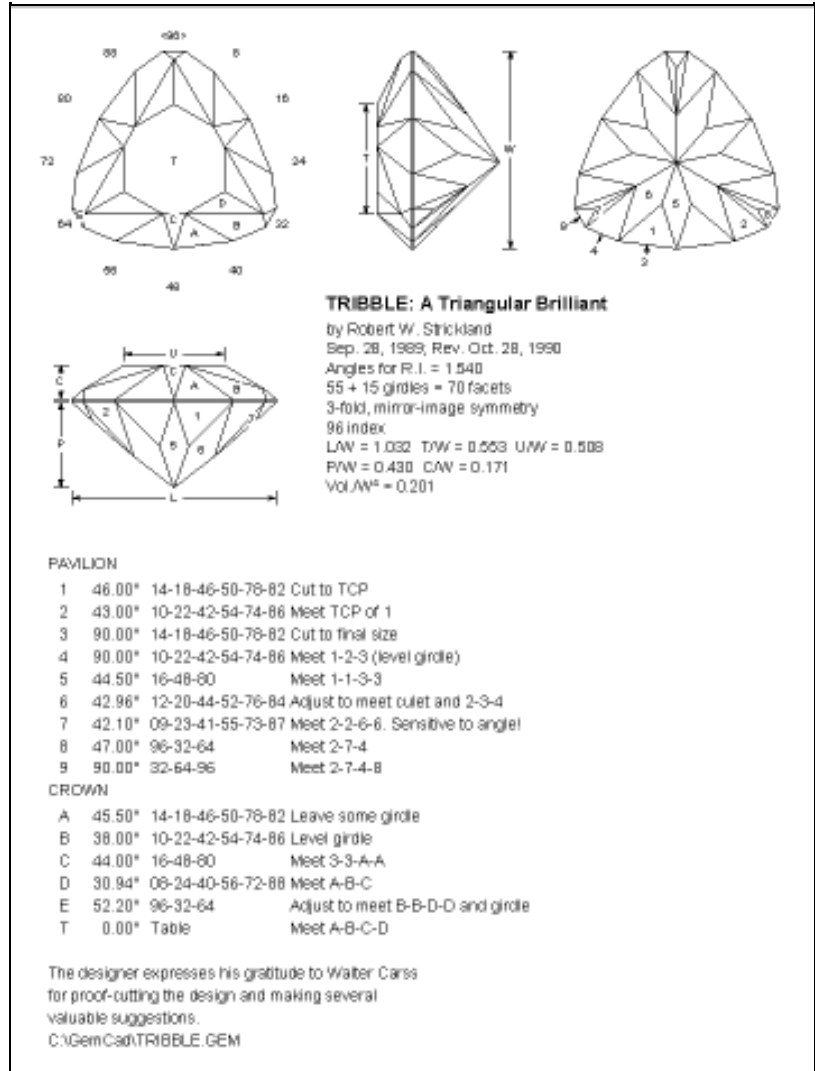
The Recent File List

The *Recent file list* allows you to locate and open a recently used file quickly.

The Exit Command

The **File/Exit** command exits the program, prompting you to save any unsaved work.

Dimensions

The **Print** and **Print Preview** commands print a table of dimensions at the top of the text information on the diagram. These numerical dimensions refer to labeled dimension lines with arrows on the diagram. The dimensions usually labeled are:

W width
L length
C crown height
P pavilion depth
T table length
U table width

In the table of dimensions, all of the dimensions are given as fractions of the width, W. All of these dimensions are measured parallel to the coordinate axes, parallel to the edges of the screen. L is always greater than or equal to W, and T is always greater than or equal to U. The girdle thickness is not included in either P or C. If the girdle line is not level, C is measured from the top of the stone to the *lowest* point on the crown girdle line. Likewise, P is measured from the bottom of the stone to the *highest* point on the pavilion girdle line. This is in contrast to the GIA's definition which measures the crown height from the top of the stone to the *highest* point on the crown girdle line. This is because using the GIA's definition with a stone with a scalloped girdle, the girdle thickness would have to be *negative* to make the total height of the stone be pavilion plus crown plus girdle thickness.

Here is an example of the table of dimensions for a simple hexagonal design:
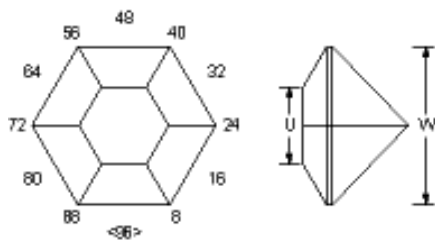
13 + 6 girdles = 19 facets
6–fold, mirror–image symmetry
96 index
L/W = 1.155 T/W = 0.559 U/W = 0.484
P/W = 0.466 C/W = 0.149
Vol./W^3 = 0.239
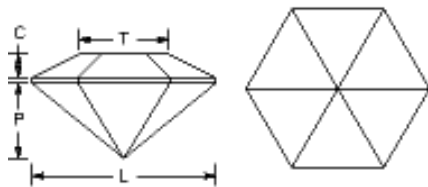
Sometimes the dimensions are measured from flat–to–flat, and sometimes from point–to–point. For instance, on this 6–sided stone with flats on the top and bottom of the top view, W is measured from flat–to–flat while L is measured from point–to–point. For this hexagon, L/W is 1.155 even though the stone is symmetrical and the points lie on a circle.

What good are these dimensions? They enable you to choose or modify a diagram to fit a particular piece of rough in order to get the largest possible finished stone. Let's say if you have a piece of beryl rough that measures 9 x 11 x 7 mm, and you want to orient the stone so that the 9 x 11 outline is facing up. The L/W is then 11/9 = 1.222. A diagram with L/W = 1.5 would be a poor choice because you would

only end up with stone that measures 11/1.5 = 7.3 by 11 mm. A design with L/W = 1.25 would be a much better choice and could produce a stone of 11 by 11/1.25 = 8.8 mm.

The P and C dimensions are used to see how the height of the design compares to your piece of rough. If you add P/W and C/W and the estimated girdle thickness, you can determine if the design will fit in the 7 mm height of the stone. After cutting the pavilion of a stone and transferring it, you can measure how much material remains to cut the crown. Let's call this Q, and you can measure your finished W. If Q/W is less than C/W plus the girdle thickness, you don't have enough material left to cut the crown. Sometimes you can fix this by scaling the crown with the **Edit/Scale** command with the **Z (crown)** option and enter Q in the **Multiply by** box and C in the **Divide by** box. This will reduce the crown height of the design to Q so it fits in the available rough. (You must remember to leave extra material to remove the subsurface damage left by the grinding process.)

The volume fraction labeled Vol./W^3 gives the volume of the stone. To convert this to carat weight, multiply the volume fraction by the width of the stone in millimeters cubed (multiply by the width three times). This gives the stone's volume in cubic millimeters. Multiply this by 0.001 to convert the volume of the stone in cubic centimeters (cc). Multiply this by the specific gravity of the stone (available in reference books or online) to get finished weight in grams. Multiply this by 5 to convert the weight to carats. The formula is:

$$\text{carats} = \text{Vol.}/W^3 \times W \times W \times W \times 0.005 \times \text{s.g.}$$

where Vol./W^3 is the number from the diagram, W is width in mm, and s.g. is the specific gravity in g/cc.

GemCad can also label diagonal dimensions of the girdle outline. Here is an example of the table of dimensions for an emerald cut:
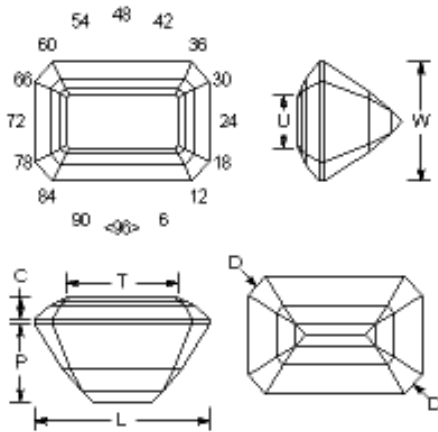
45 + 8 girdles = 53 facets
2−fold, mirror−image symmetry
96 index
L/W = 1.500 T/W = 0.950 U/W = 0.450
P/W = 0.659 C/W = 0.182
(D D)/W = 1.551
Vol./W^3 = 0.656

To get diagonal dimensions, label two girdle facets that are parallel to each other on opposite sides of the stone. For instance, in this emerald cut example, two girdle facets are labeled D in the bottom view. In the cutting instructions (in the printout or in **Print Preview**) this dimension is given by

(D D)/W = 1.551

This is the diagonal distance divided by the width of the stone. The names of the opposing facets are shown in parentheses. The labels don't have to be the same: one could be D and the other one E, for instance. Note that this dimension is not the distance between the tips of the arrows, but is the distance between the planes of the facets. It is the dimension you get if you place a caliper flat against the two facets.

The Edit Menu

The Angle and Index Commands

The **Edit/Angle** command allows you to more quickly enter an angle. It is most commonly accessed through its shortcut, *Ctrl*+A (press and hold down the *Ctrl* key, press the **A** key and release both). This will pop up a small dialog and let you type in the angle. If this gives *GemCad* the last piece of information needed to determine a facet, *GemCad* will immediately cut the facet(s), bypassing the need to press the **Cut Facet** button. This can come in handy when proof–cutting a design.

Likewise, the **Edit/Index** command allows you to more quickly enter an index, just like the **Edit/Angle** command for the angle. It's shortcut is *Ctrl*+I. When proof–cutting an existing diagram, these shortcuts allow power users to bypass the **New Facet Info** box.

The Transfer Command

The **Edit/Transfer** menu command transfers the stone. *GemCad* likes to cut facets in the top view. The **Edit/Transfer** command flips the stone over so that what was on the bottom of the stone becomes the top of the stone and *vice–versa*. If you use the **Edit/Transfer** command twice in a row, *GemCad* flips the stone twice, returning it to its original orientation. A shortcut for this command is the little transfer block button in the **Toolbar**. Another shortcut is *Ctrl*+T.

The Copy Command: Custom Diagrams

The **Edit/Copy** menu command is used to copy a portion of a faceting diagram to the Windows Clipboard so it can be pasted into another Windows application. This is used to make custom page layouts using a word processor. The active view (the one you last clicked in) will be copied. The views that can be copied are:

- **Four View**
- **Spin View**
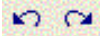- **Cutting Instruction View**

The **Four View** and **Spin View** are copied graphically as a metafile copy. This allows the images to be enlarged without the jaggies on diagonal lines. This seems to work best in word processors. If you paste to a pixel–based graphics program such as Windows Paint, you will still get jaggies. If you want to manipulate the four views separately, you will have to use the **View/Zoom** command to select the views one at a time. In your word processor, you will find that the labels will enlarge with the picture. To get proportionately larger labels, you must *reduce* the size of the view before copying it.

The **Cutting Instruction View** is copied in text mode with embedded tabs between the columns. You can use your word processor's tab ruler to adjust the column widths. These tabs are not interpreted properly by some text editors such as Windows Notepad. When this view is copied, the table of dimensions, the heading, and the footnote be copied as well.

When you use the **Edit/Copy** command, *GemCad* will pop up a dialog that tells you which view was copied. If it copied the wrong view, click once in the view you wanted to copy (and press **Cancel** if a dialog box pops up) and then do **Edit/Copy** again. Every time you use this command, *GemCad* writes over the previous contents of the clipboard.

The shortcuts to this command are the button in the **Toolbar** or the standard Windows shortcut *Ctrl*+C.

The Undo and Redo Commands

The **Edit/Undo** command will undo the previous command that changed the stone. *GemCad* keeps a stack of the 10 previous versions of the stone. If you keep pressing the undo key, you will eventually loop back around to the top of the stack again and get back to the state just before the first time you pressed **Undo**. The **Edit/Redo** goes through the stack in the opposite direction. The shortcuts are the ⟲ ⟳ buttons in the **Toolbar** or the standard Windows shortcuts, *Ctrl*+Z and *Ctrl*+Y, respectively.

The Index Gear Command

The **Edit/Index Gear** menu command is used to change the index gear. You can also use the index gear button ⚙ on the toolbar. Another shortcut to this command is to click on the ID position in the circle of index numbers in the **Four View**. This number is displayed in angle brackets, like **<96>**. In all three cases, the **Index Gear** dialog on the right will pop up. Click the down arrow to drop down the list of common index gears. If you want an index gear not on the list, just type in the number of teeth in the box. The rest of controls in this dialog are used to set the orientation of the gear in relation to the stone. *GemCad* can place the ID position (the index position that corresponds to the number of teeth on the gear) anywhere on the circle of index numbers. The four common orientations are given by the radio buttons: **Top**, **Bottom**, **Left** or **Right**. To place a different index position at the bottom of the circle, type in the index position into the **Other bottom index** box.
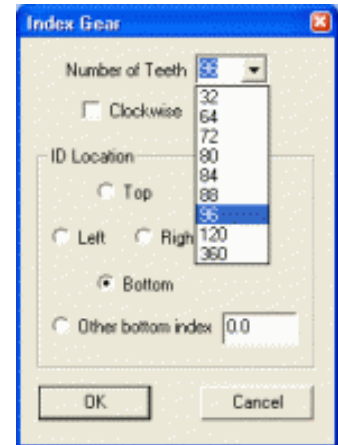
The Rotate/Tilt Command

The **Edit/Rotate/Tilt**command will rotate or tilt the stone around the origin, the center of the four views. The **Rotate or Tilt** dialog shown at the right will pop up. Most of the time, you will be rotating the stone as if spinning the dopstick to change the index. To rotate the stone around the dop axis, use one of the two **Z** axis choices. When the stone is rotated about the *z* or dop axis, *GemCad* can rotate the index gear together with the stone or rotate the stone by itself. There are three choices of units for the angle (or amount) of rotation.

You will seldom use the **X** or **Y** axis choices since these tilt the stone. If you want to tilt the stone just to view it from a different angle, use the **Spin View** which will rotate the viewpoint instead of the stone. Tilting the stone clockwise about the *x* axis will tilt the top of the stone away from the viewer (when viewed from the top). Tilting the stone clockwise about the *y* axis will tilt the right side of the stone away from the viewer. Tilting the stone will usually result in indexes not being whole numbers. It will also change the symmetry of the stone. The default rotation direction is clockwise. If you want to rotate the stone counter–clockwise, enter a negative number for the rotation amount. After tilting the stone, you can use the **Edit/Scale** command to force the facets to be regrouped in tiers.
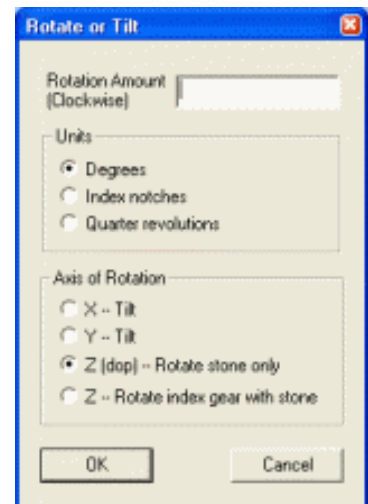
The Scale Command

The **Edit/Scale** command is used to scale or stretch the stone along one of the three coordinate axes. This is accomplished by multiplying or dividing the various coordinates by a scale factor. Perhaps the best way to explain it is with a few examples. Starting with the round brilliant at the right, the following examples show what the different options produce.
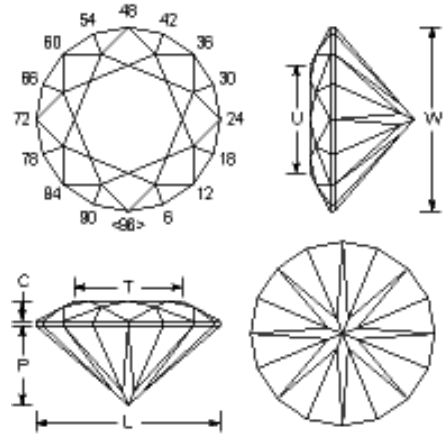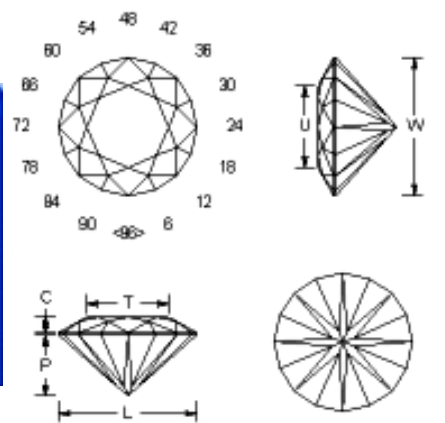

Round Brilliant

Starting with the round brilliant above, fill in the dialog box as shown. Note that multiplying by 4 and dividing by 5 would give the same result. Both result in a L/W = 1.25. The resulting shape is elliptical.
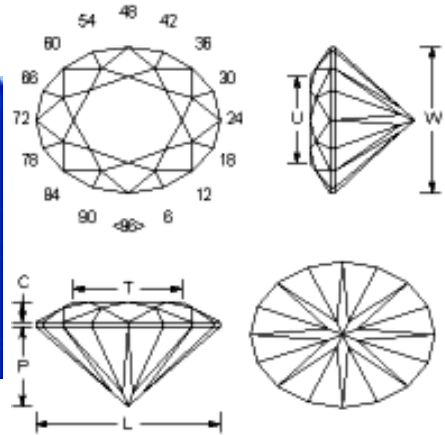

8x10 Oval

Starting with the round brilliant above, click **All** and enter a scale factor of 3/4. The resulting stone has exactly the same shape, but is smaller by a factor of 0.75.


Smaller by 3/4

Starting with the *smaller* round brilliant immediately above, click the **–Y** box to scale only the top half of the top view and multiply by 1.4 to stretch that half to make an egg shape. The round end is left unchanged.
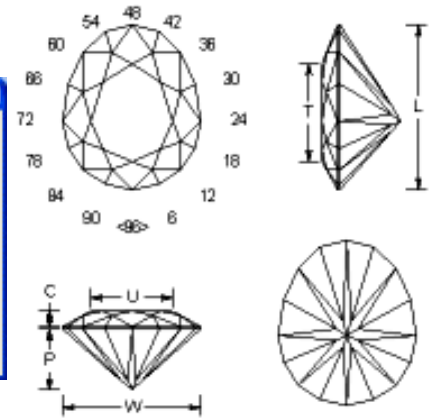
Egg–Shaped Brilliant

Starting with the first round brilliant above, click the **Z (Crown)** box to scale the crown. Multiplying by 2 will double the crown height, leaving the pavilion unchanged.
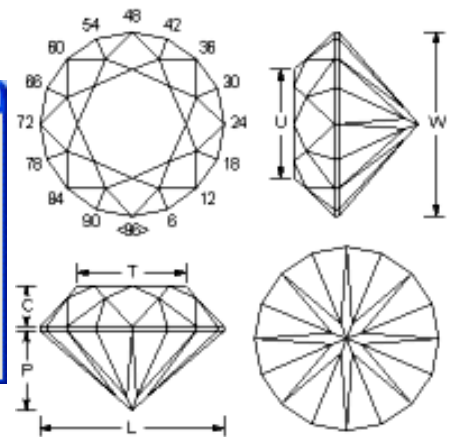

Crown Height Doubled

The **Automatic** button is enabled when the **All** button is checked. Use it when the stone is too small or too large on the screen. Pressing the **Automatic** button will ignore any scale factors in the **Multiply** or **Divide** edit boxes and will immediately scale the stone so that it fills up the screen.

Unless the **All** button is checked, the **Z (Crown)**, and **–Z (Pavilion)** buttons can never be checked at the same time as the **X**, **–Y**, or **+Y** buttons. The **X** and **Y** buttons scale both the pavilion and the crown.

With either of the *x* or *y* options, if the stone is stretched, it will be re–tiered. That is, the way that the facets are grouped will change. This is because the facets that used to belong to the same tier before the scaling will have different angles and mast heights after scaling. Also the index positions will almost always be fractional. *GemCad* will give you the opportunity to let it round off the index numbers to the nearest notch. *GemCad* will go through its list of common index gears. For each gear, it will compute the difference in angle between the index of each facet and the nearest notch of the index gear. It then sums up the angular differences for all of the facets. It then sorts the common index gears in order of increasing error. The best gear is arbitrarily assigned an error of 1.0 and all of the errors for the other gears are normalized to this value. The example at the right is for the round brilliant stretched to an 8 by 10 oval. The best gear is a 120 index. The worst gear is 96, and it is twice as bad as the 120. An 80 index is only slightly worse than the 120, and on my faceting machine it is easier to read than a 120. If you click **Yes** then *GemCad* will bring up the gear dialog. (It is up to you to make a mental note of which gear you want.) If you press **No** then *GemCad* will not attempt to adjust the stone but will leave the index numbers fractional. If you press **Cancel**, *GemCad* will undo the scaling.
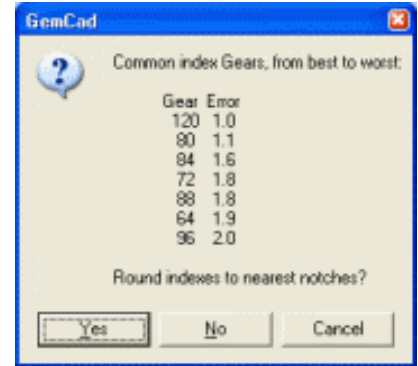
After you select the index gear, *GemCad* will move the vertexes around to try to make the facets line up with the notches on the gear. This is an iterative process that involves lots of arithmetic, so this will take a few seconds on a modern computer. With an older computer, this process might take up to a minute or so. While it is rounding the indexes, *GemCad* will display the hourglass cursor until this process is complete. If *GemCad* succeeds in rounding the index numbers to the nearest notch, it might change the L/W by a few percent since it can move the points that make up the girdle outline.

Sometimes *GemCad* will be unable to round the index numbers, and a dialog will pop up stating this. This sometimes happens when facets are only a notch or so apart in index number before rounding. The fix for this is to try stretching the stone a little bit at a time, rounding off the index numbers. Sometimes it helps to delete all of the pavilion facets and just scale the crown and girdle by itself.

If you want to change the L/W (length–to–width ratio) of a design to fit a particular piece of rough or a commercial size, there is a trick to do this without any calculations. First of all, do **File/Print Preview** or click the ⬚ button in the toolbar. Make a note of the L/W. Let's say you have a design that has a L/W of 1.25 and you want to stretch it to 1.33. Let's also say the stone is oriented so that the stone is longer horizontally than vertically. The no math way to do this is to select the **Y** option, put 1.25 in the **Multiply by** box and 1.33 in the **Divide by** box.

The Center Command

The **Edit/Center** command is used to offset the stone or change the way it is centered along one of the coordinate axes. One common use for this is to slide the stone along the dop axis. Let's say you are cutting a marquise and the stone is too low in the end view. You attempt to cut the table and you get the next picture. *GemCad* has cut off the wrong half of the stone and kept only the little sliver that you wanted to grind away! The solution to this is to center the stone before trying to cut the table. The default choices for the **Edit/Center** command will accomplish this.
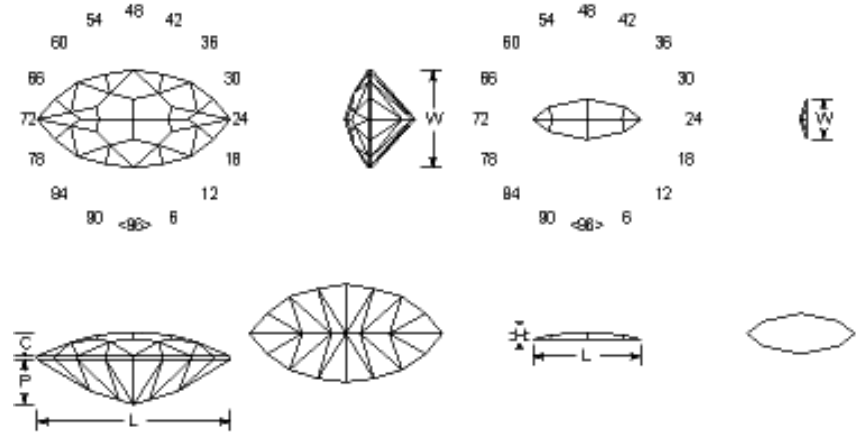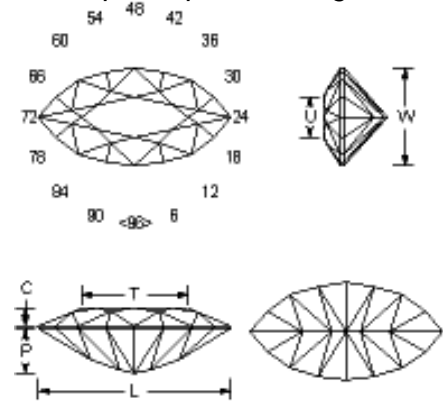

Stone is too low in side view. *Oops! Kept the wrong half.*
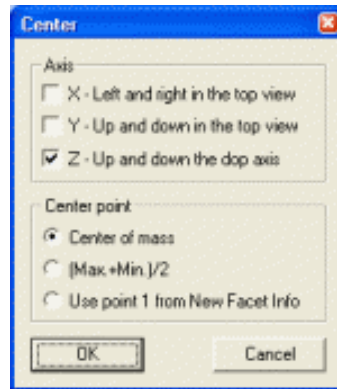
*Default choices* *After centering and re–cutting table*

The group of check boxes labeled **Axis** control which direction the stone is moved. If the **X** axis button is checked, the stone is moved horizontally in the top view. If the **Y** axis button is checked, *GemCad* will move the stone vertically in the top view. If the **Z** axis button is checked, *GemCad* will move the stone along the dop axis as if lengthening or shortening the dop stick.

The group of radio buttons labeled **Center point** control what point on the stone becomes the new center. The **Center of mass** choice places the center of mass of the stone at the center of the views. What is the center of mass? If a design has a plane of symmetry, the center of mass will lie on this plane. To find the center of mass of a large object, one can attach a string to the object at any point on the surface of the object and then suspend the object by the string, the center of mass will hang directly under the point of attachment in line with the string. By hanging the object from two different points, the lines of the string projected into the object will intersect at the center of mass. When an object rotates freely as if tossed in the air, the axis of rotation always passes through the center of mass. The **(Max + Min)/2** choice centers the stone so that the distance from the center of the stone to either end (as measured along the axis that is checked) is the same. To use the button labeled **Use point 1 from New Facet Info** requires some forethought. To use this choice, you must first enter a point in the **New Facet Info** box *before* using the **Center** command. You can use this option to offset the stone so that some reference point on the stone becomes the new center. This is sometimes used with the **Edit/Reflect** command below.

The Reflect Command

The **Edit/Reflect** command is used to mirror–image half the stone and discard the opposite half. The basic idea is that first you do something to destroy the symmetry of the stone and then reflect it to make a new design with mirror image–symmetry.

One use of the **Edit/Reflect** command is to change the length–to–width ratio of an emerald cut. If you stretch an emerald cut to change L/W, with the **Edit/Scale** command, the corners will no longer be at 45° (the 12–36–60–84 index positions with a 96 gear), and the angles on the ends of the stone will be steeper than on the sides.
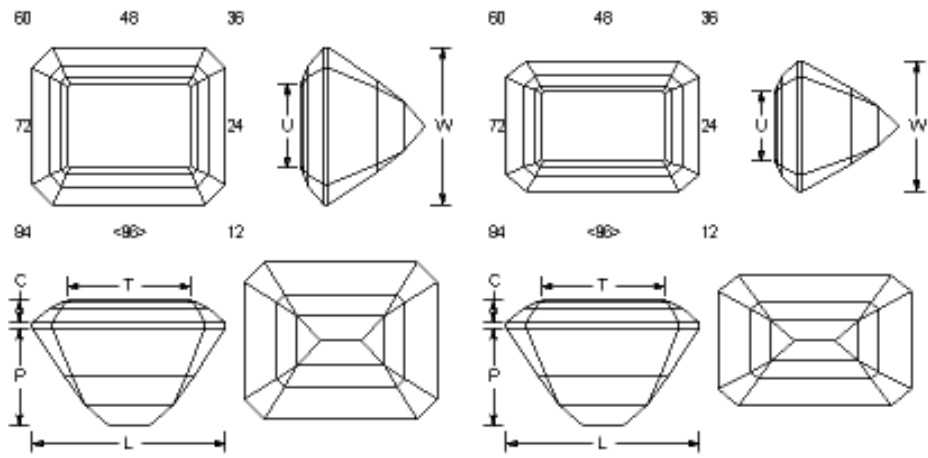

Emerald cut with L/W=1.25

Compressed to L/W=1.50
The corners are no longer at 45°
(12–36–60–84 index)

The first picture has L/W=1.25 (8 x 10 mm, for instance). The design in the second picture is stretched to L/W=1.50 (6 x 9 mm, for instance).

Corners not at 45° is not necessarily a bad thing, but the corner facets might not line up with the prongs of a commercial setting. In fact, the corners as shown can sometimes reflect diagonally across the stone. But let's say the designer really wanted corners at 45°. To do this, the first step is to do the automatic scale. This makes the right edge at x=1.000. The bottom edge then is at y=1/1.250=0.800. To get L/W=1.50, we want the bottom edge to be at 1/1.500=0.6667. Next we want to move the stone up 0.8000–0.6667 = 0.1333. Type in the point (0, 0.1333, 0) in the **Point 1** control in the **New Facet Info** box. Then do **Edit/Center** and click the **Y**, **Use Point 1**, and then the **OK** button. This will move the stone up in the top view as shown to the right. Notice that the stone is no longer centered.
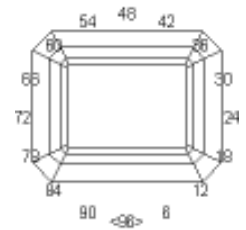

Next, use the **Edit/Reflect** command with the choice shown at the right. This will mirror the bottom half of the stone (in the top view) and throw away the top half. The result is shown below. Notice that the stone is now centered. The result has L/W = 1.500 *and* has corners at 45° (index positions 12–36–60–84). Contrast this with the right–hand figure above.

The four radio button choices tell *GemCad* which half to keep. The opposite half is thrown away. The **Flip reflection** checkbox tells *GemCad* to flip the reflection. This is useful for working with rhomboids or designs with symmetry 2 that do not have mirror–image symmetry.


33
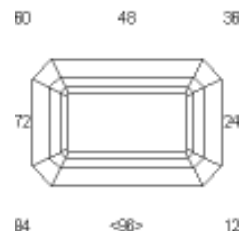
Another use of the **Edit/Reflect** command is to construct a marquise from a round. The following sequence shows how to transform a 12–sided round design into an 8–main marquise.

A   B   C   D   E
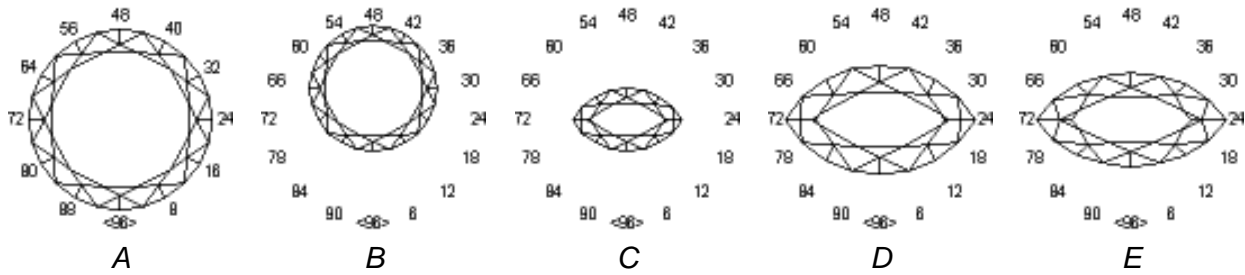
1. Cut a 12–sided round brilliant with a large table, image *A*.
2. Click on the meetpoint nearest the 16 index number on the girdle outline and press **Use to cut.**
3. Do **Edit/Center** and click the **Y** check box and **Use Point 1** boxes and click **OK**. This offsets the dop axis of the stone and makes image *B*.
4. Do **Edit/Reflect** and click the **Y** check box. This reflects the bottom half of the picture to make image *C*, discarding the top half.
5. Do **Edit/Scale** with the **All/Automatic** options to enlarge it to make image *D*.
6. Edit facets near pointy ends using the **Uncut/Recut** button on the **Facet** dialog.
7. Make skinnier with **Edit/Scale** with the **Y** option, multiplying by 1.73 and dividing by 2. This will make the stone narrower and make L/W = 2. This results in image *E*.

Here is how to make a heart–shaped design starting from an 8–sided standard round brilliant.

A   B   C   D   E
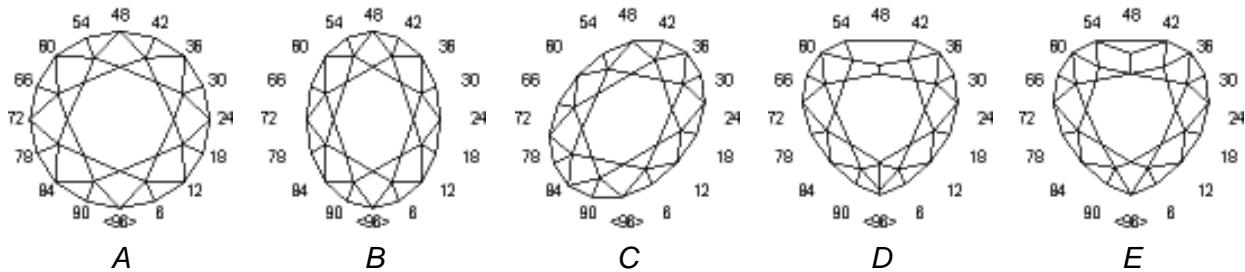
1. Start with the 8–sided standard round brilliant in image *A*.
2. **Edit/Scale** in the **X** direction, multiplying by 3 and dividing by 4. Round indexes using the 96 gear. This results in the oval in image *B*.
3. **Edit/Rotate** the design 11 index notches about the dop axis to get image *C*.
4. Do **Edit/Reflect** and select the **X** button. This results in image *D*.
5. Cut facets at 47–49 index positions and change adjacent facets on the flat end.
6. Add a facet at 96 index, delete the two small facets at the pointed end, and repair the meets on the pointed end to get image *E*.

The Sort Command

The **Edit/Sort** command sorts the cutting order as shown in the **Cutting Instructions View** and in the printout. It makes no attempt to determine whether the resulting cutting order makes sense. It just sorts the tiers in order of increasing or decreasing angle. The options are:

- *Pavilion–Girdle–Crown*: starts at culet for pavilion, increasing angle to girdle and then cuts crown from girdle to table
- *Girdle–Pavilion–Crown*: starts at girdle for pavilion, decreasing angle to culet and then cuts crown from girdle to table

- *Girdle–Crown–Pavilion*: starts at girdle for crown, decreasing angle to table, decreasing angle to culet
- *Crown–Girdle–Pavilion*: starts at table (or apex) for crown, increasing angle to girdle, decreasing angle to culet

The second choice is most common. The crown is seldom cut before the pavilion, so the last two choices are seldom used.

The Rename in order Command

The **Edit/Rename in order** menu command names or renames facets automatically. Facets are labeled with their names in the **Four View** and **Spin View**. Facet names also appear in the first column of the **Cutting Instructions** and serve to connect the pictures of the design to the cutting instructions. There are three style choices for the pavilion and crown labels. Girdle facets are labeled just like ordinary pavilion or crown facets in the sequence. Any existing facet names will be replaced. *GemCad* will automatically label only one facet in each tier. It will choose the facet in the tier with the smallest index number unless there is already a facet that has a name. The **Edit/Rename in order** command is sometimes used after the **Edit/Sort** command or after changing the cutting order with the **Move Up** or **Move Down** buttons in the **Edit Tier** dialog to get the numbers back in numerical order.

The Heading/Footnote Command

The **Edit/Heading/Footnote** command pops up a dialog box to edit the heading and footnote. These appear on the printout and **Print Preview**. The heading and footnote are limited to four lines each. The first line of the heading is usually the designs name; it will be set in large, bold type. The footnote is printed at the bottom of the diagram.
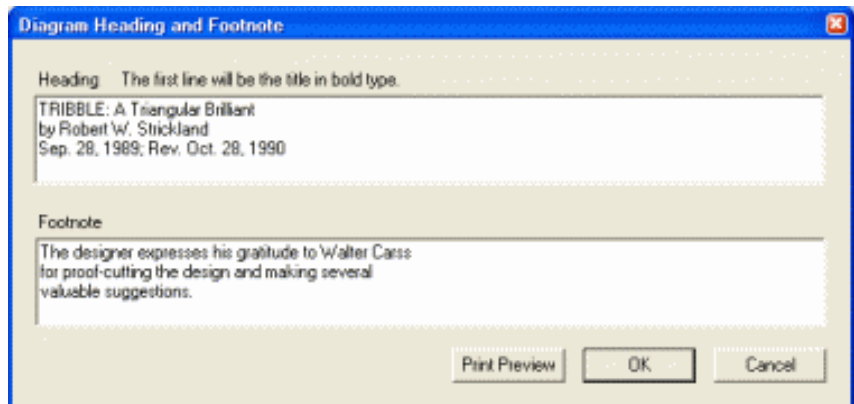
The four line limit sometimes causes these edit boxes to behave strangely. If a line of text (or edit box) doesn't seem to want to accept input, try deleting any blank lines at the end.

If you want to maintain backwards compatiblity with the DOS *GemCad,* limit the line length to 79 characters. This is about half the width of the edit box. When you save the design, *GemCad* will warn you if you exceed this limit.

The **Print Preview** button allows you to preview the diagram with the revised heading and footnote. This is just a shortcut to the **File/Print Preview** menu command.

The ReGenerate Command

The **Edit/ReGenerate** command regenerates all the points of the stone from the plane facet data. It is mainly intended as a diagnostic tool for the author.

The View Menu

The Zoom Command

The **View/Zoom** menu controls how the stone is displayed in the **Four View**. The **Zoom Out** selection will zoom out to display all four views. The other selections zoom in so one of the four views fills the entire pane. Another way to change the magnification is by clicking in one of the images in the **Four View** with the left mouse button and by clicking the **Zoom In/Out** button.

The Replay Command

The **View/Replay** command re–cuts the stone one facet at a time. This can help you see what the stone looks like as facets are cut and can sometimes help in deciding the cutting order. The current facet has a **+** symbol after its name (or just the **+** symbol if it doesn't have a name). A dialog box shows the current facet's name, angle and index, and prompts you to click the **Next** button (or the *Enter* key) to cut the next facet. The **Cancel** button ends the playback and restores all of the facets.

The Hidden Lines Command

The **View/Hidden Lines** command tells *GemCad* whether or not to display hidden lines. These are shown in gray. These can sometimes help determine which facets a light ray hits or show how the pavilion facets align with the crown.

The Toolbar and Status Bar Commands

The **View/Toolbar** and **View/Status Bar** switches hide these bars if you need a bit more screen real estate.

The *View/Refresh* command redraws the screen, erasing any light rays. The shortcut for this command is *Ctrl+D*.The letter *D* stands for draw. This shortcut is also useful for redrawing the display if it gets corrupted. *GemCad's* display is optimized for speed and not for accuracy. Sometimes *GemCad's* display can be corrupted by other windows that open on top of it.

The Preform Menu

Preforming: An Overview

What is a preform? A preform is a faceting diagram or portion of a faceting diagram designed to generate a precise girdle outline without using any measurements except for the angle and index settings available on every faceting machine.

Preforms are an outgrowth of a method of faceting popularized by Long and Steele called *meetpoint faceting.* In meetpoint faceting each successive step cuts to a meetpoint of three or more previously cuts. These designs can often be cut with no adjustment of angles or indexes if the faceting machine can repeatedly find the same facet. Facets that have no such reference point are called *floating facets.* Some designs that have floating facets can be reduced to meetpoint designs by editing the cutting order. Other designs can be reduced to meetpoint designs if temporary preform facets are added that are cut off later.

There are several preforming methods. On some designs, a group of facets is cut to a Temporary Center Point, or TCP. This temporary center point will be cut off by later facets and is below the finished bottom of the stone. One example of this is on a round brilliant cutting the pavilion break facets to a point and then going back and cutting the mains last. The mains cut off the TCP made by the breaks.

Another popular preforming method is the Centerpoint Angle Method, the CAM preform. In this method facets are cut to a TCP making an irregular pyramid shape. The angles and mast height of the CAM facets usually vary around the stone. After all of the preform facets are cut, girdle facets are cut at 90° at the same index positions to make a level *false* girdle. This false girdle is typically below (further from the table) than the finished girdle line of the stone. The original CAM preform facets are typically cut off by later steps in the cutting sequence.

The OMNI preform is another method invented independently by several designers and generalized by Robert Long with consultation from Fred Van Sant. Like the CAM preform, the OMNI preform includes facets cut to a TCP and girdle facets. Unlike the CAM preform, the indexes of the girdle facets of an OMNI preform are not the same as the indexes of the facets cut to the TCP. The distinguishing characteristic of an OMNI preform is that the false girdle line is not level (parallel to the table) but scalloped. The advantage of an OMNI preform is that its preform facets usually require fewer changes in mast height or angle. Many OMNI designs use the OMNI facets as a part of the finished design, so there are no extra facets to cut. OMNI preforms are frequently less blocky than CAM preforms and require less extra rough.

Preforms are used to generate the girdle outline of a stone using the technique of meet point faceting. Typically, several facets are cut to a common center point on the dop axis. To obtain a centerpoint on your faceting machine, you can cut three facets at a shallow angle at three different index settings spaced widely apart, say 96–32–64 on a 96 gear. This will make a three–sided pyramid. You can then cut the rest of the facets to this apex.

Keeping Facets that are Cut Off

Whenever *GemCad* cuts off a facet, a dialog box pops up that tells you how many facets were cut off. This dialog box asks if you want to save the facet(s) as a preform. If you answer yes, *GemCad* will copy the steps up to and including the last girdle facet to a preform and display the preform as a wireframe cage around the stone in the **Spin View**. This is useful for proof–cutting existing designs with CAM preforms.

The Create CAM CAM Command: Creating a CAM Preform for a Design

The **Preform/Create CAM** command is used to create a CAM preform for an existing design after the fact. Why would you want to do this? There are two situations where this is helpful.

1. When designing a stone, sometimes you get the girdle outline graphically or by trial and error. The **Preform/Create CAM** command allows you to reproduce the outline without measurements.
2. The original DOS version of *GemCad* had no way to save a preform. If you open an existing design (from *Datavue II*, for instance) that has more than one tier of girdle facets and the girdle facets are first in the cutting order, it might have been created with a separate CAM preform, or it might have required caliper measurements to establish the size of the girdle facets. The **Preform/Create CAM** command can generate a preform that will precisely generate the girdle outline.

The **Preform/Create CAM** command will create a CAM preform that includes the girdle facets and has extra facets that meet at a temporary center point and form a level false girdle. This preform will be as steep as possible while touching the stone in at least two places, usually along one or more edges. The image on the right shows the results of this command applied to the Formée Cross Rectangle, a design by the author. The preform will be displayed as a blue wireframe cage around the stone in the **Spin View**. The centerpoint of the preform might extend below the lowest point of the pavilion as is does in this example. You can see how the preform just touches the edge of the stone at the lower–right.
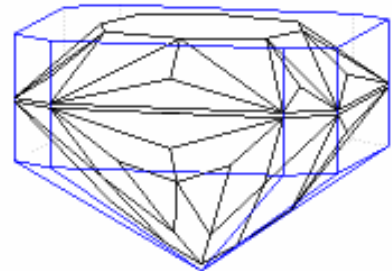
The Copy to Preform Command

The **Preform/Copy to Preform** command is used for designs that have a TCP or produce the girdle outline naturally from the cutting sequence without cutting off facets. This command will copy all of the facets up to and including the last girdle facet to the preform. This preform will be displayed as a wireframe around the stone in the **Spin View**.

The Edit Command

The **Preform/Edit** command toggles between displaying just the preform by itself and displaying the preform around the stone. This is provided so you can make a separate diagram for the preform or so you can copy views of the preform to create your own custom diagram with the **Edit/Copy** command. There is currently no way to turn off the preform without deleting it (with the **Preform/Delete** command). *GemCad* will display a check mark in the **Preform/Edit** menu when it is in the **Edit Preform** mode**.** When *GemCad* is in this mode, saving the design will save *only* the preform. Likewise, you can open a

design in the **Edit Preform** mode to read in a preform.

You can use this as a dirty trick to show how one design fits inside another:

1. Open the smaller design.
2. Generate a temporary dummy preform with the **Preform/Copy to preform** command.
3. Turn on the **Edit Preform** switch. (*GemCad* won't let you turn on the switch without a preform to edit, thus the need for step 2.)
4. Open the larger design.
5. Turn off the **Edit Preform** switch.
6. The larger design will be displayed as a wireframe cage around the smaller one.

The Delete Command

The only way to switch off the preform is to delete it with the **Preform/Delete** command.

Saving a Preform

You can save a design with a preform as a `.GEM` file and open it again with no loss of information. (The DOS version of *GemCad* and *GemRay* will ignore the preform.) If you save it as a `.ASC` file, the preform will be placed in the file before the rest of the design. If you open a design from a `.ASC` file that has a preform, it will display the preform only if some of the preform facets get cut off. If this is not the case, you can recover the preform with the **Preform/Copy to Preform** command.

Example: The OMNI Preform

The diagram below shows an oval design that uses the OMNI preform technique. The **Preform/Copy to Preform** command followed by the **Preform/Edit** command created the preform shown at the bottom. You can see how the OMNI preform's false girdle line is not level but follows a saddle–shaped curve. You can also see how all of the step 1 and 2 facets meet at a temporary center point.

OMNI Oval 1.33:1
by Robert W. Strickland 3/13/98
USFG Newsletter, Vol. 8, No. 1, Apr. 98, p. 16

Angles for R.I. = 1.630
69 + 16 girdles = 85 facets
2–fold, mirror–image symmetry
96 index
L/W = 1.330 T/W = 0.792 U/W = 0.595
P/W = 0.565 C/W = 0.147
Vol./W³ = 0.347

PREFORM

1	42.00°	04–11–17–31– 37–44–52–59– 65–79–85–92	TCP
2	41.70°	20–28–68–76	TCP
G1	90.00°	20–28–68–76	Establish length
G2	90.00°	13–35–61–83	OMNI: meet 1–2–G1*
G3	90.00°	07–41–55–89	OMNI: Meet 1–1–G2
G4	90.00°	02–46–50–94	OMNI: Meet 1–1–G3

PAVILION

3	66.61°	13–35–61–83	Level girdle
4	68.76°	07–41–55–89	"
5	70.00°	02–46–50–94	"
6	41.02°	14–34–62–82	Meet 1–1–3–4
7	40.45°	96–48	Meet culet
8	40.35°	24–72	Meet culet

CROWN

A	41.88°	02–46–50–94	Leave some girdle
B	40.23°	07–41–55–89	Level girdle
C	36.49°	13–35–61–83	"
D	34.90°	20–28–68–76	"
E	36.00°	96–48	Meet A–A at girdle
F	31.57°	10–38–58–86	Meet B–C at girdle
G	28.67°	24–72	Meet D–D at girdle
H	20.33°	05–43–53–91	Meet A–B–E–F
J	16.67°	16–32–64–80	Meet C–D–F–G
	0.00°	Table	
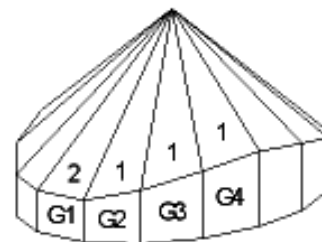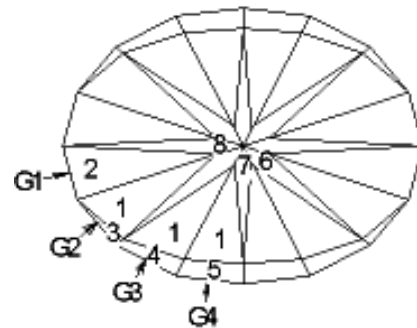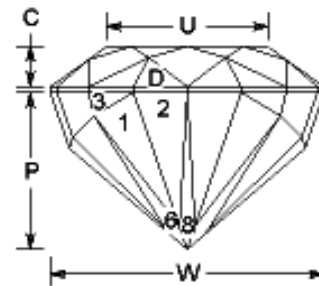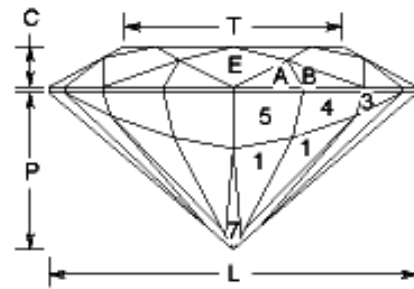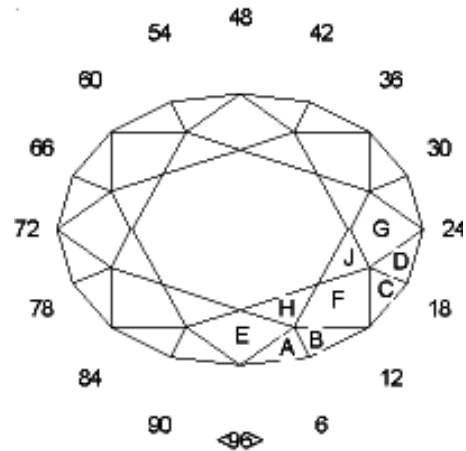
*OMNI preform is formed by steps 1–G4. The girdle line will not be level until steps 3–5 are cut.

The Raytrace Menu

The Properties Command

The **Raytrace** menu is for *GemCad's* single–shot raytracing feature. The **Raytrace/Properties** command will pop up a dialog box that allows you to change the stone's refractive index. You can type in the refractive index, or you can click the little triangular down arrow to drop down a list of representative materials. If you don't like the values in the list, you can type any value in the edit control.

The **Critical angle** is displayed. The two are directly related by the formula

1/sin(critical angle) = refractive index.

If you type a number in the critical angle box, *GemCad* will calculate the corresponding refractive index, and *vice versa*. The refractive index is displayed in the **File/Print Preview** and on the printout. The refractive index is saved with the design.

Tracing Rays

To shoot a light ray into the stone, move the mouse pointer inside the stone's outline and click the right mouse button. This works in the **Four View** or in the **Spin View**. The path of the light ray is shown in all of the views. If you hold down the right mouse button while moving the mouse, *GemCad* will shoot in a continuous stream of light rays into the stone. If you spin the stone in the **Spin View** the light ray paths spin with the stone. This can help you visualize which facets the rays hit. To shoot in light rays at a specific tilt angle, tilt the stone in the **Spin View** until the desired tilt angle is displayed in the lower left–hand corner of the **Spin View** and shoot light rays in the **Spin VIew**.

Light rays inside the stone are shown in green. Light rays outside the stone are shown in purple. This allows you to see precisely where a ray enters or leaves the stone. In the image at the right, light rays were shot into the top view of the stone in the **Four View**, but this is a copy of the **Spin View.**
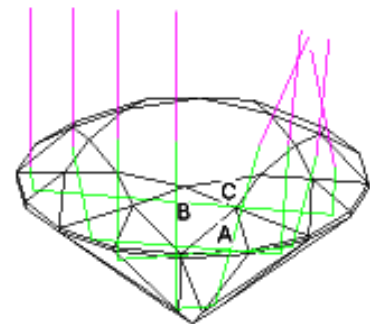
When you copy the view **Spin View** or **Four View** with the **Edit/Copy** menu command, *GemCad* will copy the light ray paths as well. That's how the figure at the right was created.

The Erase Rays Command

The ray paths persist as you resize the window or use the **Edit/Zoom** command. To clear the ray paths, use the **Raytrace/Erase Rays** menu command. The shortcut for this is *Ctrl*+D. The letter *D* stands for draw. This shortcut is also useful for redrawing the display if it gets corrupted. *GemCad's* display is optimized for speed and not for accuracy. Sometimes *GemCad's* display can be corrupted by other windows that open on top of it.

Raytracing Model

Although it is convenient to talk about shooting light rays into the stone, perhaps it is better to think of it as following ray paths backwards through the stone. Light rays follow the same paths forwards and backwards. A light ray contributes nothing to the appearance of a gemstone unless that ray goes into the viewer's eye. The important questions are, From where did that light ray have to enter the stone for our eye to see the ray? and Is it likely that there is a light source there? If our eye is where the mouse pointer is, from where did the light ray have to enter the stone to exit the stone at the mouse pointer along our line of sight? It must have entered at the same place but at exactly the *opposite* direction as the light ray that exited the stone after being directed into the stone along our line of sight.

Tangent–Ratio Scaling
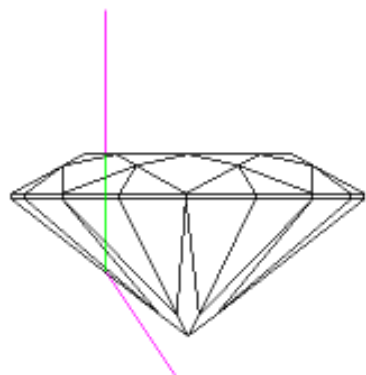
To change the angles, click in a facet in the **Four View** to get the **Facet** dialog box, or click the corresponding line in the **Cutting Instructions View** to get the **Edit Tier** dialog box. In either case, change the angle in the box labeled **New angle (tangent ratio scale 1/2 stone)** from its old value to the desired value and click the **Apply** button. This will change the height of one side of the stone but will not change the top or bottom views. As a general rule, change pavilion angles in increments of about 0.5° and crown angles in increments of about 2° to fine–tune the angles. Tangent–ratio scaling is so named because the angles change according to the relationship
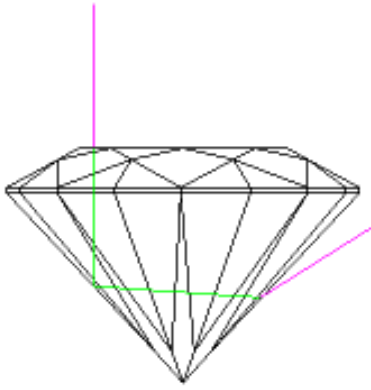
$$\tan(\text{new angle}) / \tan(\text{old angle}) = k$$

where k is a constant, the scale factor or tangent ratio.
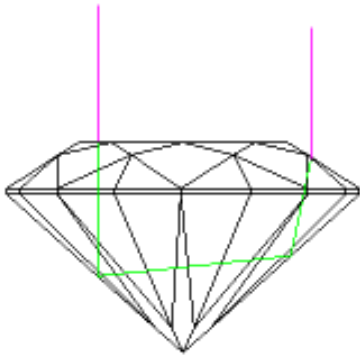
Optical Problems and Remedies

Here are some light ray paths through a stone illustrating some common problems and suggested remedies.

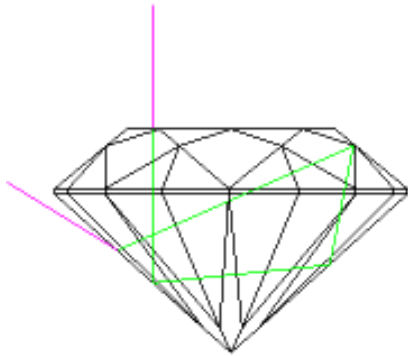| *Ray paths*	*Problem*	*Remedy*
	Pavilion too shallow: windowing under table.	Make all pavilion facets above critical angle.

Pavilion too steep

Reduce pavilion angles.

Incoming and outgoing rays parallel, head shadow: reflection of viewer's head.

Change pavilion angles slightly up or down

Light bounces off underside of crown with high refractive index materials

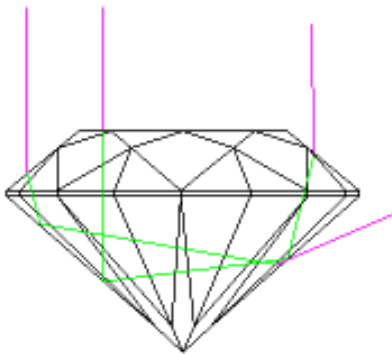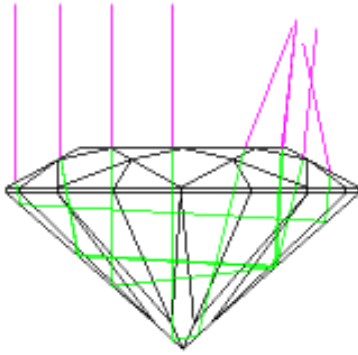Reduce crown angles or use lower refractive index material

Table ray good but leaks outside table

Reduce pavilion and/or crown angles

Minor head shadow in some rays for quartz

Use higher refractive index and increase crown angles

The Help Menu

The Contents Command

The **Help/Contents** command runs your default web browser and opens this document.

The About GemCad Command

The **Help/About GemCad** command pops up a box that gives the version number, copyright information, credits, and registration information. This box also pops up when you run an unregistered copy of the program.

The Register Command

The **Help/Register** menu command pops up the shareware registration dialog. The program will turn into a pumpkin after a 30 day trial period. If you send in the registration fee to the indicated address, you will receive a user name and registration key to reactivate the program. The registration key is like a password. The user name and registration key are case sensitive and should be typed in exactly as shown in the email or printed correspondence from GemSoft Enterprises.

Advanced Tutorial: Design Exercise

Before trying this tutorial, it is recommended that you first proof–cut several designs and at least scan the reference material above. The objective of this exercise is to reverse–engineer a diagram from a picture. The design pictured at the right is Norman Steele's Checker Square Barion as it appears in the **File/Search Datavue Database** as Steele published it in the *Datavue II* database. We will begin with the crown
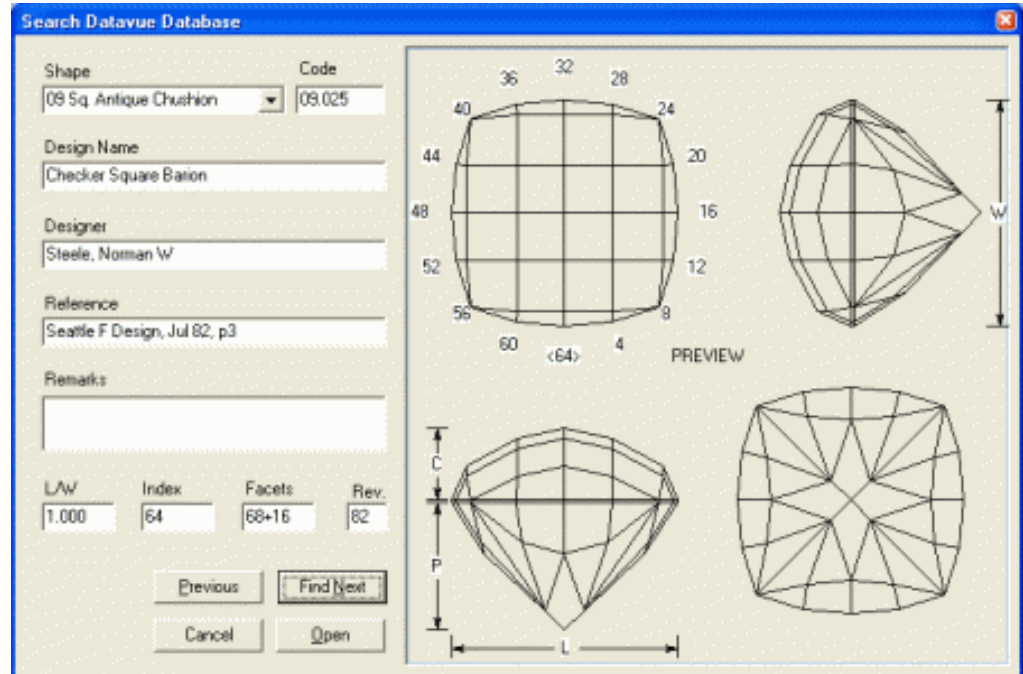

The first step is to set the symmetry for 4–fold, mirror–image and choose the 64 index gear. For this example, we will leave the 64 at the bottom, increasing counter–clockwise.

Move the mouse as shown at the right, click, and the **Outside Stone (Pierce)** dialog will pop up. Click **Use to Cut**.

Angle 90
Index 3
Click **Cut facets**

How did I know to use an index of 3? I guessed that the girdle facets are cut 2 notches apart, one set at 63–1,... and the next at 60–3,...
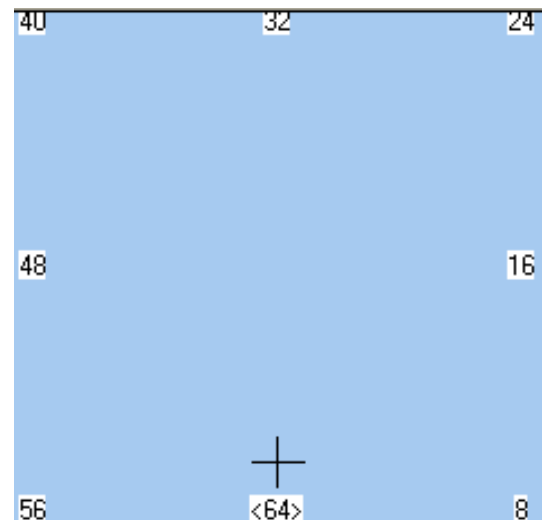
This point tells *GemCad* how deep to cut the first girdle facet. *GemCad* will assume a cutting depth if you don't give it a point for the first facet. This point makes the girdle outline of the stone a reasonable size.

Move the mouse as shown at the right, on the edge shown and click to pop up the **Point on Edge** dialog.

Change the number in the **Fraction of total edge length** to 0.5 and click **Use to Cut**. This will bisect the edge exactly. This enables us to get perfect squares on top instead of rectangles.

Angle 90
Index 1
Click **Cut facets**
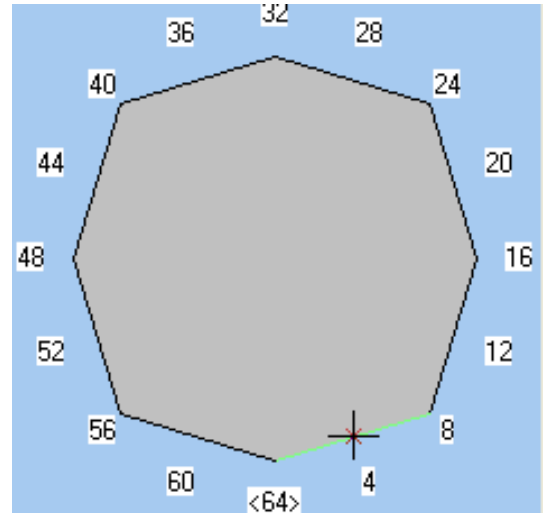
This will finish our girdle outline.

Move the mouse as shown at the right. This will be our girdle line. Click to get the **Edge** dialog and click **Use to Cut**

Angle 50
Index 1
Click **Cut facets**
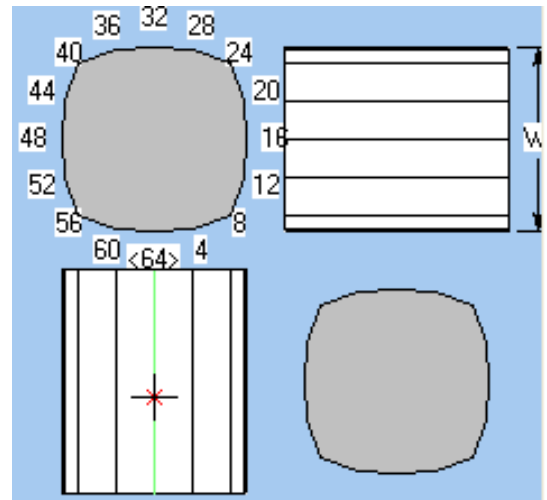
Why 50°? It really doesn't matter since we can always tangent–ratio scale the stone later. Besides the girdle angle of 90°, this will be the *only* angle we need to specify.

Move the mouse as shown at the right. *GemCad* will circle the meet point when you get close enough to it. Click to get the **Meet Point** dialog and click **Use to Cut**.

We want to get a straight line starting from this meet point. Hold down the *Shift* key while moving the mouse upwards near the point shown in the next figure.

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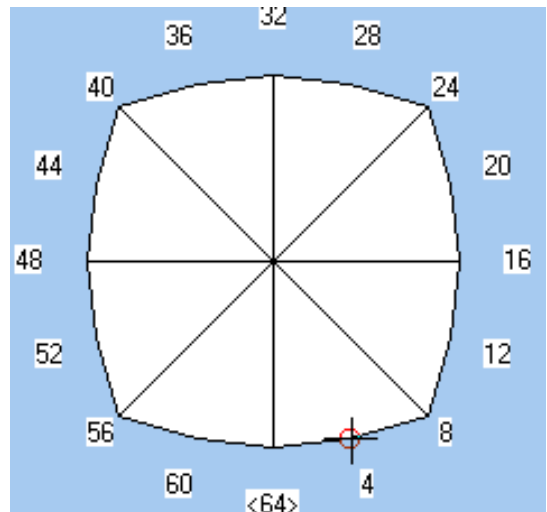
When you hold down the *Shift* key, *GemCad* limits the movement of the selected point so that it aligns vertically or horizontally with the previous point. You might notice that the little red **+** doesn't move horizontally while you hold down the *Shift* key. Click to get the **Facet** dialog and click **Use to Cut**. This will enter the point shown by the little red **+**, not the big mouse pointer.

You should have two points. If not click the **Clear** button, back up a few paragraphs and try again.
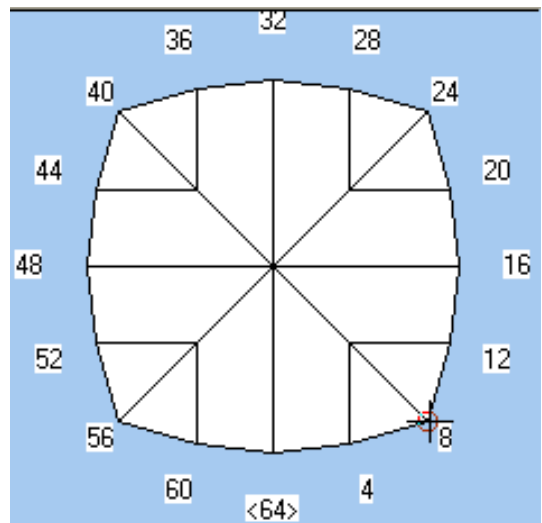
Index 3
Click **Cut facets**
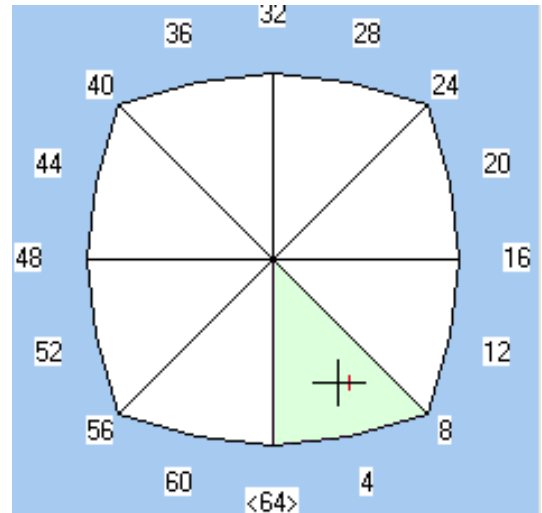
This will cut more facets. You should now have a level girdle line and lines that are exactly horizontal and vertical. Note that we didn't have to specify an angle. We gave *GemCad* an index and two points, and it figured out the angle.

Now we are ready to cut the facets that touch the corners. Move the cursor to the point shown at the right. Click to get the the **Meet Point** dialog and click **Use to Cut**.

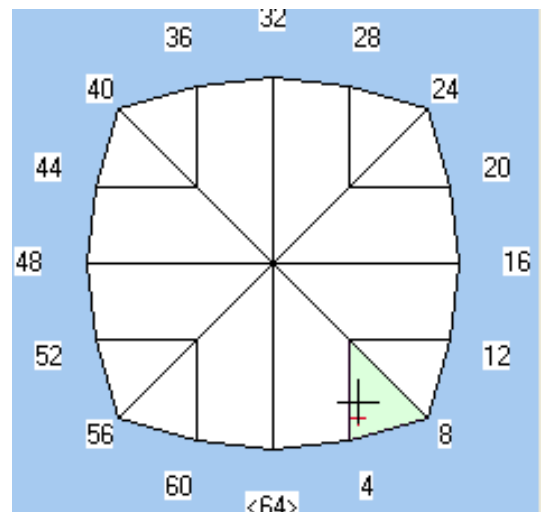Hold down the *Shift* key and move the mouse to the point shown in the next figure.

The point you get will be the point indicated by the small red **+** , not the large crosshairs. Click to get the **Facet** dialog and click **Use to cut.**
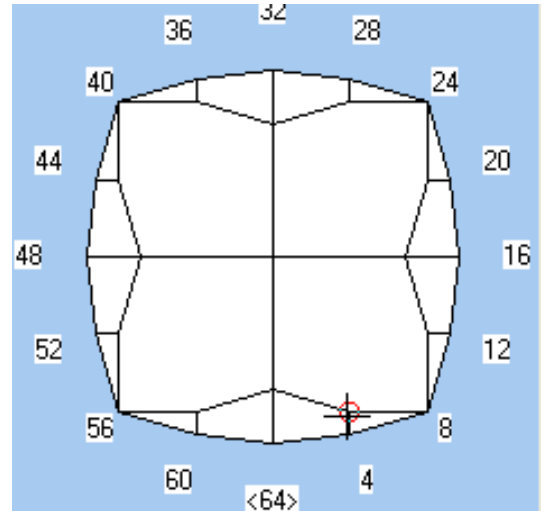
Index 8
Click **Cut facet**.

This will cut the four corner facets. Again, *GemCad* figured out the angle for us.

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Move the mouse as shown at the right and click to get the **Meet Point** dialog. Click **Use to Cut**.

Now we want to make the corner of the next square. Hold down the *Shift* key and move the mouse near the point shown in the next figure.

This time, the *Shift* key tells *GemCad* to line up the selected point *horizontally* with the previous point. The selected point will be the small red**+**, not the big crosshairs.
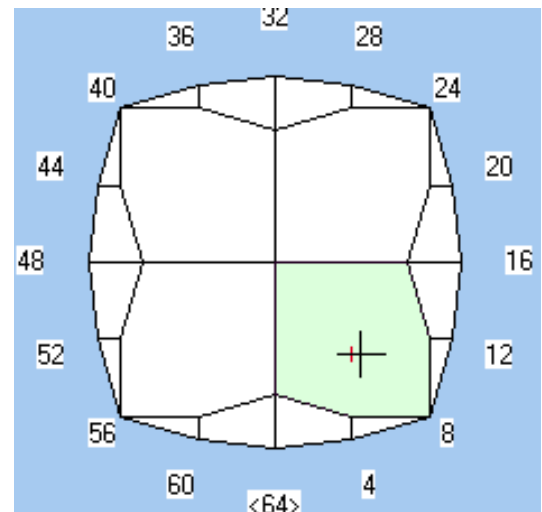
Click to get the **Facet** dialog. Click **Use to Cut**. You should now have two points.

Now for the tricky part. Move the cursor *back* to the meet point in the figure *above* and click. But this time, press **Cancel** since we have already entered this point. Now hold down the *Shift* key and move it as shown in the next figure. This anchors the cursor back to the meet point so the *Shift* key can help us make a vertical line.
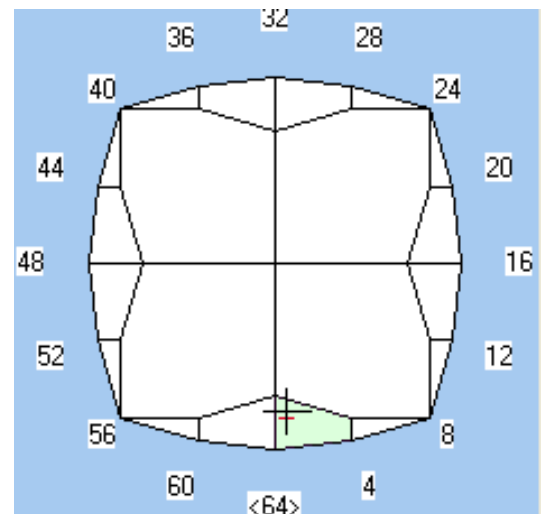
Click to get the **Facet** dialog. Click **Use to Cut**. You should now have three points. You might notice that the index is about 3.19.... Don't be alarmed about this yet. Click **Cut Facet** and you should get the next figure.

This time, we gave *GemCad* three points, so it figured out the angle for us! *GemCad* made the edges straight, and square, but it did so at the expense of cheating on the index. We will fix this by sacrificing the straightness of the edges shown in red in the next figure.

Next, we shall edit the facet highlighted in yellow to round off its index to the nearest notch. Move the mouse near meet point 1. Click to get the **Meet Point** dialog and click **Use to Cut**. Next move the cursor to meet point 2. Click **Use to Cut** again. You should have two points.

Now move the cursor inside the yellow facet near point 3 so that the facet is highlighted in green. Click to get the **Facet** dialog. Click the **Uncut/Recut** button. This will round off the index to the nearest notch. Click the **Cut Facet** button to re−cut the facet.
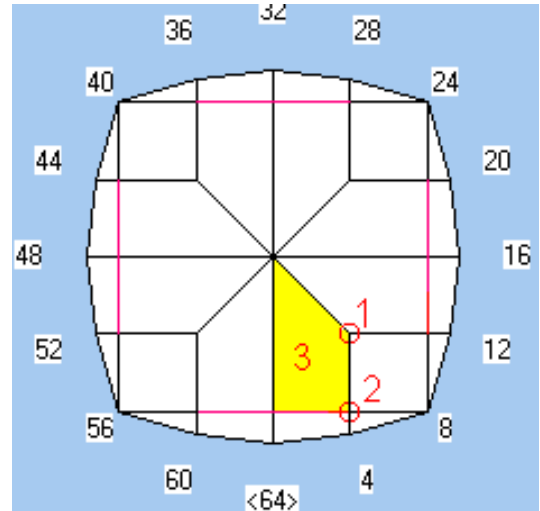
The result will look very similar, but you might notice that the edges shown in red might be slightly diagonal. The corner facets should still be perfect squares.

To cut the remaining apex facets, use the meetpoint 1 above, click to get the **Meet Point** dialog and click **Use to Cut**.

Hold down the *Shift* key and move the mouse to the left and click to get the **Facet** dialog. Click **Use to Cut** to enter a second point.

Give it an index of 8 and click **Cut Facet** to cut the apex facets. This completes the crown. This version is a slight improvement on the original in that the squares have precise right angle and are of equal size. Besides points, the only numbers we had to type in were the index numbers 1, 3, and 8 and the angles 90° and 50°.
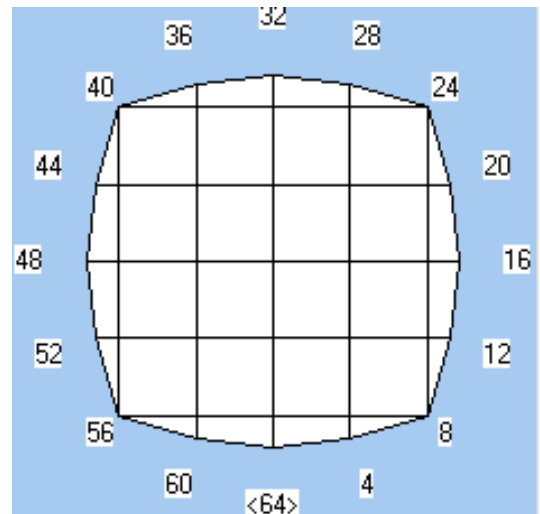
Here is a summary of what we can learn from this example:

- *GemCad* can figure out angles and indexes given enough points.
- *GemCad's* use of symmetry reduces greatly the amount of information you need to give it.
- Before cutting the first facet, clicking a point will pop up the **Outside Stone (Pierce)** dialog and allow you to override the default cutting depth for the first facet.
- You can use the *Shift* key to construct horizontal or vertical edges
- The **Uncut/Recut** button on the **Facet** dialog can round off the index of a facet to the nearest notch.
- The **Fraction of total edge length** edit box on the **Point on Edge** dialog can bisect a line.

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Next, we will design a pavilion. Instead of the barion pavilion of the original by Norm Steele, let's try a simple brilliant pavilion. Transfer the stone with the **Edit/Transfer** command or shortcut and move the mouse pointer as shown. Click to get the **Point on Edge** dialog. Change the number in the **Fraction of W** box to 0.02. This will set a point on edge exactly 2% of the width of the stone from the crown girdle line. Click **Use to Cut**.

Enter an angle of 43° and an index of 1. Click the **Cut Facets** button, and *GemCad* will cut 8 pavilion facets.
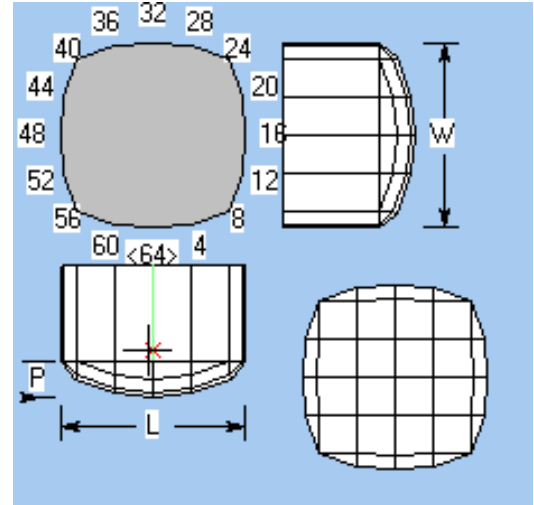
Why did we use an angle of 43°? It really doesn't matter because we can always tangent–ratio scale the design later. The girdle thickness is exactly 2% of W because of the **Fraction of W** trick.

Move the mouse as shown at the right. Click to get the **Meet Point** dialog and click **Use to Cut**. Then move the mouse to the center of the top view, where the 8 pavilion facets meet. Click to get the **Meet Point** dialog and click **Use to Cut**. Enter an index of 3, click **Cut Facets**, and *GemCad* will cut 8 more pavilion facets.
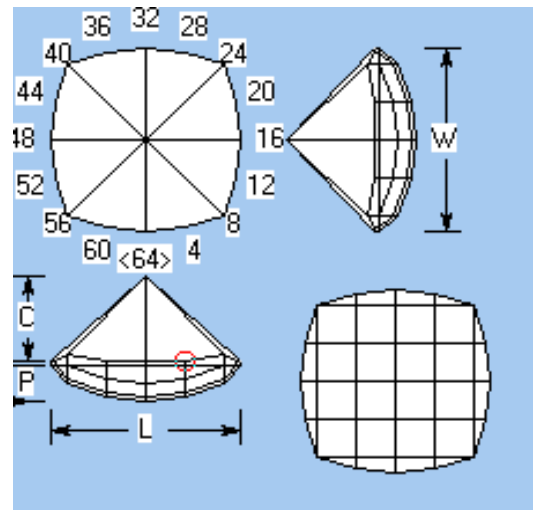

Now we have a simple pavilion that can serve as a preform to generate the girdle outline without any measuring.

Next, let's cut 8 main facets. Let's cut these at index position 2, halfway between the pavilion facets at 1 and 3. These will cut off the temporary center point.

Enter an index of 2.

Move the mouse to the same meetpoint as the figure above, on the girdle line, and click to get the **Meet Point** dialog. Click **Use to Cut**.

Move the mouse as shown at the right and click to get the **Point on Edge** dialog and click **Use to Cut**. Then click **Cut Facets** to cut 8 main facets.
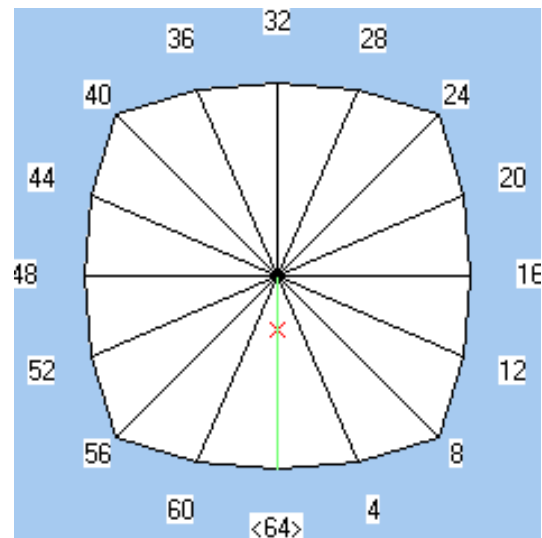
After transferring the stone, it should look like the figure at the right (except for the facet names and labels).

Do **Edit/Sort...** with the **Pavilion–Girdle–Crown** choice. Then do **Edit/Rename in order** with the default choice to automatically name and label the facets. The names and cutting order for the pavilion will be as shown in the table below, not what is pictured at the right.

1	41.78°	03–13–19–29–35–45–51–61
2	41.86°	02–14–18–30–34–46–50–62
3	43.00°	01–15–17–31–33–47–49–63
4	90.00°	01–15–17–31–33–47–49–63
5	90.00°	03–13–19–29–35–45–51–61

In the **Cutting Instructions View**, click on a line to get the **Edit Tier** dialog and use the **Move up** and **Move down** buttons to reorder the pavilion facets. Repeat this process until you get the following cutting order:

3	43.00°	01–15–17–31–33–47–49–63
1	41.78°	03–13–19–29–35–45–51–61
4	90.00°	01–15–17–31–33–47–49–63
5	90.00°	03–13–19–29–35–45–51–61
2	41.86°	02–14–18–30–34–46–50–62
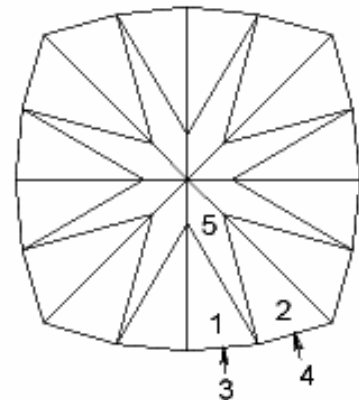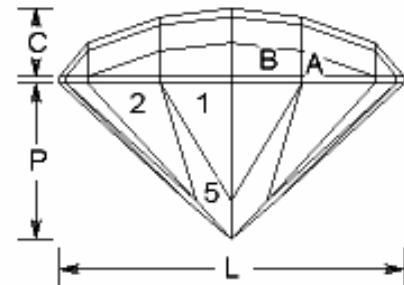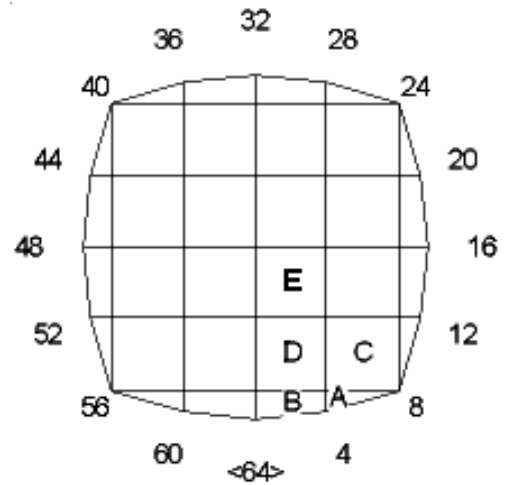
Then use the **Edit/Rename in order** command to renumber the facets to get the order shown in the picture. This sequence is a meetpoint sequence that generates the girdle outline automatically.

1	43.00°	01–15–17–31–33–47–49–63
2	41.78°	03–13–19–29–35–45–51–61
3	90.00°	01–15–17–31–33–47–49–63
4	90.00°	03–13–19–29–35–45–51–61
5	41.86°	02–14–18–30–34–46–50–62

Your angle for facet 5 will be different than this example since one of the two points was a point on edge, and *GemCad* calculated the angle to make the facet touch these two points. After you get this cutting sequence, use the **View/Replay** command to see how the design develops as each facet is cut.

As an exercise, print out the diagram and see if you can proof–cut the design to reproduce the design, but this time entering the angles in the diagram.

In this section of the tutorial, we learned:

- *GemCad* can sort and rename facets in order automatically.
- By clicking on a tier of facets in the **Cutting Instructions View**, you can move that line up or down in the cutting sequence. By repeating this process with other tiers, you can reorder the cutting sequence as desired.
- By editing the cutting order, you can often create a meetpoint sequence that will exactly reproduce a design with no measurements.
- You can place facets by eye without worrying about precise angles until after the design is nearly complete.
- The **View/Replay** command shows how the design develops as each facet is cut.

Appendix A: *GemCad for DOS* Command Equivalents

If you are a user of the DOS version of *GemCad,* you might find the following table useful.

DOS		Windows	DOS		Windows
a	angle	**New Facet Info**, *Ctrl–A*	**A**	jam Angle	click in facet, **Copy Angle**
b	blink	click in facet	**B**	Blink tier	N/A
c	center	**Edit/Center**	**C**	Change facet	click in facet, **Uncut/Recut**
d	draw	Raytrace/Erase Rays, *Ctrl*–D	**D**	Demo	N/A
e	pt,. on edge	click on edge	**E**	Export	**File/Export**, **Save as type** B3D
f	pt. on facet	click inside facet	**F**	Footnote	**Edit/Heading/Footnote**
g	gear	**Edit/Index Gear**	**G**	Gloss	click in facet, **Cutting Instructions**
h	help	Status Bar text	**H**	Heading	**Edit/Heading/Footnote**
i	index	New Facet Info, *Ctrl*–I	**I**	Index of Refraction	**Raytrace/Properties**
j	jam index	click in facet, **Copy Index**	**J**	N/A	
k	kill facet	click in facet, **Delete Facet**	**K**	kill tier	click in facet, **Delete Tier**
l	list to screen	**File/Print Preview**	**L**	list to file/printer	**File/Print**, **Edit/Copy**
m	meet point	click on meetpoint	**M**	iMport B3D	N/A
n	name	click in facet, **Name** box	**N**	New	**File/New**
o	N/A		**O**	Open	**File/Open**
p	pierce	click outside stone	**P**	Playback	**View/Replay**
q	query	Type coordinates in **New Facet Info** point	**Q**	Quit	**File/Exit**
r	rotate	**Edit/Rotate/Tilt**	**R**	Read ASC file	**File/Open**, **Files of type** ASC
s	save	**File/Save**	**S**	Save as	**File/Save As**
t	tack	*Shift* key	**T**	Tangent ratio	click in facet or row in **Cutting Instructions New angle** box
u	undo	Edit/Undo	**U**	N/A	
v	vector	N/A	**V**	Vector	N/A
w	waytwace	right mouse button	**W**	Write ASC	**File/Save As**, **Save as type**
x	xfer	Edit/Transfer	**X**	Scale	**Edit/Scale**
y	sYmmetry	**Symmetry** box	**Y**	bYsect	click on edge, **Fraction of total edge length** box
z	zoom	**View/Zoom**	**Z**	Z–axis intercept	click in facet, **Copy Z–axis intercept**

Appendix B: Answers to Frequenty Asked Questions

- When I print this document, why are the figures cut off and page layout different from the screen?
- One of the views has disappeared. How do I get it back?
- When I try to cut the table, why does *GemCad* keep the little part above the table and throw away the main part of the stone?
- I cannot get a facet to cut the way I expect it to. Why?
- How do I view the table of dimensions without printing the diagram?
- How do I change the font size or page layout on the printed diagram?
- When I copy a view with the *Edit/Copy* command, the labels are too big (or too small). How do I change the label size?
- Why is the *Open* button in the *Datavue* dialog disabled (grayed)?
- When cutting a freeform, how do I cut facets on the hidden side of the stone?
- How do I adjust the size of the table facet?
- How do I edit or delete a tiny facet?
- Why won't the *Heading/Footnote* command let me enter any text?
- A portion of GemCad's window appears to be the wrong color. Why? How do I fix it?
- Why are the button labels missing or garbled on the *Print Preview* screen? Why is the label on the *Save* dialog box (or other system dialog) garbled?

Q: When I print this document, why are the figures cut off and page layout different from the screen?

A: This is a bug in Windows Explorer and later as well as Netscape Navigator. The Opera browser does a better job printing aligned graphics. Or, look on the GemCad website, www.gemcad.com, for a PDF version of this manual that can be printed with the Adobe Acrobat Reader®. Or better yet, don't print it at all and save a tree!

Q: One of the views has disappeared. How do I get it back?

A: Look carefully at the margins of the remaining windows. You will find that one margin has an extra line along one edge. This is the resizing gadget for the hidden view. Follow the instructions above.

Q: When I try to cut the table, why does *GemCad* keep the little part above the table and throw away the main part of the stone?

A: The stone is too far down in the side and end views. *GemCad* uses a sawblade instead of a lap, and it has to decide which part of the stone to keep and which part to throw away. It keeps the part that contains the origin, the center of all of the views. The solution is to use the **Edit/Center** command to move the stone up so that the center of the side and end views is between the culet and the level of the table.

Q: I cannot get a facet to cut the way I expect it to. Why?

A: There are several possible causes. *GemCad* likes to cut the top of the stone instead of the bottom. If you are trying to cut a facet on the bottom of the stone, use the **Edit/Transfer** command to flip the stone over.

When you give *GemCad* an index and a point, the point has to be near that index position and not on another index related by symmetry. Let's say that while cutting an oval, you are trying to cut a set of 4 facets at index positions 2–46–50–94. If you give *GemCad* an index of 2 and a point, the point has to be near the 2 index position, not the 94 index position.

If you are proof–cutting an old design, the angle or index might be incorrect causing the facet to miss the stone or cut too deeply. Instead of giving *GemCad* an angle, index, and point, try giving *GemCad* the index and two points, and let it figure out the angle. If the facet cuts OK, compare the angle to the one in the diagram. If you suspect a problem with the index, try giving *GemCad* three points and let it figure out the angle and index. If it cuts correctly, compare the index and angle that *GemCad* calculated to the one in the diagram.

Q: How do I view the table of dimensions without printing the diagram?

A: Use **Print Preview**.

Q: How do I change the font size or page layout on the printed diagram?

A: *GemCad* has a fixed font size and page layout. If *GemCad's* choices do not suit your needs, it is straightforward to copy from *GemCad* and paste to your favorite word processor. Use the **Edit/Copy** command to copy a picture or the cutting instructions to the Windows Clipboard. This method is not just a screen copy but a metafile copy and so does not suffer from the jaggies on diagonal lines.

If your diagram is complicated, and the labels are too small, you might try a larger paper size, such as legal–size, 8.5 by 14 inches. Be sure to use the **File/Print Setup** command to select the paper size.

Q: When I copy a view with the *Edit/Copy* command, the labels are too big (or too small). How do I change the label size?

A: The labels in the clipboard copy are proportionately the same size as the labels on the screen. To get proportionately larger labels, make the window *smaller* before you copy it. To get smaller labels, make the window *larger* before you copy it.

Q: Why is the *Open* button in the *Datavue* dialog disabled (grayed)?

A: Your copy of *Datavue* probably did not install the files in *GemCad* format. See above.

Q: When cutting a freeform, how do I cut facets on the hidden side of the stone?

A: Rotate the stone 180° with the **Edit/Rotate/Tilt** command so that the other side of the stone is visible. If you are cutting an existing diagram, you will probably want to rotate the index gear as well, so click this checkbox.

Q: How do I adjust the size of the table facet?

A: There is no easy way. If it is a minor change in size, you can click in the table, do **Uncut/Recut**, give it a new meetpoint, an angle of 0° and recut the table. This will destroy the meetpoints around the table. Then go around and **Uncut/Recut** each facet that forms an edge of the table. You might have to adjust several tiers of facets.

Q: How do I edit or delete a tiny facet?

A: Sometimes, holding down the *Ctrl* key will allow you to select a small facet. If it is too small for this, you can find the facet's line in the **Cutting Instructions View** and click on it. To delete a small facet, sometimes it is easiest to enter three points on edge surrounding the facet and cut it off with a dummy facet. Then you can delete the dummy facet.

Q: Why won't the *Heading/Footnote* command let me enter any text?

A: There are probably some blank lines at the end. Headings and footnotes are limited to four lines each. Go to the end of the last visible line and press the *Delete* key several times.

Q: A portion of GemCad's window appears to be the wrong color. Why? How do I fix it?

A: The portion of the program that highlights facets and edges sometimes gets confused when another window or dialog box opens on top of *GemCad's* window. Use the *View/Refresh Ctrl+D* command to redraw the screen.

Q: Why are the button labels missing or garbled on the *Print Preview* screen?
Why is the label on the *Save* dialog box (or other system dialog) garbled?

A: The problem can be caused by installing Microsoft Picture It! 2000. According to Microsoft tech support, after you install Microsoft Picture It! 2000, instead of being prompted to save a file when you quit a program, you may receive a message similar to the following:

untitled _____?

This occurs because Microsoft Picture It! 2000 installs a system file used for Japanese formatting (`Mfc42loc.dll`) that may not be compatible with many programs, including CorelDraw, Adobe PhotoDeluxe, and Microsoft Paint, and others, including *GemCad*.

To resolve this problem, rename the `Mfc42loc.dll` file to `Mfc42loc.old`. In Windows 95 and 98, do the following:

1. Search for the file `MFC42LOC.DLL` in your `c:\windows\system` or `c:\windows\system32` folders. Make a note of the location.
2. Exit all programs.
3. Click **Start**, and then click **Shut Down**.
4. Click **Restart in MS–DOS mode**, then click **OK**.
5. Type one of the following lines at the command prompt, and then press **Enter**:
   `ren c:\windows\system\MFC42LOC.DLL MFC42LOC.OLD` **OR**
   `ren c:\windows\system32\MFC42LOC.DLL MFC42LOC.OLD`
6. Restart the computer.

If you have a later version of Windows, exit all programs, run the C:_ Command Prompt, and do steps 1, 2 and 5 above. If this fails, try to rename the file with Windows Explorer. If this fails, contact Microsoft tech support and mention Microsoft Knowledge Base Article Q249592.

Alphabetical Index(Links)