

# **GemCad User's Manual**

## **Version 4.51**

by

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### **Dedication**

GemCad is dedicated to the memory of my father

Robert L. Strickland

who introduced me to faceting.

### **Acknowledgements**

I gratefully acknowledge the many suggestions of Walter Carss, Bob Long, Norm Steele, Greg Thompson. I thank all of the GemCad users whose continued suggestions have helped me to improve the program. I thank my wife, Dorothy, who let me put in the long hours on GemCad and helped me proofread this manual.

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## Introduction

This manual describes GemCad 4.0, a computer-aided design program to assist in designing faceted gem cuts. GemCad simulates a faceting machine. You can specify angles and indexes, and GemCad will cut facets on the screen, drawing the stone at each stage. This is valuable for checking the validity of published faceting diagrams. Although GemCad simulates a faceting machine, its real purpose is to do the "grunt work" of designing new gem cuts. GemCad can figure out the angle of a facet given two points and its index, and it can figure out the angle and index given three points. You can specify meet points on the screen with the cursor keys or the mouse. GemCad understands radial and mirror-image symmetry. If you tell it to cut one facet, it will automatically cut the other facets on the tier. GemCad can scale a stone, adjusting the angles for different indexes of refraction. GemCad can turn a round design into an elliptical one. GemCad can produce formatted listings suitable for use as faceting diagrams.

GemCad is written in the C programming language and was compiled with Borland's C++. GemCad runs on an IBM PC™ or compatible with at least 512KB of memory and VGA, EGA, Hercules™ or CGA graphics adapter card. (The CGA resolution of 640X200 is a bit sparse, but is sufficient for many designs.) An 80x87 numeric co-processor is strongly recommended but not required. A hard disk is also strongly recommended. GemCad supports a Microsoft Mouse or compatible. The driver supplied with your mouse (such as `MOUSE.COM`) must be loaded before running GemCad. This is most commonly done in the `AUTOEXEC.BAT` file, but may be done anytime at the DOS prompt. GemCad will not work with a `MOUSE.SYS` device driver such as is loaded in the `CONFIG.SYS` file.

To run the program, type `GEMCAD` at the DOS prompt. The program will try to detect which kind of graphics adapter card you have, but if your screen is messed up, try again by typing `GEMCAD X` where "X" specifies the graphics adapter and is one of the characters "c" for CGA, "e" for EGA, "h" for Hercules, "v" for VGA. This will bypass the auto-detection software and will hopefully get things going in the right direction.

GemCad can be "driven" with the function keys, legends for which appear at the left of the screen. Legends beginning with ">" change to a new menu of functions. You can also point at a function key legend with the mouse and click a mouse button to activate it. The **Help (h)** key (Function key `F11` [or `Shift-F11`] in every menu) followed by another function key will print a short description of what that key does (when it is NOT preceded by the `F11` key).

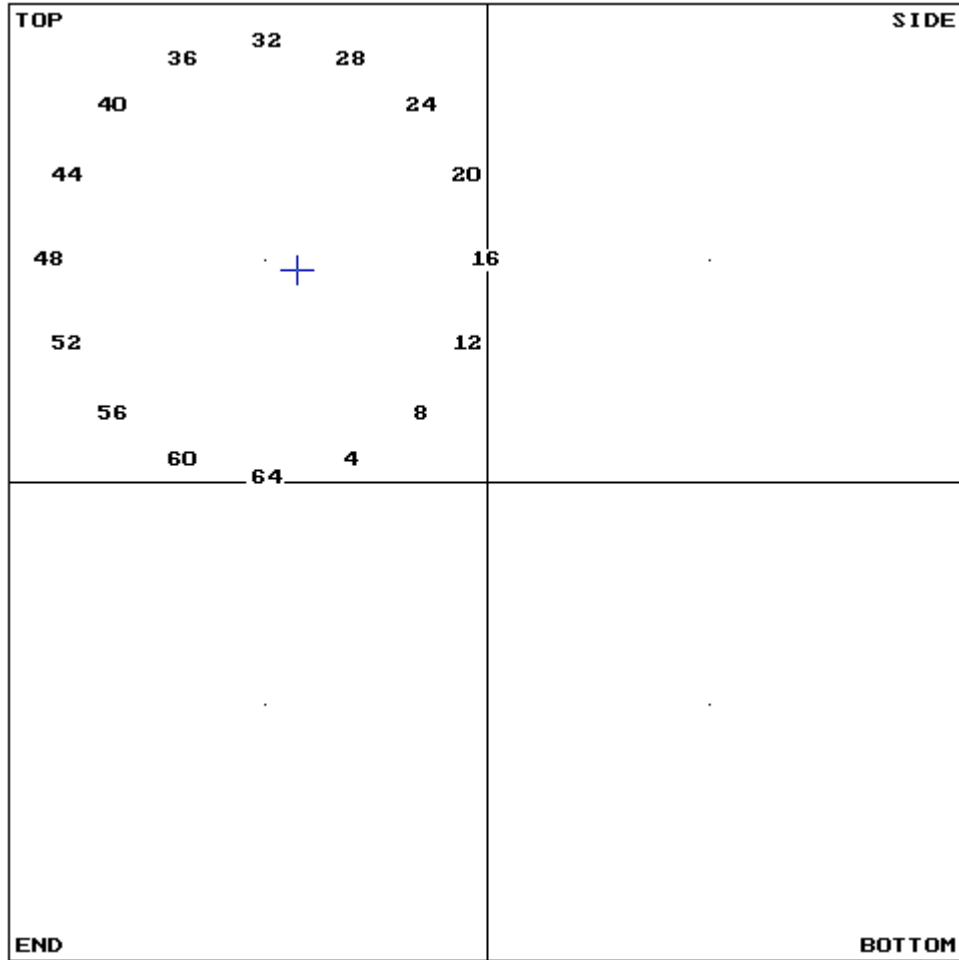
To install the program onto your hard disk, I recommend making a subdirectory called `GEMCAD` on your hard disk and then copying all of the files to that directory. If your hard drive is `C:` and your floppy is `A:`, do the following at the DOS prompt:

```
C:
CD \
MD GEMCAD
CD GEMCAD
COPY A:\*.*
```

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## GemCad Tutorial Lesson 1

To run GemCad, type GEMCAD at the DOS prompt. GemCad will print its version number and copyright notice. After you press any key or mouse button to acknowledge the message, GemCad will switch your display to the graphics mode. Your display should then look something like Figure 1.



**Figure 1.** Display when GemCad is first run

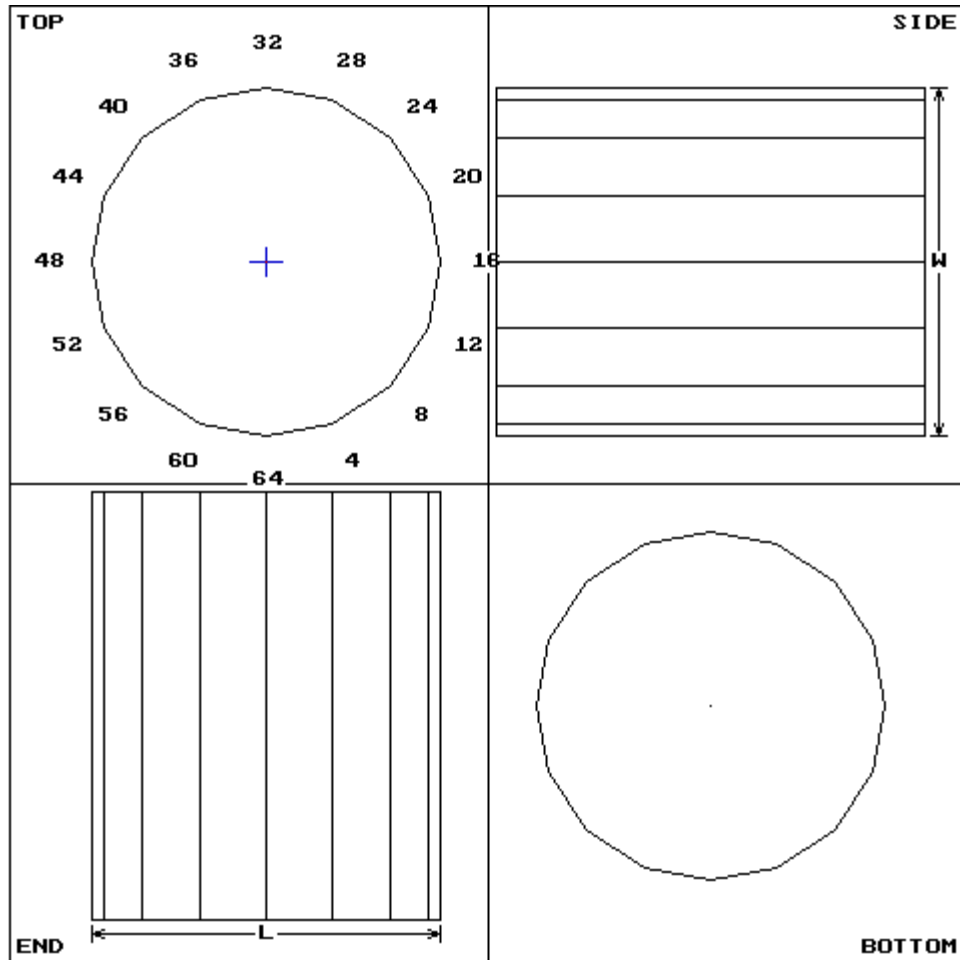
This is an actual screen dump with a VGA display. (An EGA display will look slightly less resolved vertically, and a CGA will look considerably less resolved vertically.) The screen is divided into four views, similar to an engineering drawing. The Top View is at the upper-left, the Side View is at the upper-right, the End View is at the lower-left, and the Bottom View is at the lower-right. The index gear is indicated by a circle of numbers in the Top View. When GemCad is first run, a 64-tooth index gear is used. The index positions start at 64 at the bottom of the Top View and increase counterclockwise. This rather peculiar orientation was chosen to keep facets cut at small index numbers visible in the Top, Side, and End Views simultaneously. This will make better sense as we cut our first stone. (You can make the I.D. position be at the top if you want. See the **Index gear (g)** key in the reference section at the back of this manual.)

While working through this tutorial, be careful not to press the standard alphabetic keys unless responding to questions that GemCad asks. Most of the alphabetic keys are shortcuts for commands that we shall learn to execute with the function keys. `caps lock` should also be turned off (the light should not be lit) since there are more commands than letters, and commands performed by pressing capital letters are generally more dangerous than commands performed with lower-case letters.

What better way to learn than by doing! Let's begin with a standard round brilliant in quartz. We will use 44° for the pavilion mains and 40° for the crown mains. A round brilliant has eight-fold, mirror-image symmetry and can be cut on a 64 index gear. These are the default settings when GemCad is first run. (You can change the symmetry with the **Symmetry (y)** command described in the reference section of this manual.) We shall begin by cutting girdle facets at 90° to preform the stone. At the left of your display you will notice the title "MAIN MENU" and several lines beginning with `F1-F6` that correspond to the function keys on your keyboard. The function keys will be along the left or top of your keyboard depending on the model. In the Main Menu, all of the labels begin with the `>` character indicating that selecting the corresponding function key will move to a different menu. Now, experiment with moving around in the menu structure by pressing the function keys corresponding to labels starting with `>` If you are using a mouse, you can also point at one of the function key legends to cause it to "light up." Then press any mouse button to execute the highlighted choice.

You will notice single alphabetic characters to the right of function key labels. These are abbreviations for the corresponding function key commands. Typing the alphabetic key is equivalent to pressing the corresponding function key. So what's the shortcut if either takes but a single keystroke? The advantage is that you don't have to be in any particular menu to execute a command with an alphabetic key. This saves you the trouble of wandering through the menu hierarchy if you already know the commands since all the commands are available all the time. If you type reasonably well, the alphabetic keys might be easier to locate than the function keys. Remember to be sure that `caps lock` is off (the light is not lit) since upper-case commands are different from (and generally more dangerous than) lower-case commands.

The help key is `F11` (or `Shift-F11`) in every menu. If you press the **Help (h)** key followed by another function key, GemCad will print a one-sentence description of what the key does. This tells what the key does when it is not preceded by the **Help (h)** key. You should have received a sheet of paper listing all of the menus. (A file called `MENUS.TXT` contains the same information.) Use this for a road map as you explore the menus. After you have explored the menus, get back to the **Main Menu** by pressing the `>Main Menu` function key.



**Figure 2.** Girdle facets

Cutting is done while in the menu called **Cut Facets Menu**. To get to the **Cut Facets Menu** from the **Main Menu**, press the **>Cut Menu** key. We shall begin by cutting 16 girdle facets at  $90^\circ$  to preform the stone. (GemCad can handle only faceted or knife-edge girdles--it cannot handle a round girdle.) Using a 64 index, the girdle facets are at indexes 2, 6, 10.... To tell GemCad to cut at index position 2, use the **Index (i)** key. You will see the question, "Index?" appear at the top of your screen in dark letters on a white background. Enter 2. (That is, press the 2 key and then press the key labeled **Enter**.) You can correct mistakes with the **Backspace** key any time before pressing **Enter**. Any time GemCad needs a response from you, it will prompt you at the top of the screen. After you enter the 2, you will notice the message **i2.0** in the status box at the lower-left-hand corner of your screen. This portion of the screen contains information about facets about to be cut.

Now we need to tell GemCad at what angle to cut the facet. To do this, press the **Angle (a)** key. GemCad will ask "Angle?" at the top of the screen. Enter 90. (Press the 9 key, the 0 key and then the **Enter** key.) You might notice the message **a90.00, i2.0** appear briefly in the status box at the lower-left-hand corner of your screen while GemCad cuts the *sixteen* girdle facets! Your screen should look like Figure 2. GemCad knows to cut sixteen facets because it is set for eight-fold, mirror-image symmetry. (These are the default settings, but they may be changed easily.)

GemCad will cut a facet or course of facets as soon as you have given it enough information. In this case, we specified the index, angle. For the other facets we will cut later, we will also have to specify a cutting depth, but for this first tier of facets, a reasonable cutting depth is assumed. The fundamental rule of GemCad is that it cuts a set of facets as soon as you give it enough information to completely specify one of the facets.

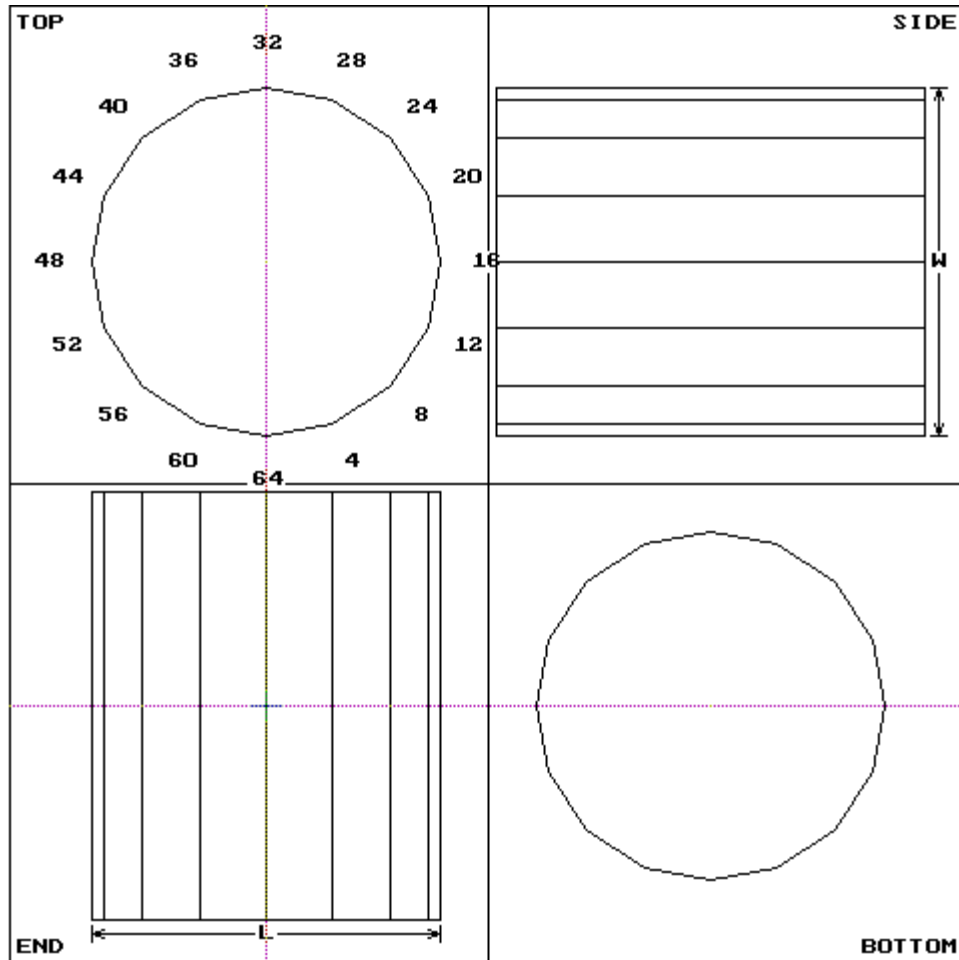
The four views of the stone are projections of the stone onto the faces of a cube. The advantage of cutting facets in the Top View is that the  $x$  coordinate is shared with the End View and the  $y$  coordinate is shared with the Side View. Neither axis of the Bottom View aligns with any of the other views.

A word about correcting errors in entry: Entering two different indexes will cause the first index to be discarded. If you make a mistake entering the index, simply enter it again. If GemCad has just cut a facet that didn't come out as you hoped, you can use the **Undo (u)** key found in several of the menus. This will undo the previous command that changed the stone. The **Undo (u)** command only undoes the last change to the stone. The undo command will not undo itself. If GemCad is busy cutting off facets or otherwise taking longer to do something than you might expect, press the `ESC` key to interrupt. This will automatically perform an undo.

Now back to our brilliant. We shall cut the pavilion mains next. We need to indicate to GemCad at what depth to cut the mains. You specify the cutting depth of a facet to GemCad by entering one or more points on the facet-to-be. You specify points to GemCad by moving the cursor around on the screen and by making choices in the **Point Menu** with the function keys. Now go to the **Point Menu** by pressing the **>Point Menu** key.

The cursor is located at the intersection of cross-hairs on the screen that look like a + sign. To move the cursor around on the screen, you can use either the arrow keys on the calculator-style numeric keypad or the cursor keys (if your keyboard has them). The odd numerals 1, 3, 9, and 7 on the numeric keypad make the cursor move diagonally. If the numeric keys on your keyboard are the same keys as the cursor keys, it doesn't matter whether or not the `NUM LOCK` key is active. Now experiment with moving the cursor around. The cursor accelerates if held down--that is, the step size increases the longer you hold down a key. GemCad can also make use of a Microsoft or compatible mouse (most are). If your mouse doesn't do anything, it's probably because you have not loaded the driver software supplied with your mouse. See the section on mice at the end of the reference section of this manual.

Move the cursor down to near the center of the End View. If you press the space bar, GemCad will draw a pair of dotted lines across the screen intersecting at the cursor. This allows you to line up things in different views. Move the cursor so that it aligns horizontally with the dot at the center of the Bottom View and so that it aligns with the vertical edge of the girdle facet at the center the End View. (Pressing the space bar again will remove the previous cross-hairs.) When the cursor is in the End View, it specifies the  $x$  and  $z$  coordinates. When it is aligned horizontally with the dot at the center of the Bottom View, the  $z$  coordinate is zero. Your cursor should be positioned as in Figure 3.

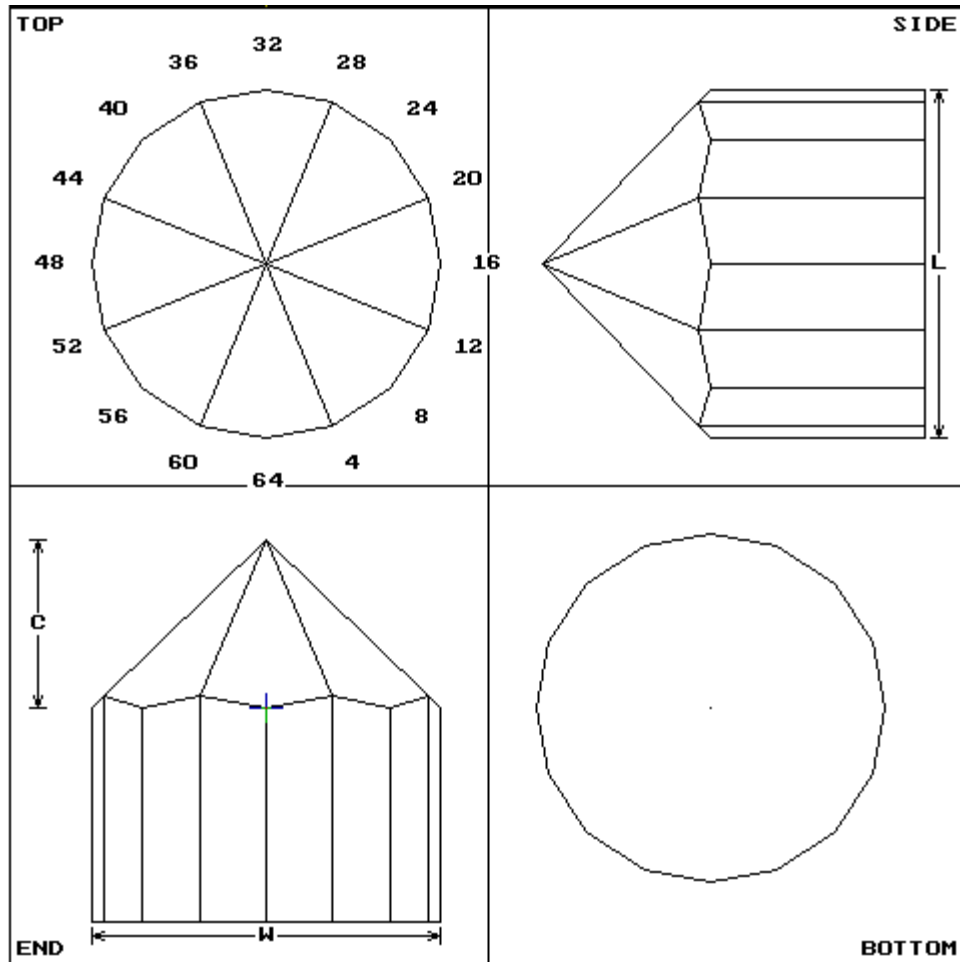


**Figure 3.** Positioning the cursor to pick the girdle line

Press the **Pt on edge (e)** key. This causes GemCad to look in the view containing the cursor is for the edge nearest the cursor. The cursor does not have to be exactly on the edge; it will "snap" to the nearest edge. If the  $(x, y, z)$  coordinates GemCad prints are close to  $(0.0, 1.0, 0.0)$ , enter  $y$  in response to the question about whether to use the point. GemCad will ask you this question whenever you enter a point with any of the commands in the **Point Menu**. You should see the message `1pt` in the status box at the lower-left-hand corner of your screen.

What if you enter  $y$  to use a point when you didn't mean to? If you redraw the stone with the **Draw (d)** key in the **Cut Facets Menu** or **Point Menu**, all points, the angle, and the index will be discarded. The status box will display the total number of facets.

Now we can tell GemCad at what index to cut the mains. Press the **>Cut Menu** key. Next, press the **Index (i)** function key. Enter 0. (Index position 0 is the same as index position 64.) You should see the message `1pt, i0.0` in the status box. Now press the **Angle (a)** key and enter the pavilion main angle 44. GemCad will then proceed to cut the eight main facets. Redraw the stone with the **Draw (d)** key. Your screen should look like Figure 4. The **Draw (d)** command updates the dimension lines. The **List to scrn (l)** command gives the numerical values of various ratios of the dimensions indicated by the abbreviations.

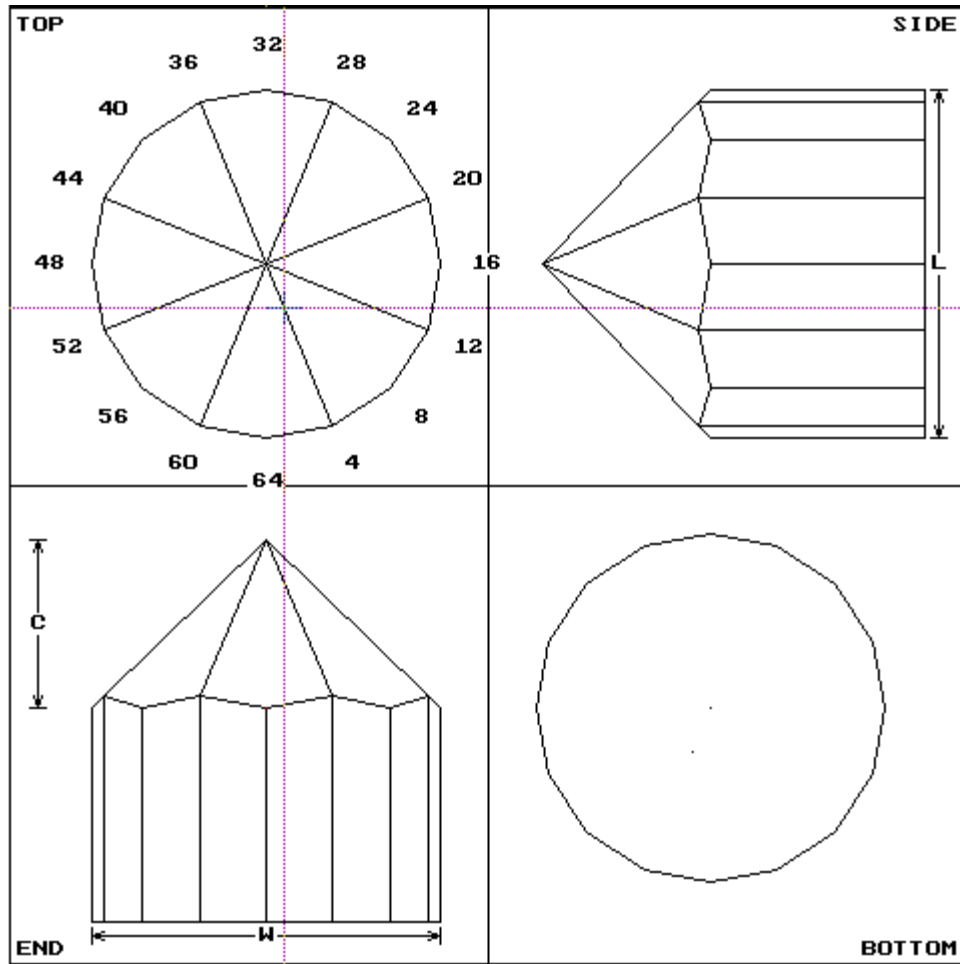


**Figure 4.** After cutting the pavilion mains

Now, you might be wondering what the bottom of our stone is doing in the Top View. Not to worry: we will transfer the stone later. Generally, you will find it easiest to cut facets on the Top View. You might also be wondering how GemCad knew to cut only eight main facets but sixteen girdle facets. Since we are using mirror-image symmetry, index position 64 (or 0) is mirrored by itself. The same is true for the star facets which we will cut at index position 4, 12, 20...

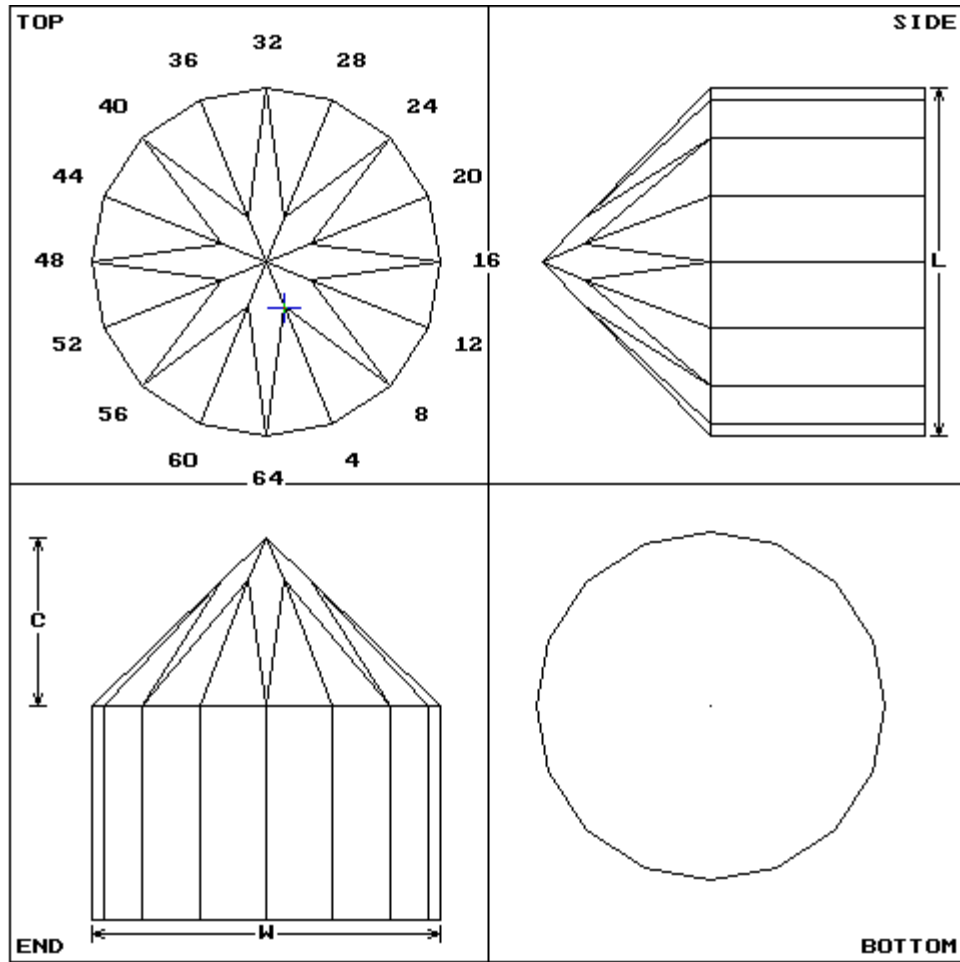
Now we will cut the pavilion break facets. Instead of telling GemCad at what angle to cut the breaks, we will tell GemCad where to cut the facet and have it figure out the angle. The cursor should still be near the meet point of the main facet at the 64 index and the girdles in the End View. (You don't have to be right on the meet point, just near it.) Press the key labeled **>Point Menu**. Now press the **Meet pt (m)** key. The cursor should "snap" to the nearest meet point and ask you whether to use the point. Answer with a **y** if GemCad has found the meet point of the girdles and the main at index 64. Now move the cursor to the Top View. How far down do you like your pavilion break facets to extend? Some faceters prefer about half way from the girdle to the culet. I prefer them cut about two-thirds of the way down to the culet. Move the cursor wherever you desire along the right edge of the main at index 64 as shown in Figure 5.





**Figure 5.** Defining the extent of the pavilion break facets

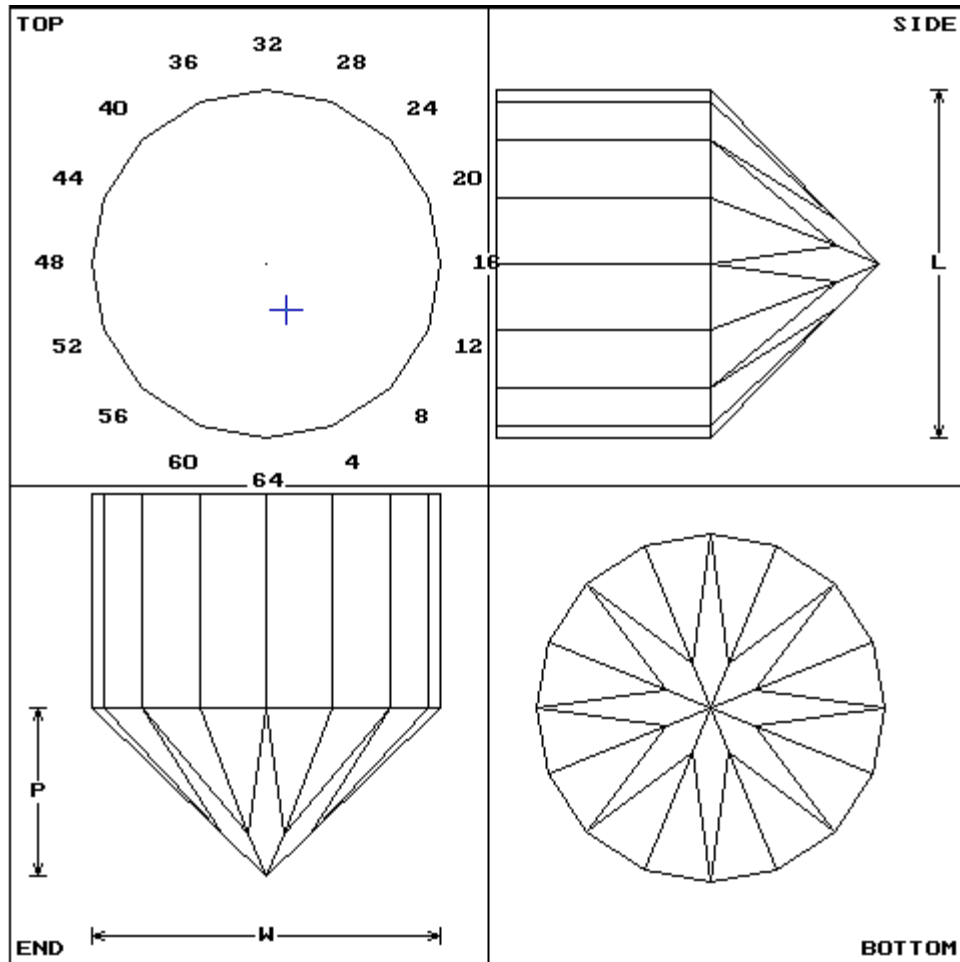
When you get to the point, press the **Pt on edge (e)** key. GemCad will snap to the nearest edge and ask you whether to use the point. If you're satisfied, enter *y*. You should see the message *2pt* displayed. Next, go back to the **Cut Facets Menu**. We shall cut our break facets at index positions 2 and following. Press **Index (i)** key and respond with 2. After GemCad cuts the 16 break facets, your screen should look like Figure 6.



**Figure 6.** After cutting the pavilion break facets

Note that you didn't have to tell GemCad at what angle to cut the breaks; it figured it out from the index and the two points you entered.

We have now completed the pavilion and are ready to transfer the stone. Press **>Main Menu** function key and then go to the **Cut Menu** by pressing the **>Cut Menu**. Press the **Xfer (x)** key to transfer the stone. Your display should look like Figure 7.



**Figure 7.** After transferring the stone

It is a good idea to save your work frequently to protect your work from yourself and from power-outages. This is particularly important when designing a new cut. Let's save our work now. Press the **Main Menu** key and then press the **File Menu** key. Press the **Save (s)** key. GemCad will ask you, "Project name?" GemCad is asking you for the name of the file in which to store the project. Enter something like `lesson.gem`. If a file by that name already exists, GemCad will ask you if it is O.K. to write over the file. If the file does not yet exist, the file will be created. The data files that GemCad reads and writes may have any legal DOS file name (eight characters or less plus an optional three character extension). (It's best for to name your GemCad files with names that have extensions beginning with `g` so that the file picker can find them without having to change the wildcard.)

It is a good idea to save your work frequently when designing a new stone. This is done with the **Save (s)** command. With the **Save as (S)** command, GemCad will always ask you for the file name, whereas with the **Save (s)** command, GemCad only asks if you haven't yet given it a name. It will still ask if it's O.K. to write over an existing project, however. If you inadvertently exit the program without saving your work, if the power should fail, or (forbid!) the program should "crash," you can still recover most of your work. Run GemCad press `Enter` and then *immediately* press the **Undo (u)** key (found in several of the menus). This will get you back to

just before the last change. To save its work, GemCad uses a file named GEMCAD.BAK in whatever directory from which it was run. It updates this file whenever you make a change to the stone. Note that the undo command will not undo itself.

Lesson 1 is now complete. You might want to take a break now to let the stone and your brain cool off a bit. If you have used the **Save (s)** as command and specified a project name and the status message "saved" has been printed in the upper-left-hand corner of your screen, it's safe to exit the program. This done with the **Quit (Q)** selection in the **File Menu**.

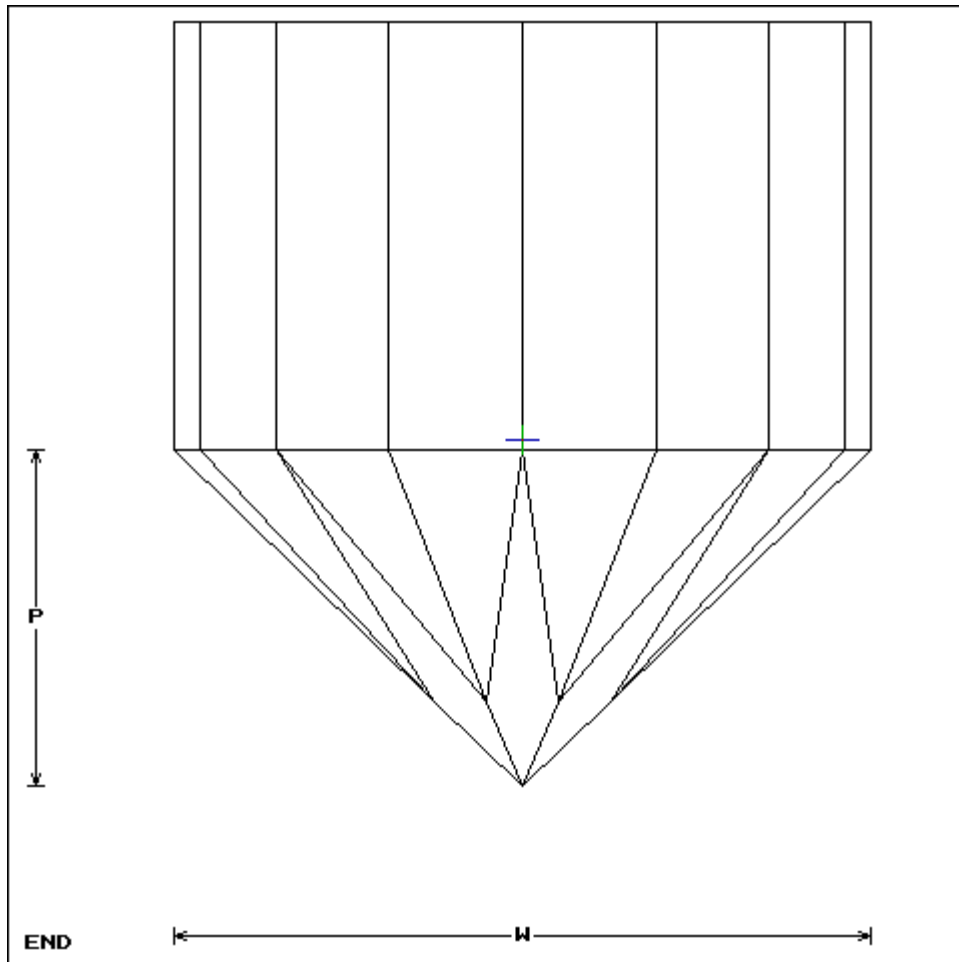
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## GemCad Tutorial Lesson 2

Welcome back. In this lesson we shall cut the crown of our round brilliant. Run the GemCad program. Press the **File Menu** key to get to the **File Menu**. Now we need to open the project. Press the **Open (O)** key to reopen the project. GemCad will ask you for the name of the project (file). Here, you could type in the name of the project, but just respond by pressing the `Enter` key, and GemCad will activate a file picker. This allows you to open projects by clicking on their names with the mouse or by selecting them with the cursor keys. You should see the name of the current directory printed at the top of your display. You should see the entry labeled `file spec` at the top of the column of files. You should also see the name of your file and perhaps other GemCad files. If you don't see your file name one of two things could have happened. If you didn't give your file name an extension that doesn't begin with `G`, the file will not be matched by the wildcard. If this is the case, click on `file spec` and change the wildcard to `*.*`. Now, all of the files in the current directory will be visible, including your project file. If not, you are probably not in the same directory as you were when you saved the file at the end of the last lesson. You can navigate through the directory tree by selecting the directories that end with the backslash `\` character. The special directory `..\` is the parent of the current directory, and clicking on it moves closer to the root of the directory tree.

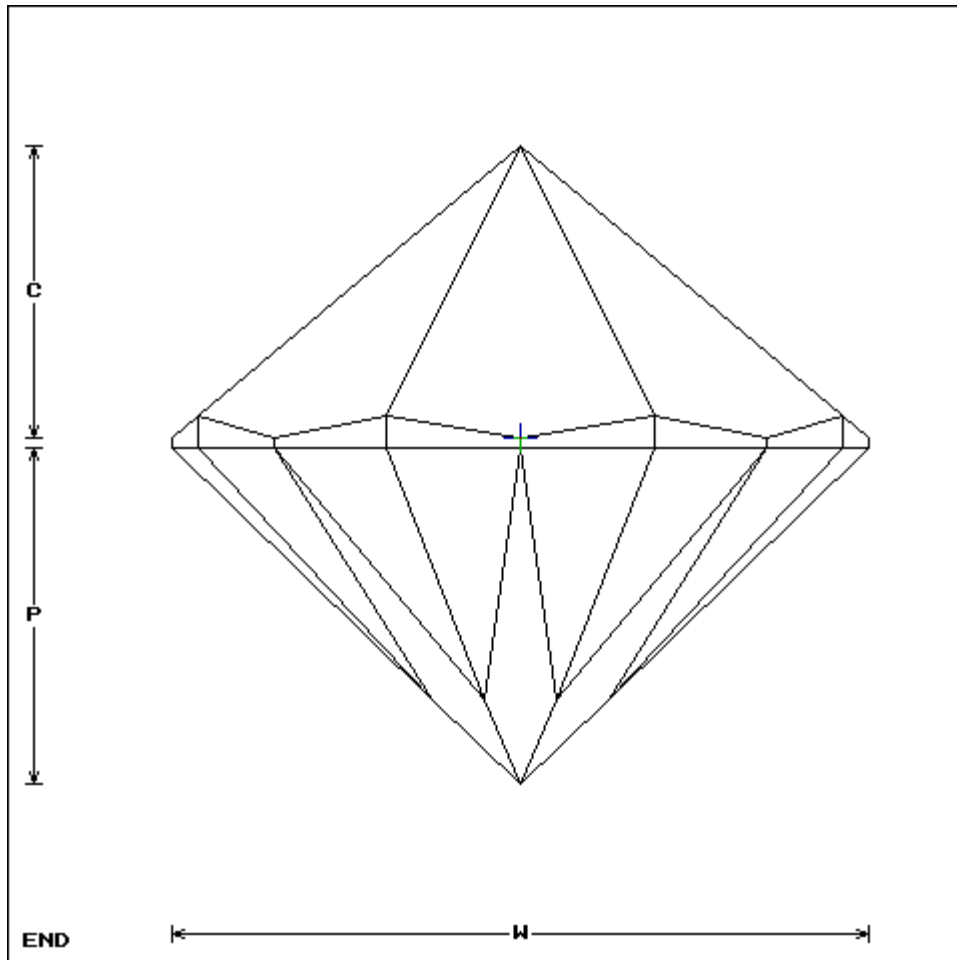
So, when you locate your project, move the cursor box around with the mouse or cursor keys to highlight your file name. Then press a mouse button or the `Enter` key. The stone should look the same as when you saved the project at the end of Lesson 1 as shown in Figure 7.

Now we are ready to cut more facets. Press the **>Main Menu** key to return to the **Main Menu** and then press the **>Cut Menu** key to get to the **Cut Facets Menu**. We shall now cut our crown mains at index position 64 at an angle of 40°. Press the **Index (i)** key and enter 0 for the index. Now, enter the angle by pressing the **Angle (a)** key and entering 40. Now we must enter a point on the facet. In order to see more clearly to position this facet precisely, we can zoom in on the End View. Move the cursor down to the girdle line on the End View. Then press the **Zoom (z)** key. GemCad will enlarge the End View to fill the entire screen. Move the cursor to where you want the main at index 64 to meet the girdle facets--decide how much girdle to leave by eye. The cursor should be positioned as shown in Figure 8.



**Figure 8.** Position the cursor to define the girdle thickness

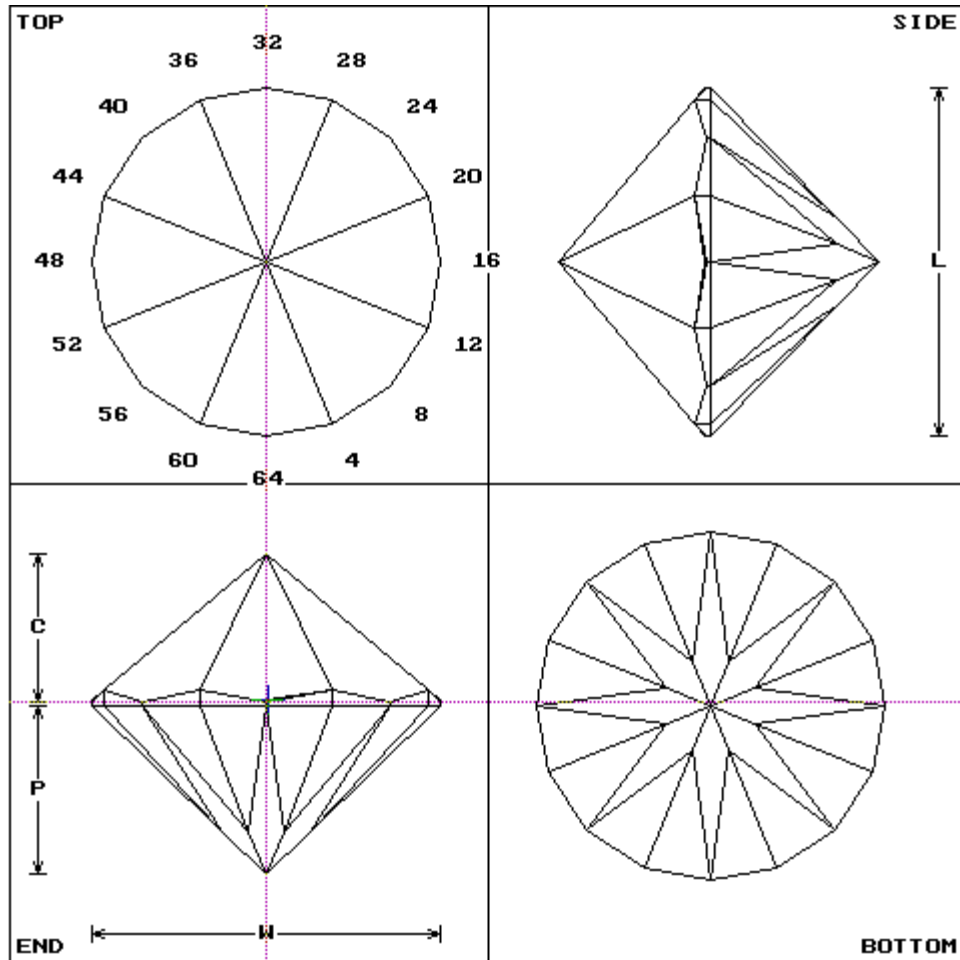
Press the **>Point Menu** key. Then press the **Pt on edge (e)** key to pick a point on the facet-to-be. If the cursor snaps to the edge you wanted, enter  $\gamma$  to cut the facets. Your display should look like Figure 9.



**Figure 9.** After cutting the crown mains

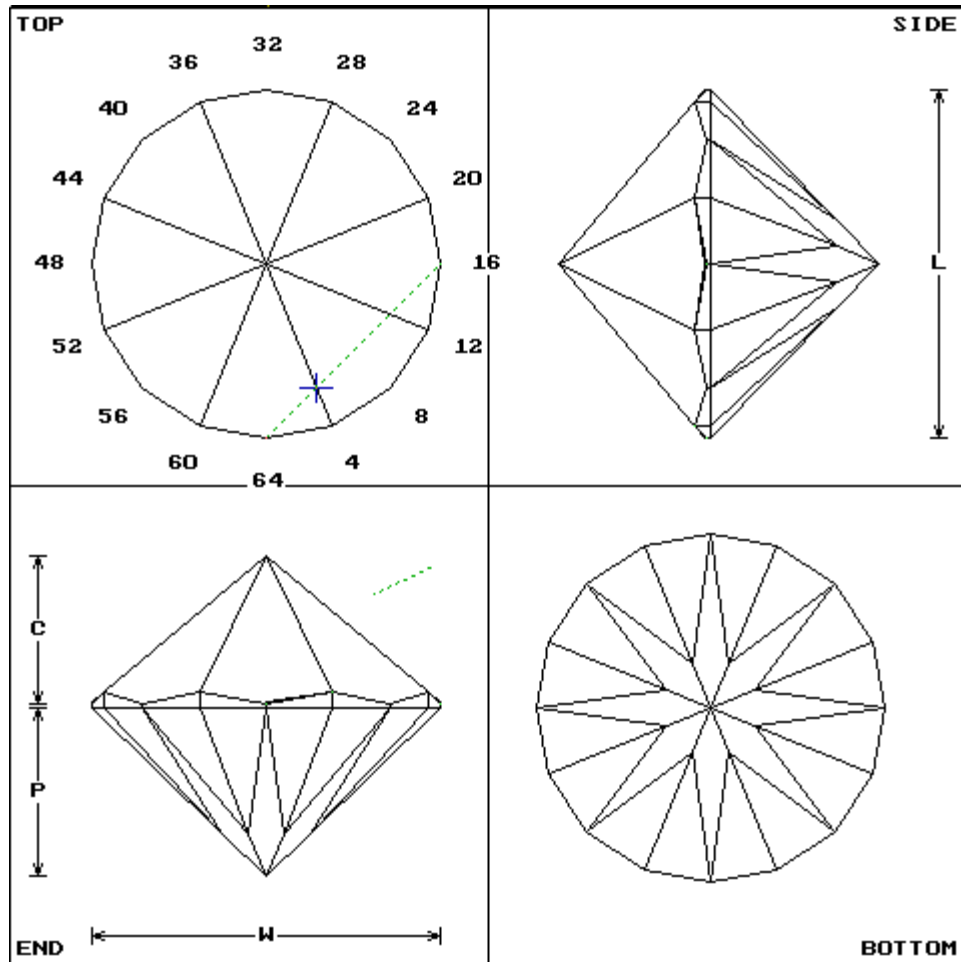
The mains meet at a point on the crown. (We're cutting cheap rough with an oversized preform.) We are now ready to enter information about the crown break facets. The cursor should be near the meet point of the crown facet we just cut at index 64 and the girdle facets. Since we want the break facets to meet here also, press the **Meet pt (m)** key to select this meet point. Enter  $\gamma$  to use the point. You should see the message  $1_{pt}$  in the status box.

Now we need to zoom back out to get the big picture. Press the **Zoom (z)** key. You should now see all four views again as shown in Figure 10. There are only two magnifications--the zoom command toggles between the two.



**Figure 10.** Zoom out to see the big picture

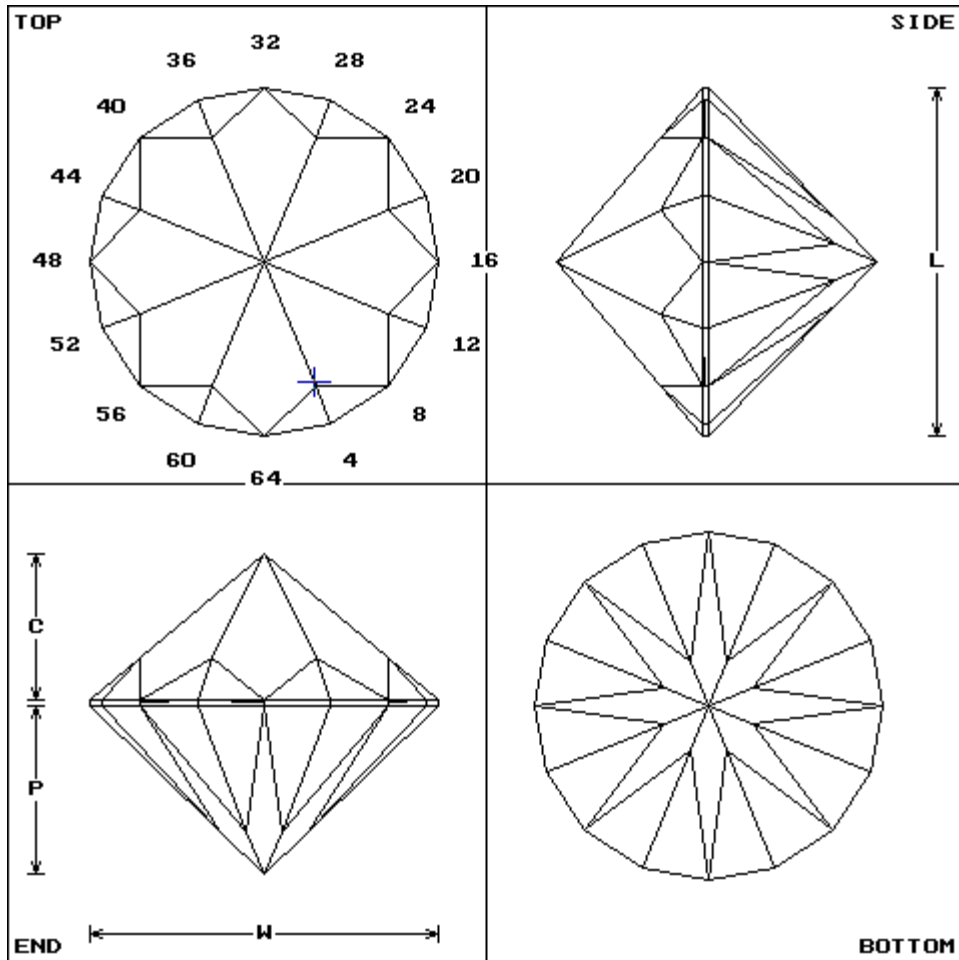
Now we must decide how large to make the crown break facets. Instead of entering the angle explicitly, we shall let GemCad figure it out. Let's make a construction line to assist us in placing these facets. The minus key (the hyphen or -) is used to draw construction lines. The **Constr line (-)** command is also found in the **Utility Menu**. Let's draw a line. Move the cursor away from the stone and press the - key. Move the cursor again and press the - key again. GemCad will draw a dotted line from the first point to the second point. (You can use the **Draw (d)** command to erase construction lines.) Position the cursor in the Top View near the meet point of the main at 64 and the girdle. To help you position the cursor, you can press the **Meet pt (m)** key to snap the cursor to the meet point. Enter n (or simply press the **Enter** key) to discard the point. (Here we are only using the **Meet pt (m)** key to snap to the meet point quickly.) Press the - key to begin our construction line. Next move the cursor near the meet point of the main facet at index position 16 and press the **Meet pt (m)** key to snap to the meet point. Press **Enter** to discard the point. Next, press the - key to draw the construction line. Now move the cursor near the intersection of the construction line and the edge formed by the intersection of the mains at indexes 64 and 8. (The edge will align radially with the 4 index position.) Your cursor should be positioned as shown in Figure 11.



**Figure 11.** Position the cursor to set size of mains

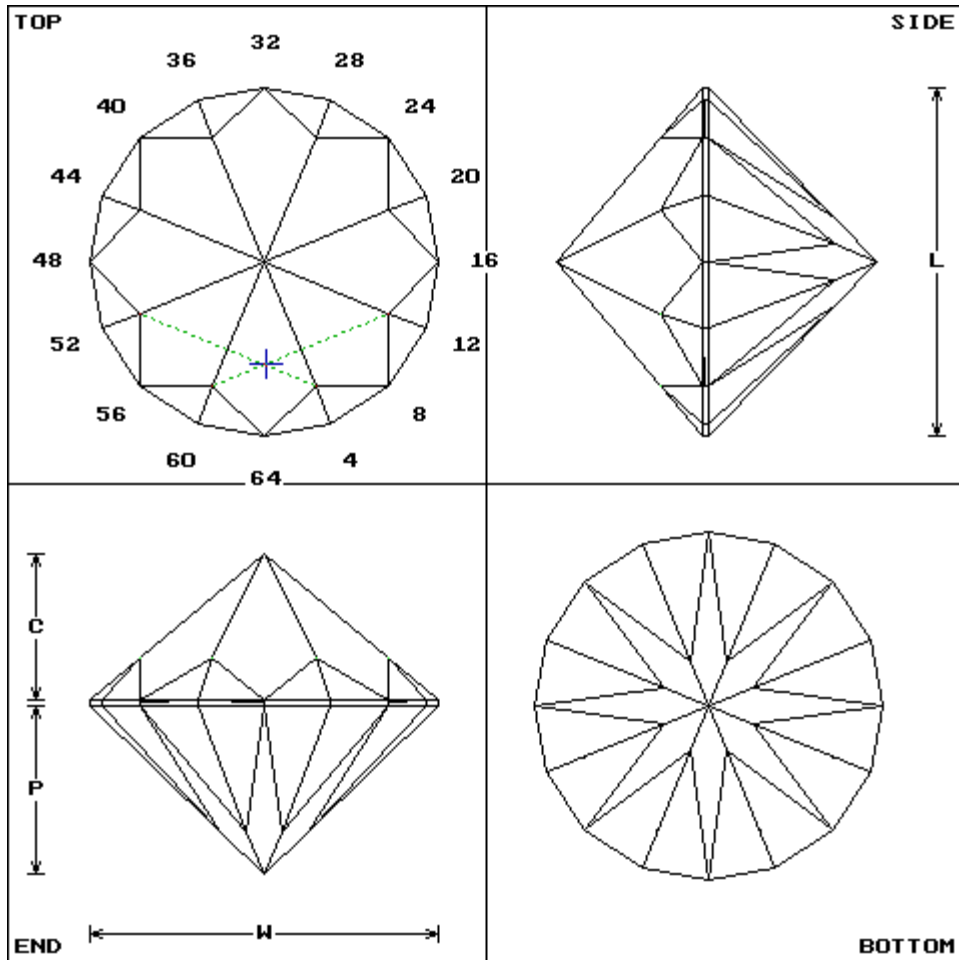
If we enter a point on the edge at the intersection of the construction lines we will end up with about a 60% table. If you want a smaller table, move towards the center of the crown a bit. When you have the cursor where you want it, press the **Pt on edge (e)** key to set the point. If the cursor moves only slightly to snap to the edge, enter  $\gamma$  to tell GemCad to use the point. You should see the message  $2_{pt}$  at the lower-left-hand corner of your screen. (If it says  $1_{pt}$  then you forgot to enter the meet point of the main at 64 and the girdle facets about four paragraphs back.) Now we need to tell GemCad at what index to cut the facet. Press the **>Cut Menu** key. Press the **Index (i)** key and enter "2" as the index. GemCad should proceed to cut the 16 crown break facets, and your display should look like Figure 12.





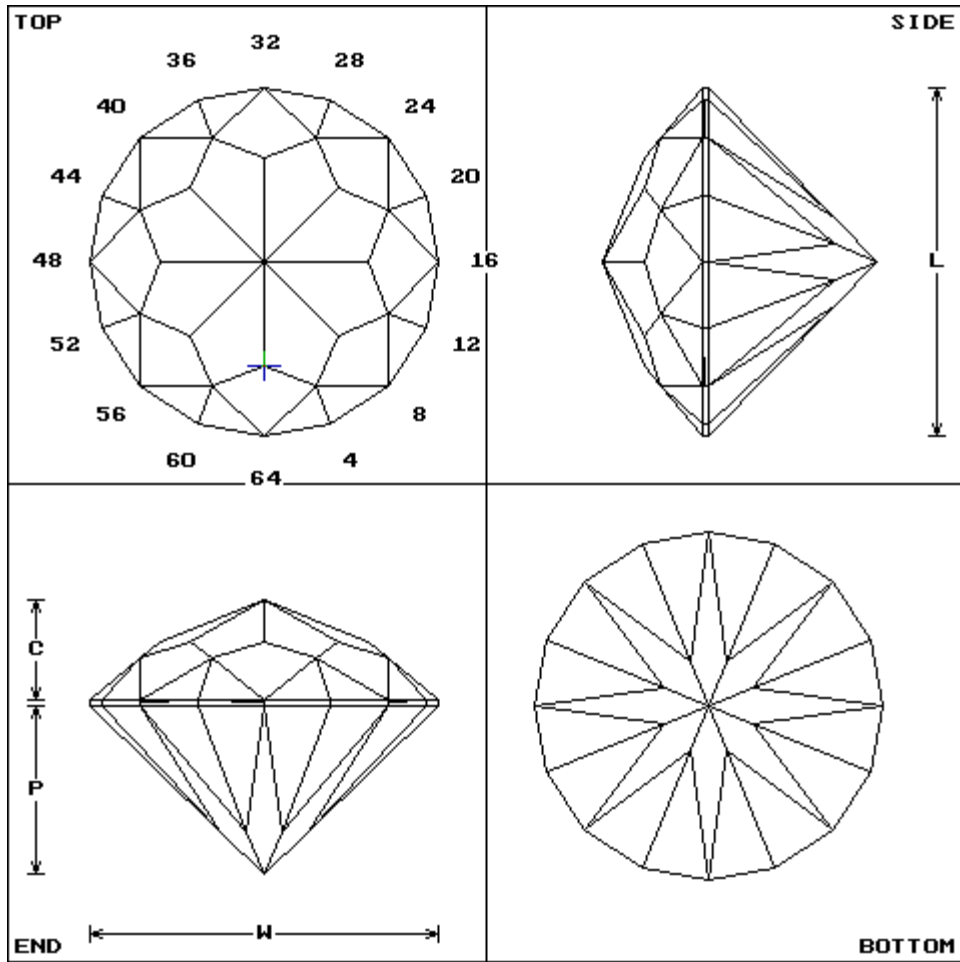
**Figure 12.** Crown mains and breaks

Now we are ready to cut the star facets. Press the **>Point Menu** key to go to the **Point Menu**. The cursor should still be at the intersection of the main and break facets along the radius of the stone at the 4 index position. Press the **Meet pt (m)** key to enter the point and press **y** to use the point. Now we shall make two more construction lines. We want the line to begin at this meet point, so press the **-** key to start the construction line. Next move the cursor near the corresponding meet point along the radius at the 52 index position. Press the **Meet pt (m)** key to snap to the meet point, but press **Enter** to discard the point. (Again, we are only using the **Meet pt (m)** key to position the cursor quickly; we *don't* want our star facet at index 4 to meet here.) Press the **-** key again to draw the construction line. Now we shall make another construction line. Move the cursor near the meet point of the mains and breaks along the radius at the 60 index position and press the **Meet pt (m)** key to snap to the meet point, and press **Enter** to discard the point. Press the **-** key to start a new construction line. Move the cursor near the corresponding meet point along the radius at the 12 index position, press the **Meet pt (m)** key to snap to the point, press **Enter** to discard the point and then press the **-** key to draw the construction line. The two construction lines should intersect on the main facet at the 64 index position. Move the cursor to this point of intersection. Your display should look like Figure 13.



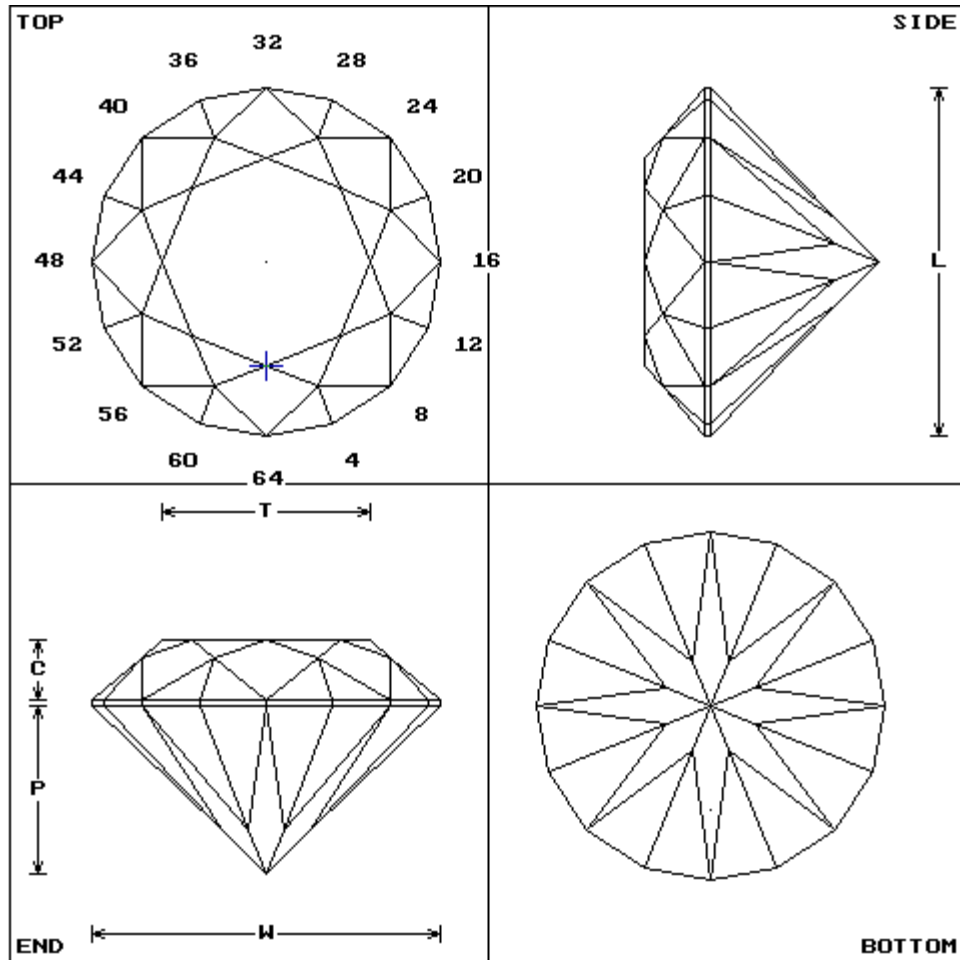
**Figure 13.** Establishing the meet point for the star facets

We want the star facets to meet the mains at this point. Press the **Pt on facet (f)** key to set this point and enter *y* to use it. This will drop a perpendicular down until it hits the main facet and set the point of intersection of the perpendicular and the facet. You should see the message *2pt* at the lower-left-hand corner of your screen. Now we need to tell GemCad to cut the facets at the 4 index position. Press the **>Cut Menu** key. Then press the **Index (i)** key and enter 4. Gem will cut the star facets. Redraw the stone by pressing the *a* key to update the dimension lines. Your display should now look like Figure 14.



**Figure 14.** After the star facets are cut

Now for the table. Press the **Angle (a)** key and enter 0 (zero). Press the **>Point Menu** key. Your cursor should still be at the meet point of the main at 64 and the star facets. Press the **Meet pt (m)** key. As soon as you enter  $y$  GemCad will cut the table. Note that you only had to enter the angle zero and not the index since index has no meaning for angle zero. You should now see the completed brilliant cut on your display as in Figure 15.



**Figure 15.** The crown is complete

This completes our round brilliant. Note that the only angles we had to enter were 44 for the pavilion mains, 40 for the crown mains, and 90 for the girdle facets. The remaining angles were set by "eye" by picking points along existing edges or on existing facets. This is often the way you will work when designing a new cut.

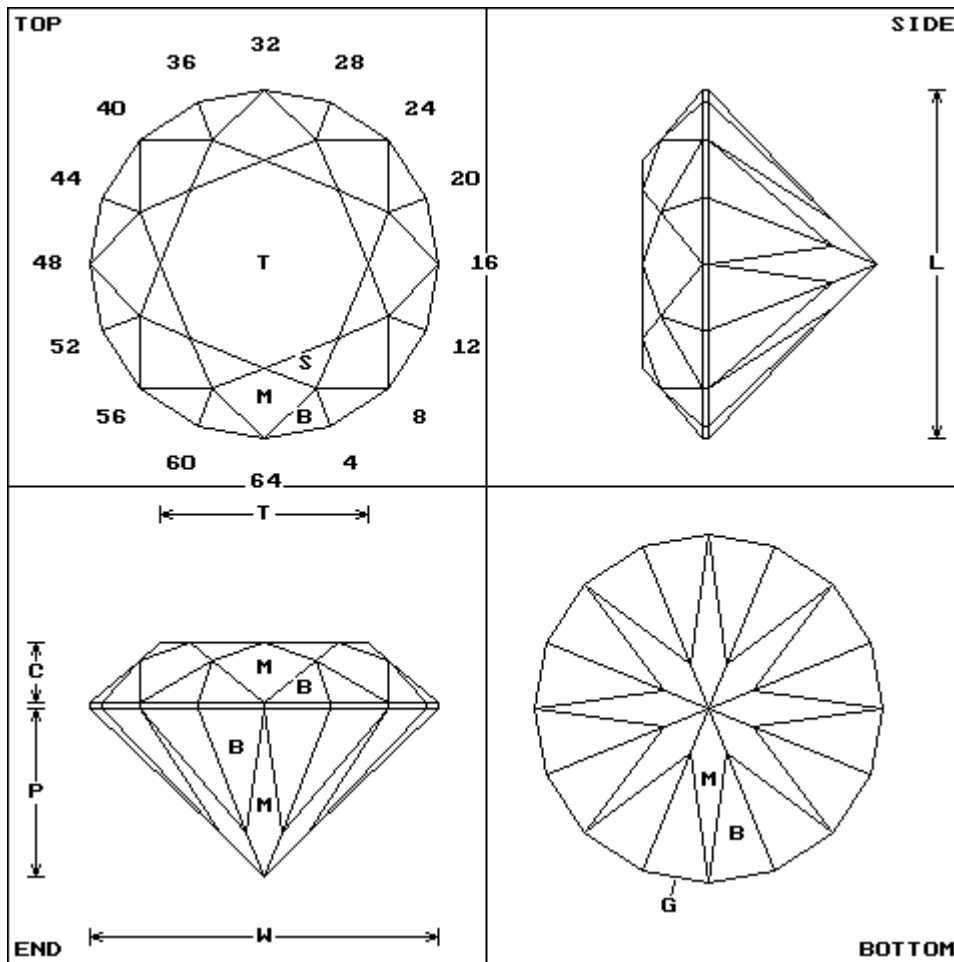
This completes Lesson 2, the crown of a round brilliant. Be sure and save the stone: Press **>Cut Menu** key, the **>Main Menu** key and then the **>File Menu** key. Then press the **Save (s)** key. Since we specified the project name when we opened it, GemCad will not ask you for a file name. GemCad will tell you that the file already exists and ask you if it's O.K. to write over the file. After saving the project, quit the program by pressing the **Quit (Q)** key.

### GemCad Tutorial Lesson 3

In this lesson, we will find out how to make a cutting schedule. We will also optimize the angles for quartz.

Open the project to read our brilliant back from disk. Now, change to the **Diagram Menu**. To list out the cutting schedule, press the **List to scrn (I)** key. Let's study this for a moment. GemCad will clear your screen and list the schedule. The first line shows the name of the project. The next shows the refractive index. The next shows the total number of facets, with and without the girdles. Next come the symmetry of the stone and the index gear. The next section gives the relative dimensions. The abbreviations refer to the drawing of the stone. Next, comes the facet data. Each tier of facets is shown on a separate line. The angle of the tier (in degrees) is given, and then the index of each facet is given. All facets in a tier are cut at the same angle and cutting depth. Unfortunately there is no way to tell which line goes with which tier. We will remedy this shortly. After you have viewed the listing, press any key to redraw the stone.

Now, let's name (or label) the facets. Move the cursor inside the table in the Top View. Press the **Name (n)** key. GemCad will highlight the facet and ask you for the name of the facet. Enter T for table. GemCad will then redraw the facet and label it with a T. Names can be up to three characters long, but one or two character names make for less clutter. Name all the facets as shown in Figure 16.

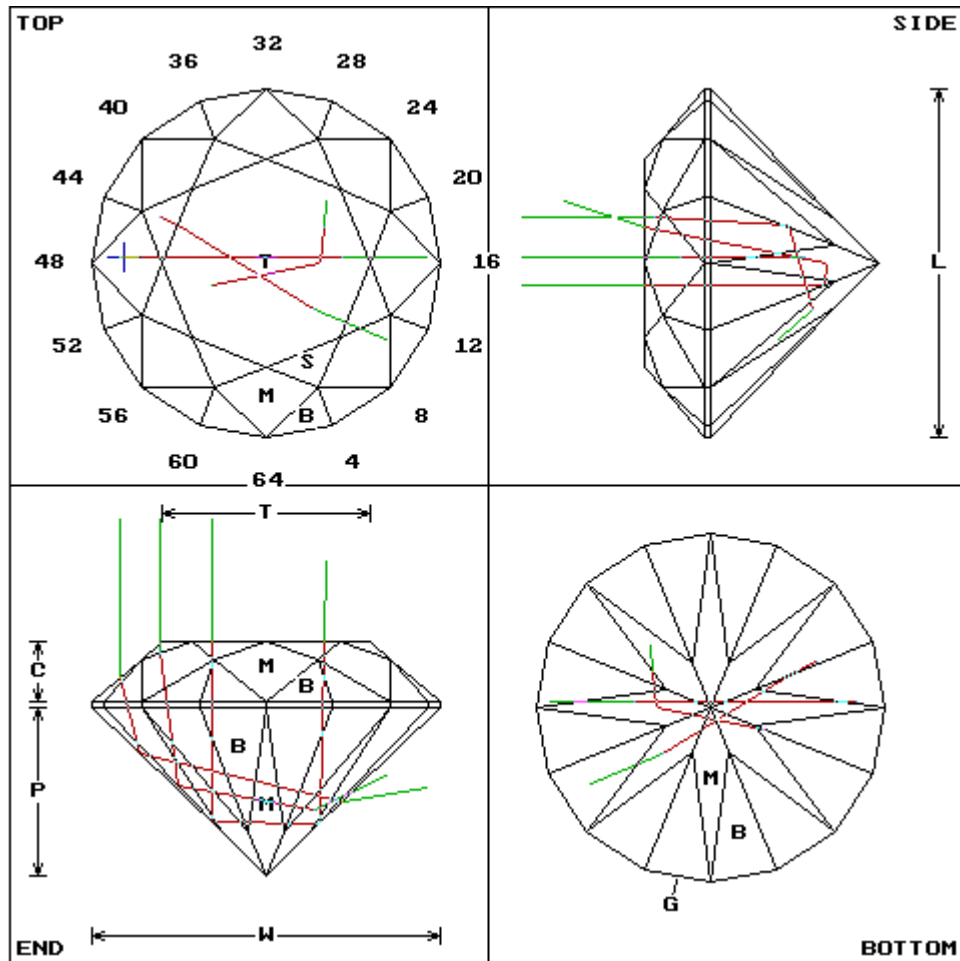


**Figure 16.** After naming all of the facets

Now, press the **List to scrn (I)** key to list the cutting schedule. Now each line of the facet data

begins with the name of the corresponding tier. You *can* name two facets on a tier with different names, but only one will be printed in the listing.

Now let's analyze the optical performance of our stone. Move the cursor inside the table near the perimeter of the table and press **Waytwace (w)**. GemCad will trace the ray into the stone and back out. (The raytrace command is in the **Cut Menu**.) Repeat the same for the star and the crown break facets. If your screen becomes too cluttered, redraw with the **Draw (d)** command. In particular consider the rays shown in Figure 17. On your screen, the portion of the rays inside and outside the stone are shown in different colors. Light entering the stars, mains and breaks leak out the pavilion. Only light entering the table is returned through the crown.

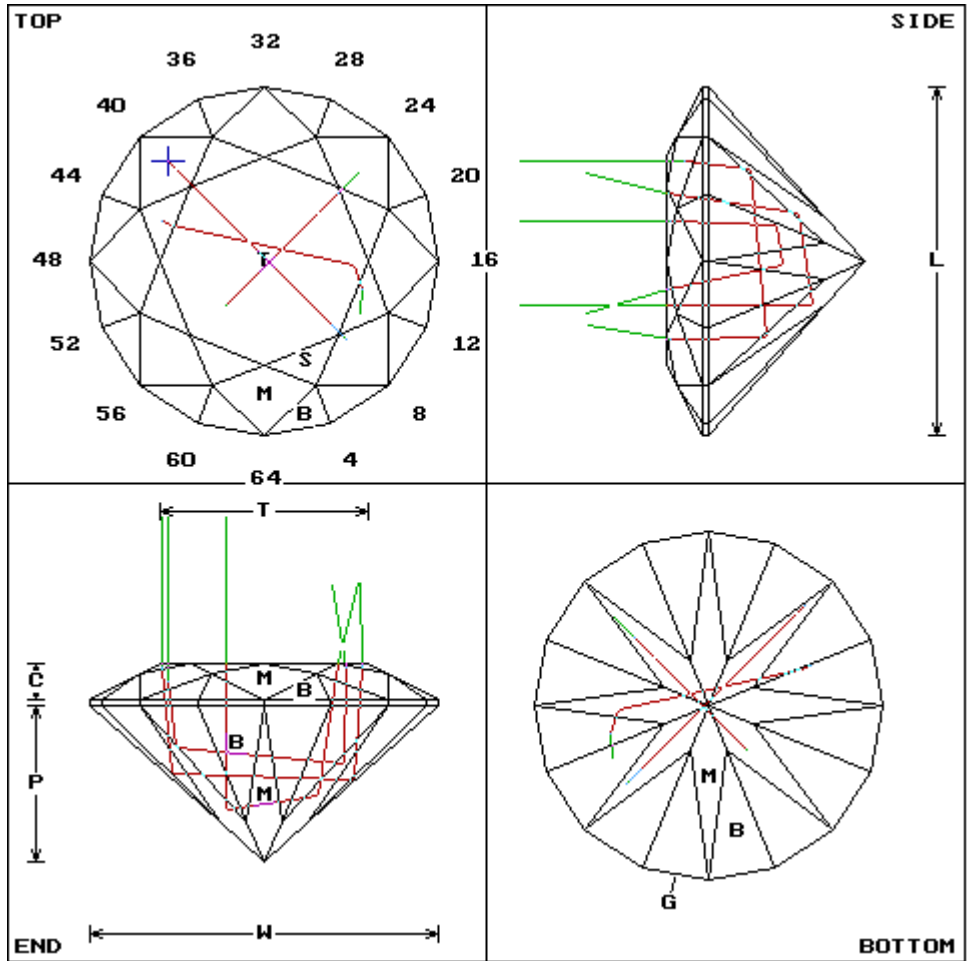


**Figure 17.** Some light rays

Now let's lower the angles. Move the cursor inside one of the crown mains. Press the **Blink facet (b)** key (located in the **Utility Menu**. The angle of the facet will be shown in the box in the upper-left-hand corner of your screen and should be  $40^\circ$ . Now let's scale the crown to make this angle  $27^\circ$ . Make sure the cursor is still inside a crown main and press the **Tan ratio (T)** key. (This command is in the **Cut Menu**.) GemCad will tell you what the old angle was and ask you for the new angle. Enter 27. GemCad will immediately rescale the crown.

Next, move the cursor inside a pavilion main and change the pavilion mains from  $44^\circ$  to  $42^\circ$ . The

smaller angles are near those recommended by Long & Steele and result in a much better performance for quartz. Now, use the **Waytwace (w)** command to check the performance. You should see rays similar to Figure 18. All light entering vertically through the mains, and stars now exits through the crown.



**Figure 18.** Paths of light rays after changing the angles

Execute the **Playback (P)** command (in the **Utility Menu**). GemCad will show an animation of the stone. The completed stone should look like Figure 19. You can list a cutting schedule to your printer by moving to the **Diagram Menu** and pressing the **List to file (L)** key and entering PRN for the file name. The resulting schedule should look like the listing in Table 1, but the angles might be a bit different since their numerical values were not entered but were set by "eye."

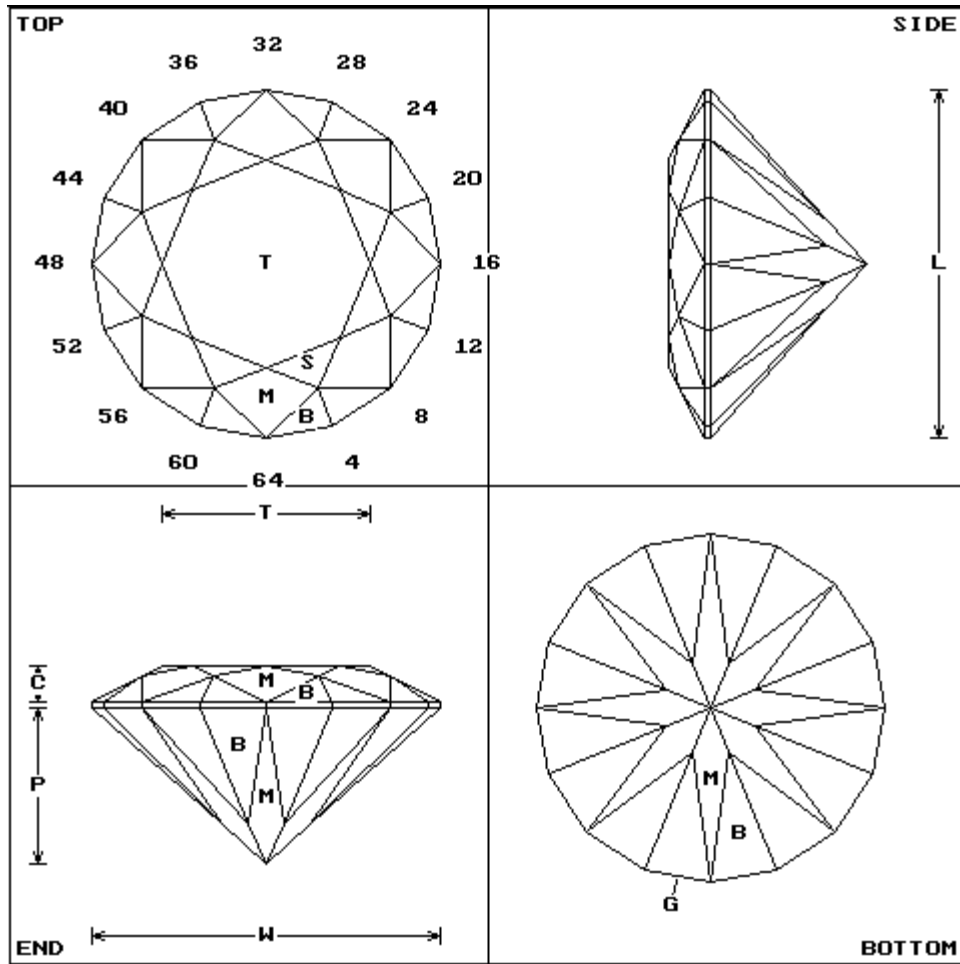


Figure 19. The completed brilliant

LESSON.GEM

Angles for R.I. = 1.54

57 facets + 16 facets on girdle = 73

8-fold, mirror-image symmetry

64 index

$L/W = 1.000$   $T/W = 0.583$   $T/L = 0.583$

$P/W = 0.450$   $C/W = 0.108$   $H/W = (P+C)/W+0.02 = 0.578$

$P/H = 0.778$   $C/H = 0.187$   $Vol./W^3 = 0.190$

GIRDLE

G 90.00 02-06-10-14-18-22-26-30-  
34-38-42-46-50-54-58-62

PAVILION

M 42.00 64-08-16-24-32-40-48-56  
B 43.31 02-06-10-14-18-22-26-30-  
34-38-42-46-50-54-58-62

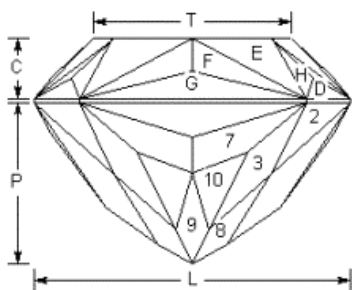
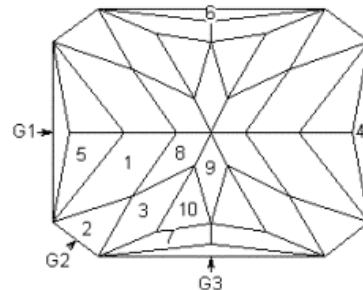
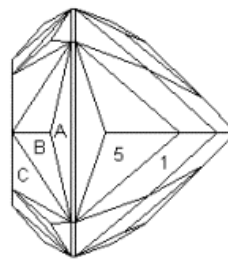
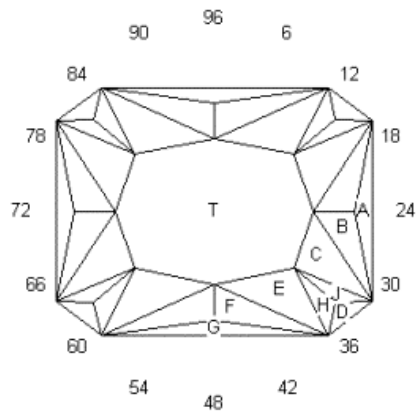
CROWN



M 27.00 64-08-16-24-32-40-48-56  
 B 33.08 02-06-10-14-18-22-26-30-  
 34-38-42-46-50-54-58-62  
 S 15.66 04-12-20-28-36-44-52-60  
 T 0.00 Table

Be sure to save your design with the **Save (s)** key. This completes the tutorial on the round brilliant.

### GemCad Tutorial Lesson 4



**Formée Cross Rectangle (FORMEE\_R.GEM)**  
 by Robert W. Strickland  
 Revised 7/28/91, 5/10/92, 5/8/93  
 Angles for R.I. = 1.54  
 67 facets + 8 facets on girdle = 75  
 2-fold, mirror-image symmetry  
 96 index  
 $L/W = 1.272$   $T/W = 0.795$   $T/L = 0.625$   
 $P/W = 0.649$   $C/W = 0.240$   
 $H/W = (P+C)/W + 0.02 = 0.909$   
 $P/H = 0.714$   $C/H = 0.264$   
 $Vol./W^3 = 0.526$

#### CAM PREFORM

PF1	33.40	10-38-58-86	Cut to TCP
PF2	35.00	24-72	Cut to TCP
PF3	41.70	96-48	Cut to TCP
G1	90.00	24-72	Cut to final length
G2	90.00	10-38-58-86	Level false girdle
G3	90.00	96-48	Level false girdle

#### PAVILION

1	43.00	13-35-61-83	Cut to TCP of preform
2	46.00	10-38-58-86	Meet G1-G2-1
3	45.81	07-41-55-89	Meet G2-G3-2
4	62.00	24-72	Level girdle
5	54.00	23-25-71-73	Meet 2-4 at girdle line
6	70.00	96-48	Meet 2-3 at girdle line

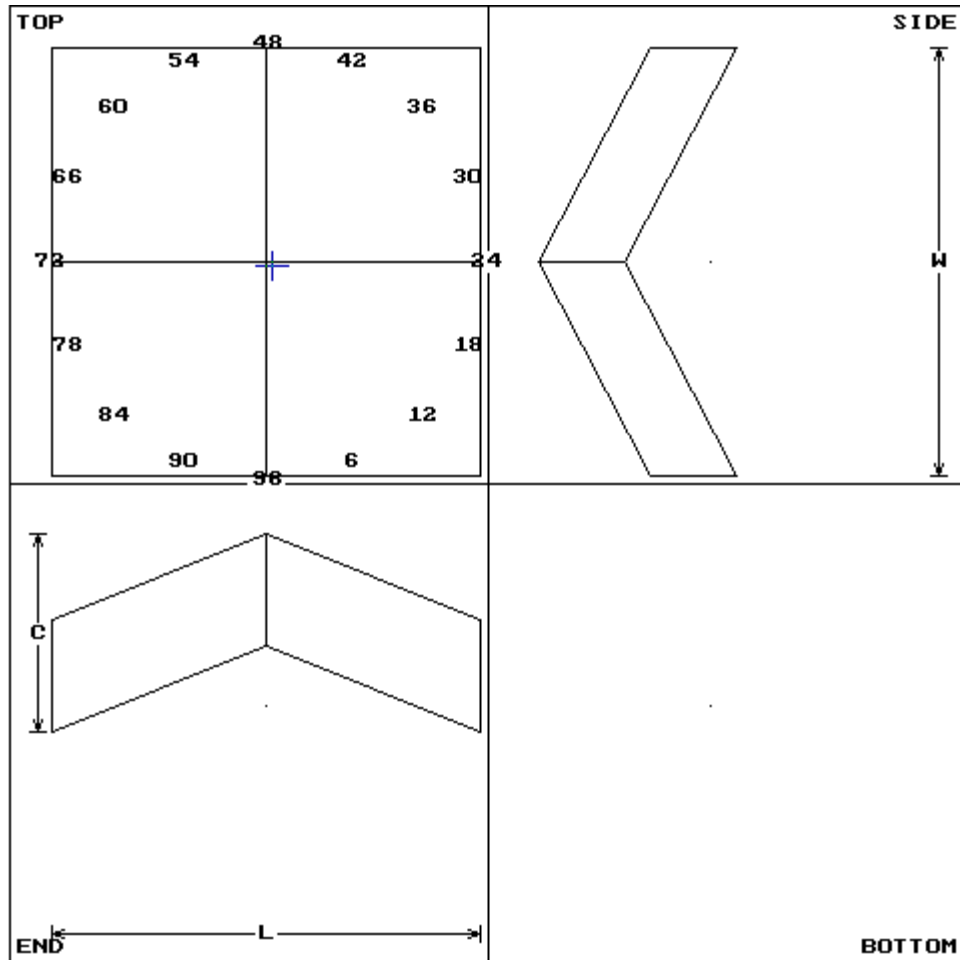
7	60.00	01-47-49-95	"
8	42.20	10-38-58-86	Meet 1-2-3
9	45.00	96-48	Meet 8 at culet
10	47.31	03-45-51-93	Adjust angle if needed

CROWN

A	51.00	24-72	Leave some girdle
B	42.50	23-25-71-73	Meet girdle line
C	35.00	19-29-67-77	"
D	44.00	10-38-58-86	Level girdle
E	39.40	03-45-51-93	Meet girdle line
F	42.19	02-46-50-94	"
G	61.00	96-48	Level girdle
H	38.31	07-41-55-89	Meet girdle line
J	35.82	14-34-62-82	"
T	0.00	Table	Table

In this lesson, we will cut a rectangular design called the Formée Cross Rectangle. For this design, we will need a Centerpoint Angle Method (CAM) preform. Briefly, this technique allows you to reproduce the girdle outline of the design without having to make any measurements. One cuts several facets to a common centerpoint, a meet point on the dop axis. This set of facets will be cut off later by the actual pavilion facets. One then cuts facets at 90°, making a level false girdle-line and establishing the outline of the stone.

Run GemCad. Change to the **Parameter Menu** and press the **Index gear (g)** key and set the index gear to 96. GemCad will ask you for the number of teeth and the bottom index position. Enter 96 for the number of teeth and 0 for the offset. This will make the 96 position at the bottom of the circle of numbers in the Top View. Next, change the symmetry to two-fold mirror-image with the **Symmetry (y)** command. Enter 2 and  $\gamma$  in response to GemCad's questions about the symmetry. Now we are ready to cut the first four facets. Change to the **Point Menu** and use the **Query user (q)** command. GemCad will ask you for the coordinates of the point. Enter 0, 0, 1 for the  $x$ ,  $y$ , and  $z$  coordinates, respectively. Enter  $\gamma$  to tell GemCad you want to use the point. You will see 1pt displayed in the status box. (Recall that if you make a mistake and the information in the status box is incorrect, you can clear it with the **Draw (d)** key in either the **Cut Facets Menu** or **Point Menu**.) Next, change to the **Cut Facets Menu** and press the **Index (i)** key. Enter 10. Now press the **Angle (a)** key and enter 33.4. GemCad will then cut four facets at index positions 10-38-58-86, and your display should look like Figure 20.

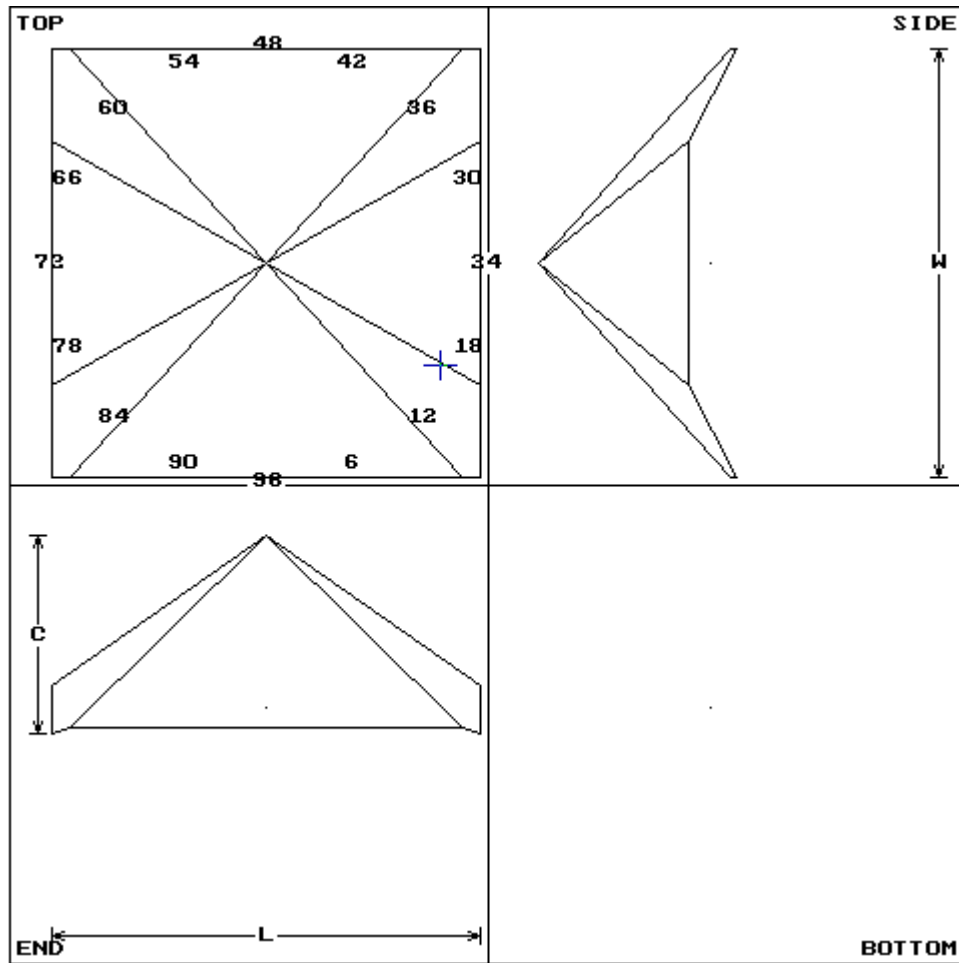


20. The start of the CAM preform

For many cuts, you can just enter the angle and index of the first set of facets, and GemCad will assume a "reasonable" cutting depth. Here, we typed in the coordinates of the centerpoint. Note also that it was necessary to enter this centerpoint *before* the angle and index. For some designs with high angle facets (about  $50^\circ$  or higher) the center point will be off the screen, and instead of a centerpoint you will see what looks like a facet at the top of the stone. GemCad starts off with a cube of rough a bit smaller than each view. The faces of this cube are not drawn, but all facets cut will be truncated at the faces of the cube.

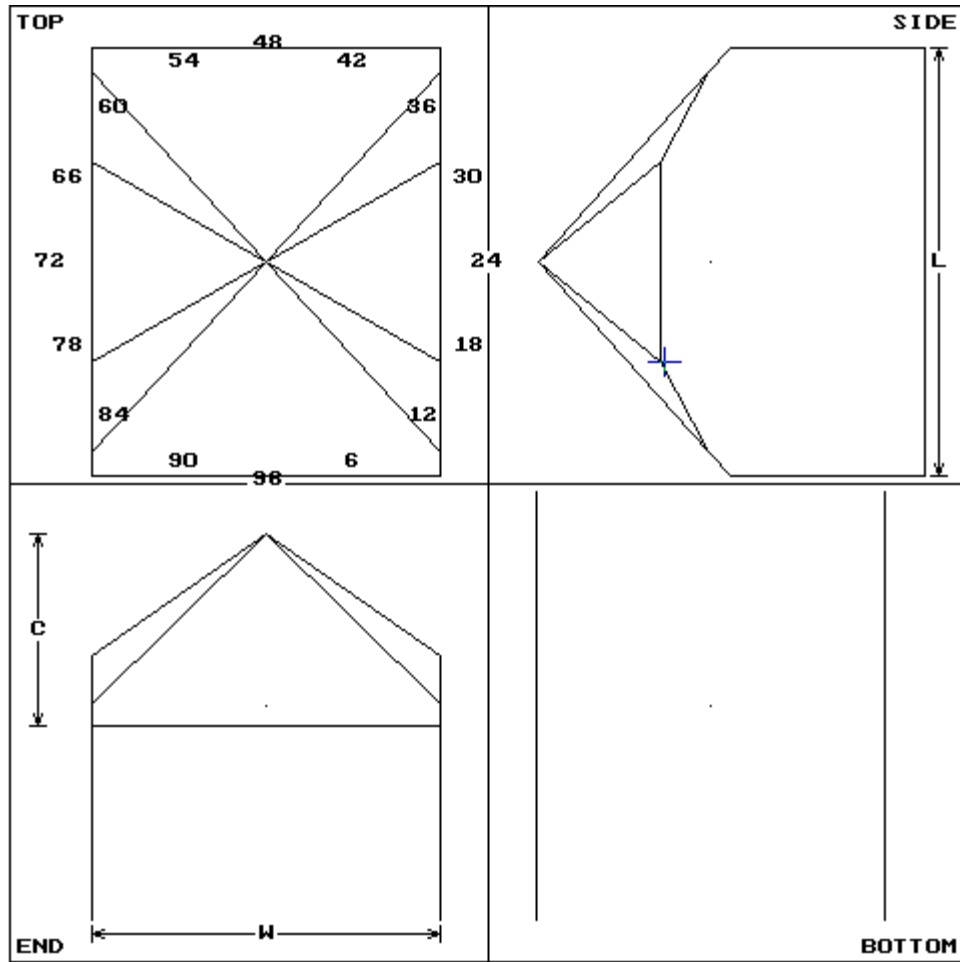
The four facets meet at the exact center of the Top View. This is the centerpoint to which the other facets of the preform will be cut. Now, change to the **Point Menu**. Move your cursor near the centerpoint, as shown by the crosshairs in Figure 20. Press the **Meet pt (m)** key (or the left mouse button) and enter  $y$  to tell GemCad you want to use the point. Now change to the **Cut Facets Menu**, press the **Angle (a)** key and enter 35. Then, press the **Index (i)** key and enter 24. GemCad will then cut two facets at 24-72, making a total of 6 facets. Now let's cut the last pair of facets cut to the common centerpoint. Press the **Index (i)** key and enter 96 (or zero). Press the **Angle (a)** key and enter 41.7. Verify that you have  $a41.7, i0.0$  displayed in the status box in the lower-left-hand corner of the screen. If so, change to the **Point Menu**. Move the cursor back to the centerpoint in the Top View, if it is not still there. Press the **Meet pt (m)** key. After you

enter/tt yto tell GemCad you want to use the point, GemCad should cut two more facets at 96-48., and your display should look like Figure 21.



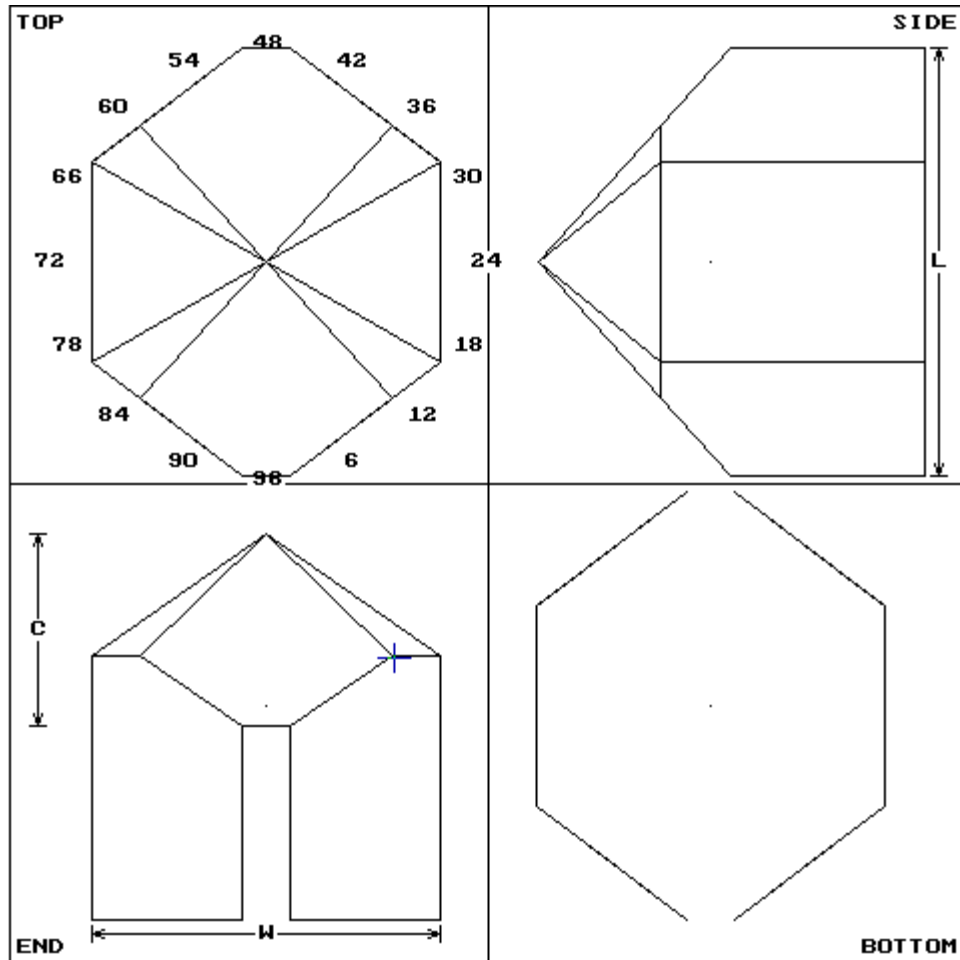
21. Facets cut to centerpoint for CAM preform

Now we are ready to cut the girdle facets at  $90^\circ$ . Move the cursor to the location of the crosshairs in Figure 21. Press the **Pt on edge (e)** key (or the right mouse button) and enter *y* to use the point. You should see *1pt* in the status box. Change to the *Cut* Menu, and we will explore a new command. Move the mouse cursor inside one of the facets in the Top View and press the **Jam index (j)** key. You will see the index show up in the status box just as if you had entered the index with the **Index (i)** command. Try it with several of the facets. Now, find the facet cut at 24 index and use the **Jam index (j)** key to "jam" its index in the status box. You should see *1pt, i24.0* displayed in the status box. Then, press the **Angle (a)** key and enter 90. GemCad will then cut the two facets at 24-72. Your display should now look like Figure 22.



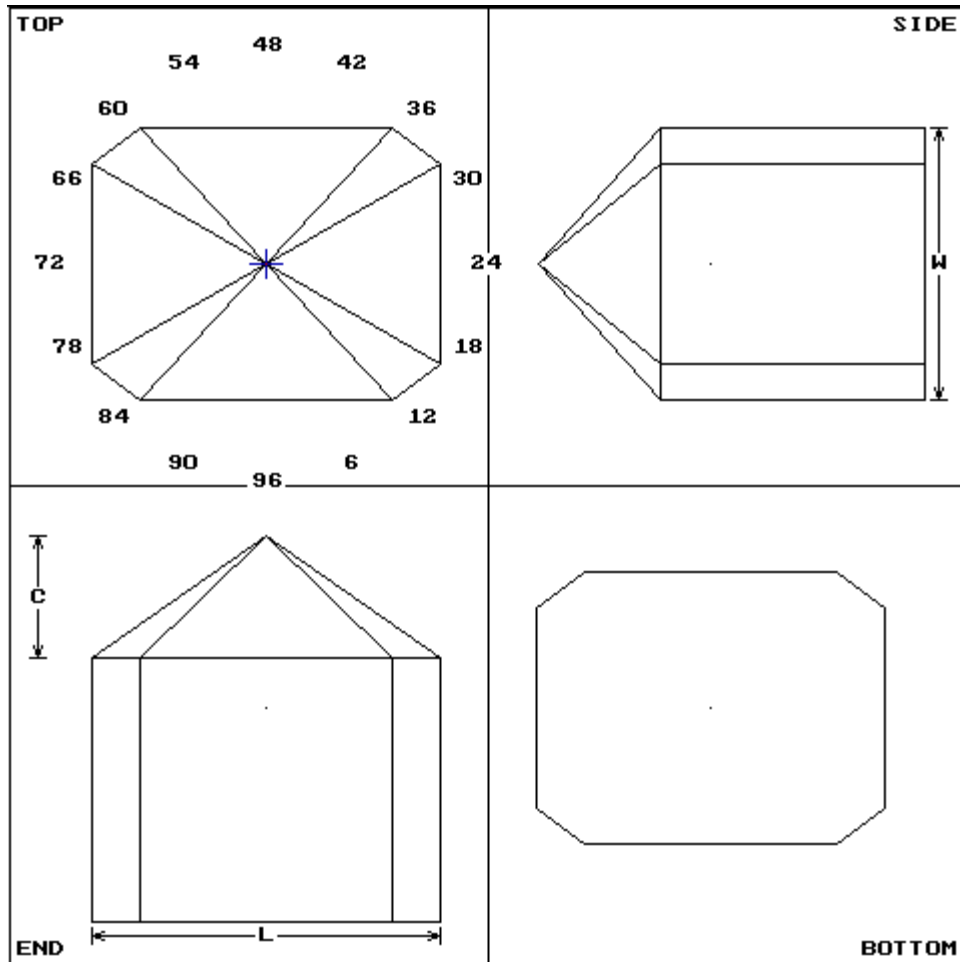
22. The length of the preform is now established

Now, move the cursor inside the facet at index 10. Use the **Jam index (j)** command to grab its index. (Keep trying until GemCad displays "i10.0" in the status box.) Now move the cursor inside the big facet at 90° in the Side View. Use the **Jam angle (A)** command to grab its angle. You should see a90.0, i10.0 displayed in the status box. Now change to the **Point Menu**, move your cursor to the point in the Side View as indicated in Figure 22. Press the **Meet pt (m)** key (or left mouse button) to pick the meet point and enter  $\gamma$  to tell GemCad to use the point. GemCad will then cut the four facets at 10-38-58-86, and your display should look like Figure 23.



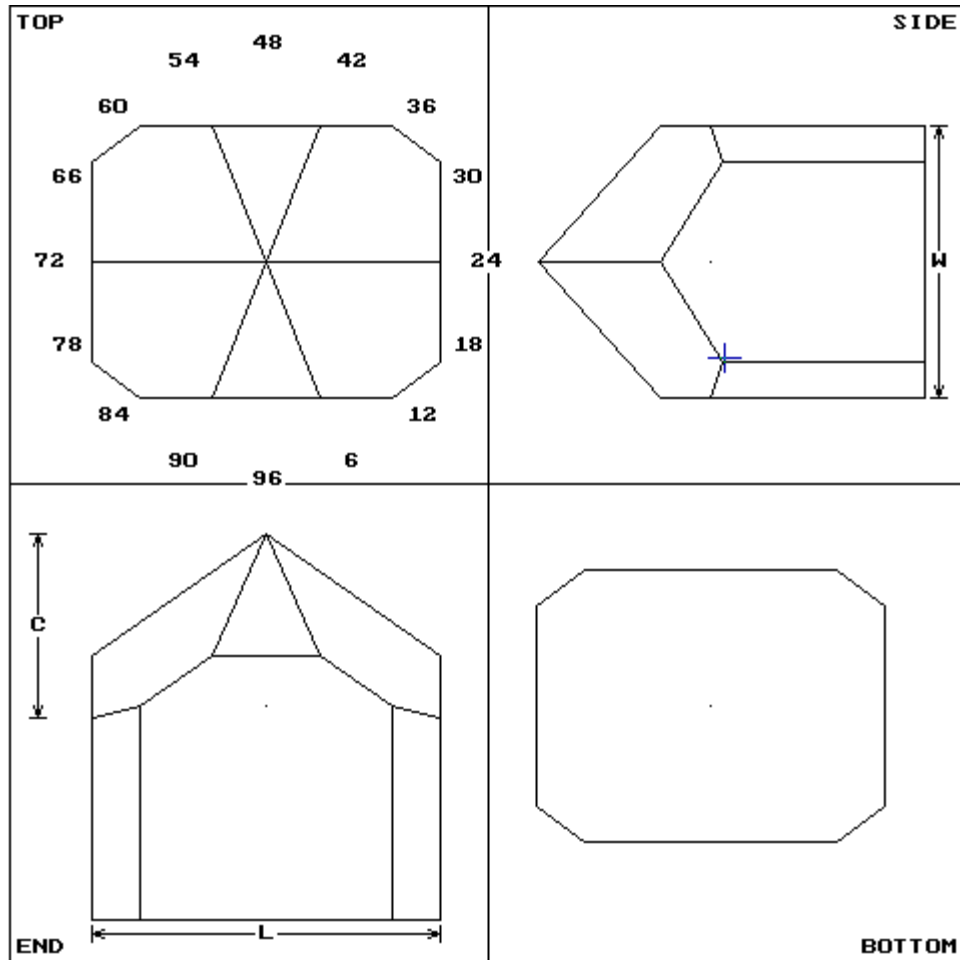
23. Corners cut off

Move the cursor to the point in the End View indicated by the crosshairs in Figure 23. Press the **Meet pt (m)** key (or left mouse button) to pick the meet point and enter  $\gamma$  to use the point. Change to the **Cut Facets Menu** and move the cursor inside the facet at the 96 index position. (Just a bit up and to the left of the position in Figure 23.) Use the **Jam index (j)** command to grab its index. You should see  $1pt, i0.0$  in the status box. (Recall that index position 0 is the same as 96.) Now move the cursor inside the girdle facet at the 10 index position (just below the position in Figure 23). Use the **Jam angle (A)** command to jam in its angle of  $90^\circ$ , and GemCad will cut the final two girdle facets at 96-48. This completes the CAM preform. Your display should now look like Figure 24.



24. The completed CAM preform

Next we will cut the actual pavilion facets. These will cut off the preform facets that meet at the centerpoint. Now we shall cut facets at index positions 13-35-61-83. Press the **Index (i)** key and enter 13. Press the **Angle (a)** key and enter 43. You should now see/tt a43.0,i13.0 in the status box. Change to the **Point Menu** and move the cursor to the centerpoint as shown in Figure 24. Press the **Meet pt (m)** key (or the left mouse button) and enter  $y$  to use the point. GemCad will cut 4 facets and tell you that 6 facets were cut off. You must press any key to acknowledge this warning. The 4 new facets cut off 6 of the CAM preform facets, and we will lose the other 2 later. Your display should look like Figure 25.



25. First four pavilion facets

Move the cursor to the location in the Side View shown in Figure 25. Press the **Meet pt (m)** key (or left mouse button) to enter the meetpoint and press enter  $\gamma$  to confirm. Change to the **Cut Facets Menu** and enter an angle of 46 and an index of 10. GemCad will cut the four facets at 10-38-58-86. Your display should look like Figure 26. From now on, I'll assume you are now sufficiently familiar with changing back and forth between the **Cut Facets Menu** and the **Point Menu** and know how to use the **Meet pt (m)** key command, the **Index (i)** key command, and the **Angle (a)** key command. The remaining instructions will be in outline form.

**Angle (a)** 45.81

**Index (i)** 7

Move cursor as shown in Figure 26.



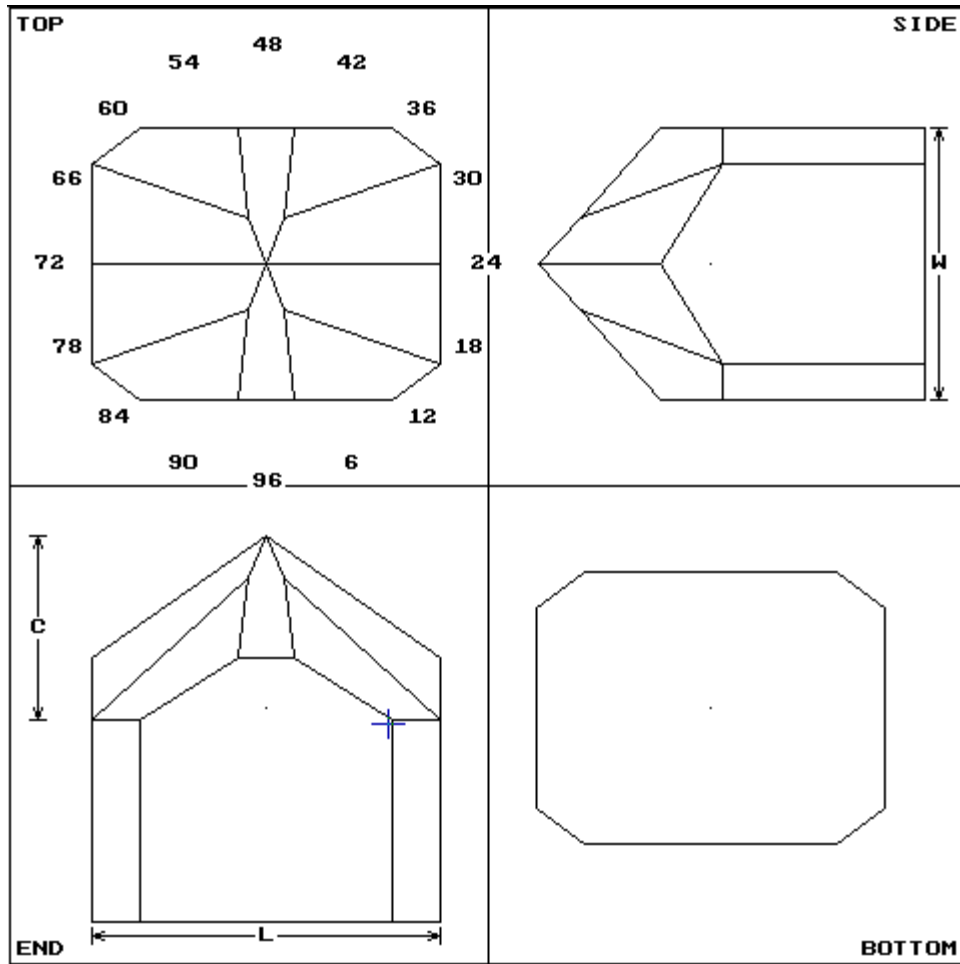


Figure 26.

Move cursor as shown in Figure 27.

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 62

**Meet pt (m)** and confirm with  $\gamma$

Four facets will be cut at 07-41-55-89, and display will look like Figure 27.

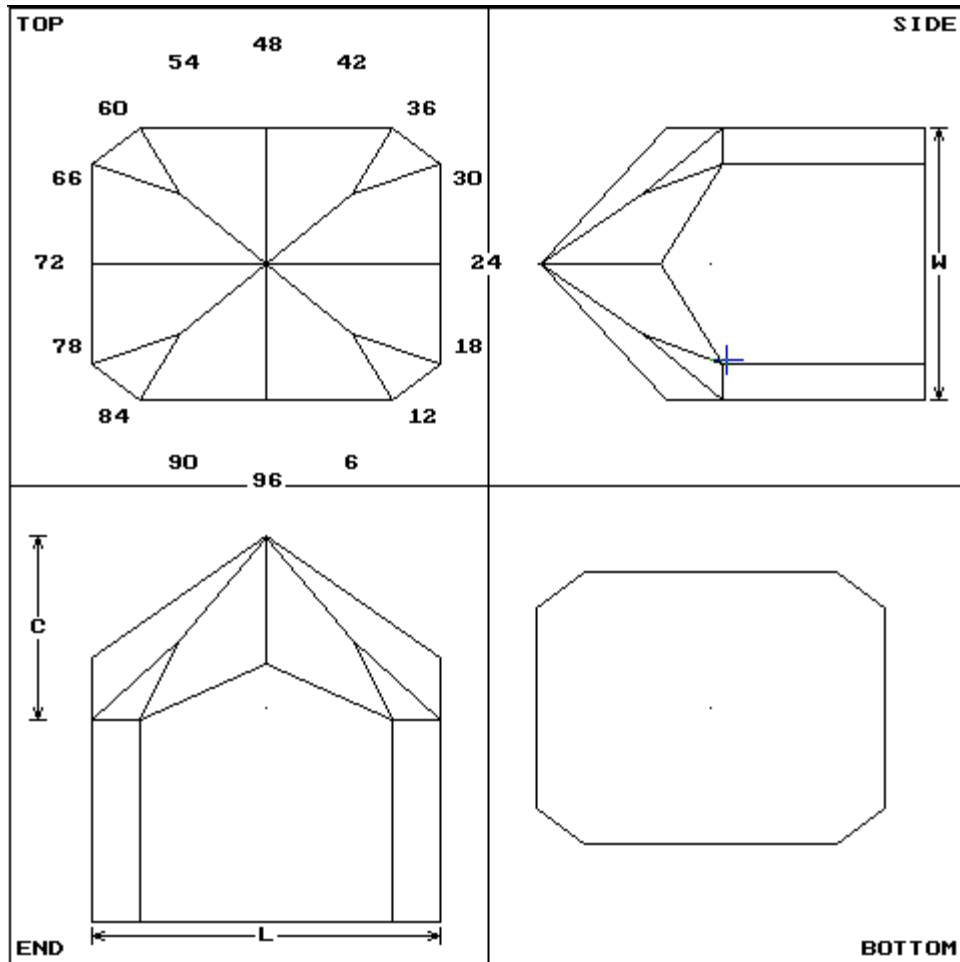


Figure 27.

Move cursor as shown in Figure 27.

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 62

**Index (i)** 24

Two facets will be cut at 24-72

**Angle (a)** 54

**Index (i)** 23

Move cursor as shown in Figure 27. (This is same point as used in the last step.)

**Meet pt (m)** and confirm with  $\gamma$

Four facets will be cut at 23-25-71-73, and your display will look like Figure 28.

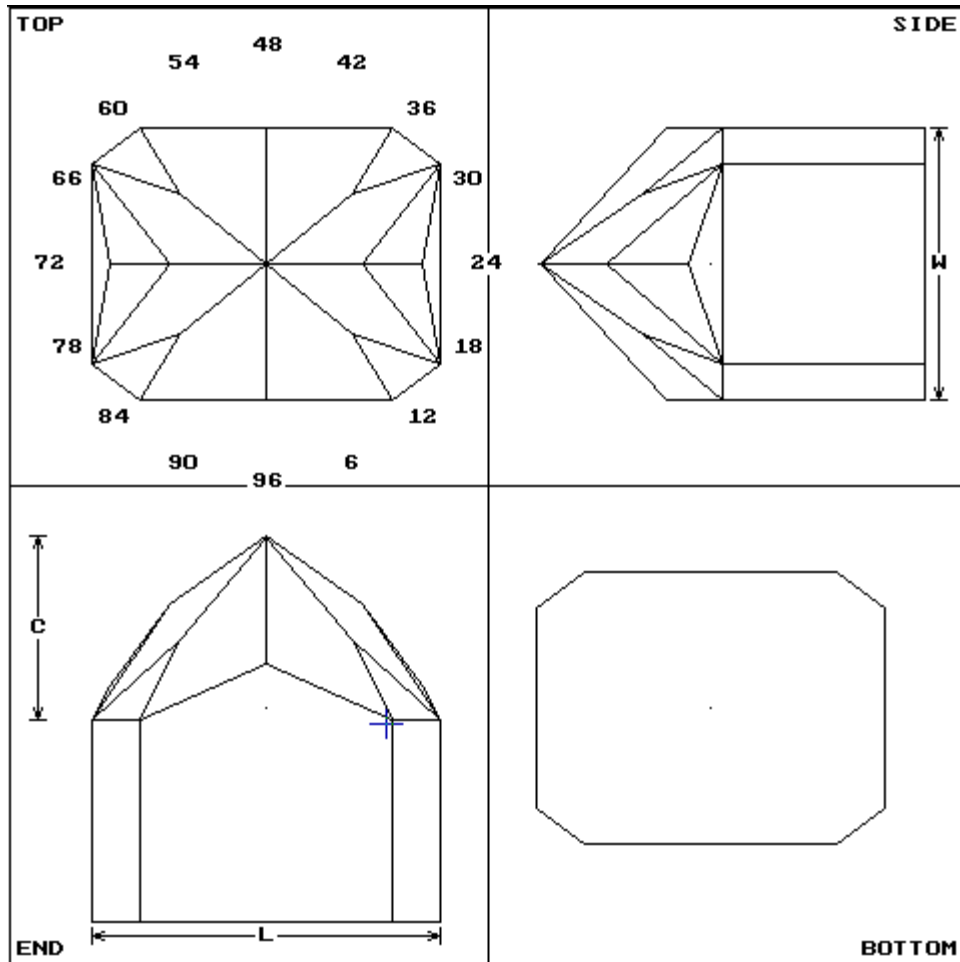


Figure 28.

Move the cursor as shown in Figure 28.

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 70

**Index (i)** 96

Two facets will be cut at 96-48.

Move the cursor to the same point as before (Figure 28).

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 60

**Index (i)** 1

Four facets will be cut at 01-47-49-95, and your display will look like Figure 29.

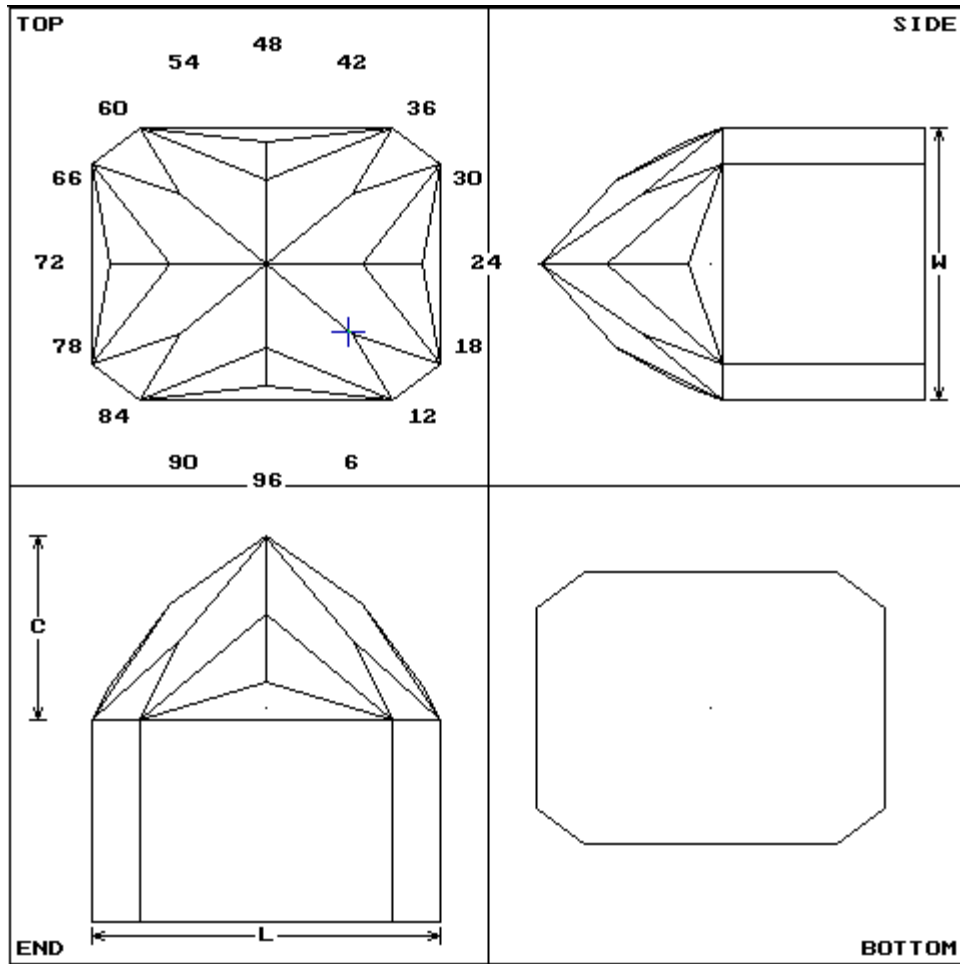


Figure 29.

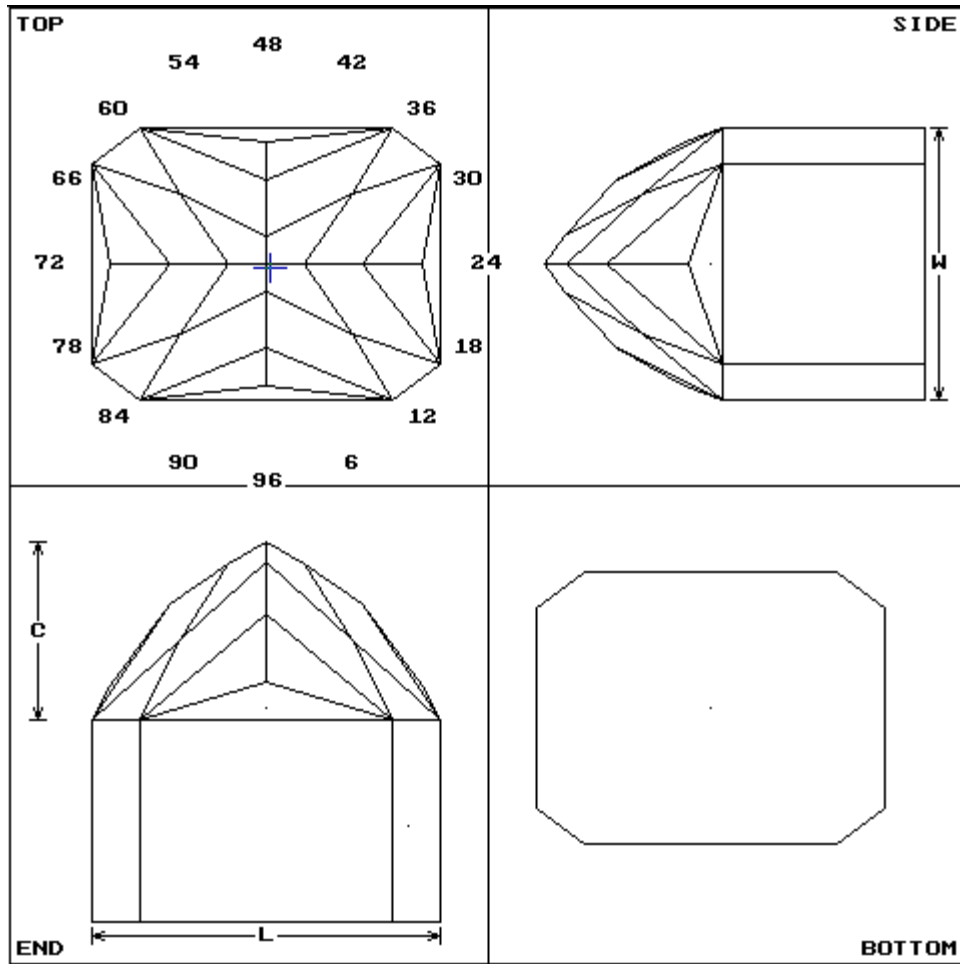
**Angle (a)** 42.2

**Index (i)** 10

Move cursor as shown in Figure 29.

**Meet pt (m)** and confirm with  $\gamma$

Four facets will be cut at 10-38-58-86. GemCad will warn you that these facets cut off the remaining CAM preform facets. Your display will look like Figure 30.



**Figure 30.**

Move cursor as shown in Figure 30.

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 45

**Index (i)** 96

Two facets will be cut at 96-48, and your display will look like Figure 31.

**Angle (a)** 47.31

**Index (i)** 3

Move cursor as shown in Figure 31.

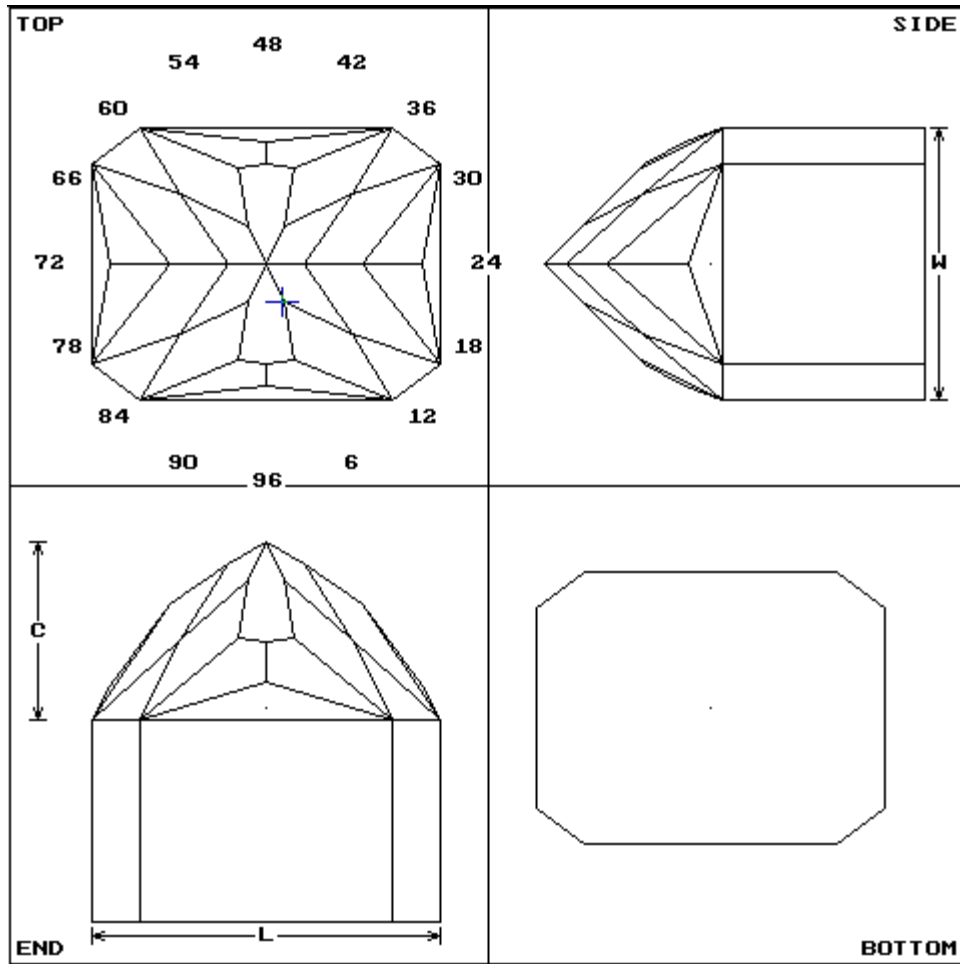


Figure 31.

**Meet pt (m)** and confirm with  $\gamma$

Four facets will be cut at 03-45-51-93.

This completes the pavilion. Change to the **Cut Menu** and press the **Xfer (x)** key to transfer the stone. Your display should look like Figure 32.

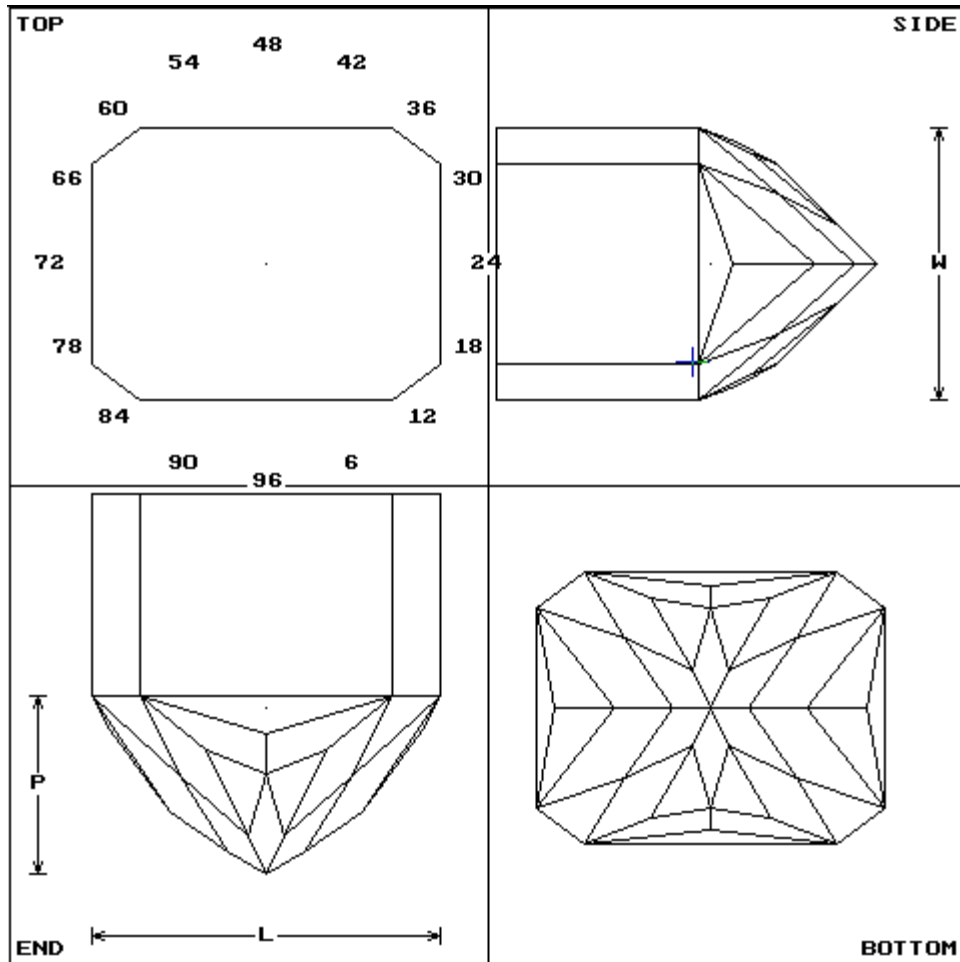


Figure 32.

Now we need to establish the thickness of the girdle. Move the cursor to the point shown in Figure 32. The cursor should be on the horizontal line in the Side View a bit to the left of the girdle line. Press the **Pt on edge (e)** key (or the right mouse button) and confirm with **y**. There should now be a vertical dotted line in the Side View, and this line should define the girdle thickness. If the girdle thickness is not correct, redraw with the **Draw (d)** key, and set the point again.

**Angle (a)** 51

**Index (i)** 24

Two facets will be cut at 24-72, and your display should look like Figure 33.

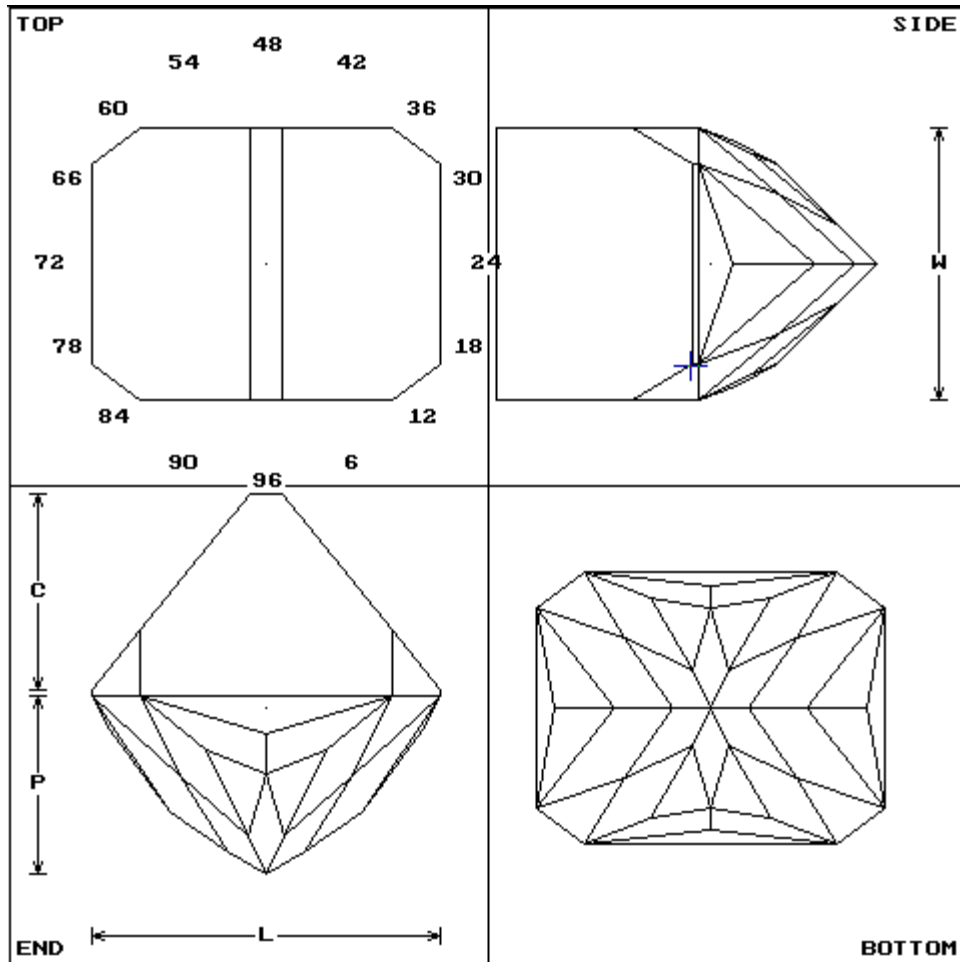


Figure 33.

**Angle (a)** 42.5

**Index (i)** 23

Move the cursor as shown in Figure 33. This meet point will be used for the next 3 steps as well.

**Meet pt (m)** and confirm with  $\gamma$

Four facets will be cut at 23-25-71-73.

Move the cursor back to the point shown in Figure 33 if it is not already there.

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 35

**Index (i)** 19

Four facets will be cut at 19-29-67-77.



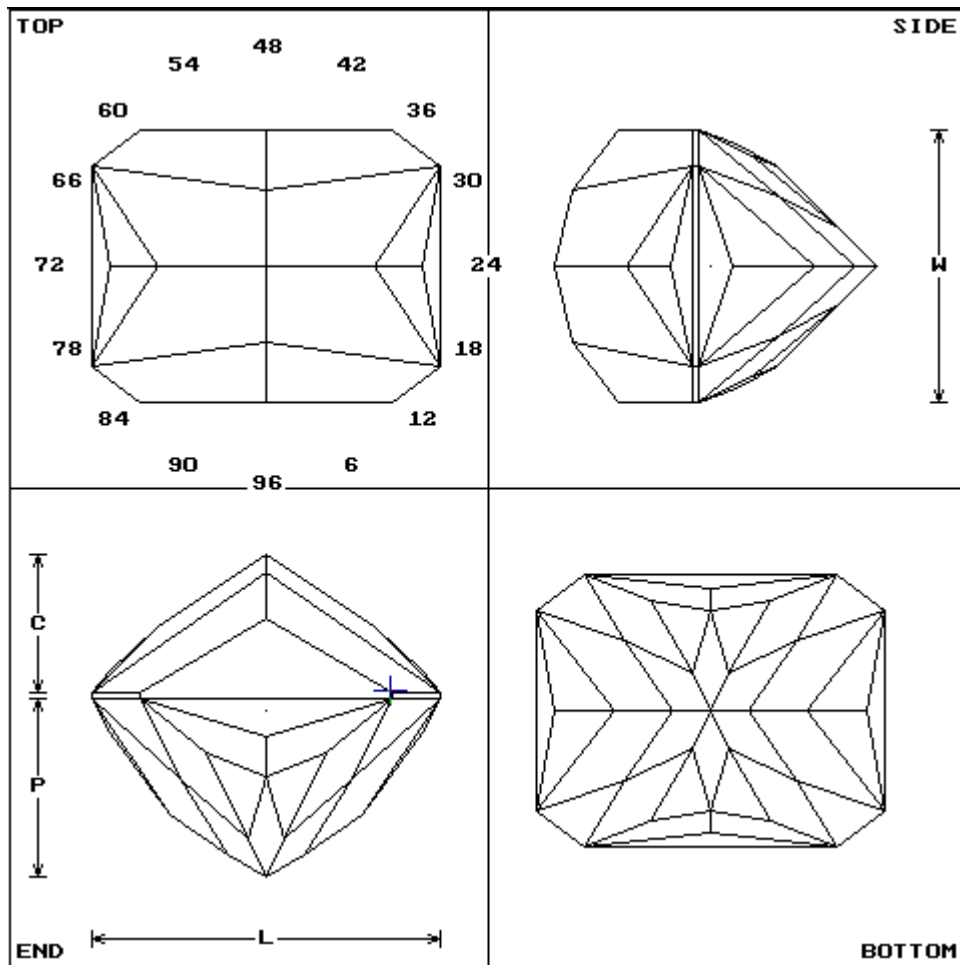
**Angle (a)** 44

**Index (i)** 10

Move the cursor back to the point shown in Figure 33 if it is not already there.

**Meet pt (m)** and confirm with  $\gamma$

Four facets will be cut at 10-38-58-86, and your display will look like Figure 34.



**Figure 34.**

Move cursor as shown in Figure 34.

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 39.4

**Index (i)** 3

Four facets will be cut at 03-45-51-93.

**Angle (a)** 42.19

**Index (i) 2**

Move the cursor back to the point shown in Figure 34 if it is not already there.

**Meet pt (m)** and confirm with  $y$

Four facets will be cut at 02-46-50-94.

Move the cursor back to the point shown in Figure 34 if it is not already there.

**Meet pt (m)** and confirm with  $y$

**Angle (a) 61**

**Index (i) 96**

Two facets will be cut at 96-48.

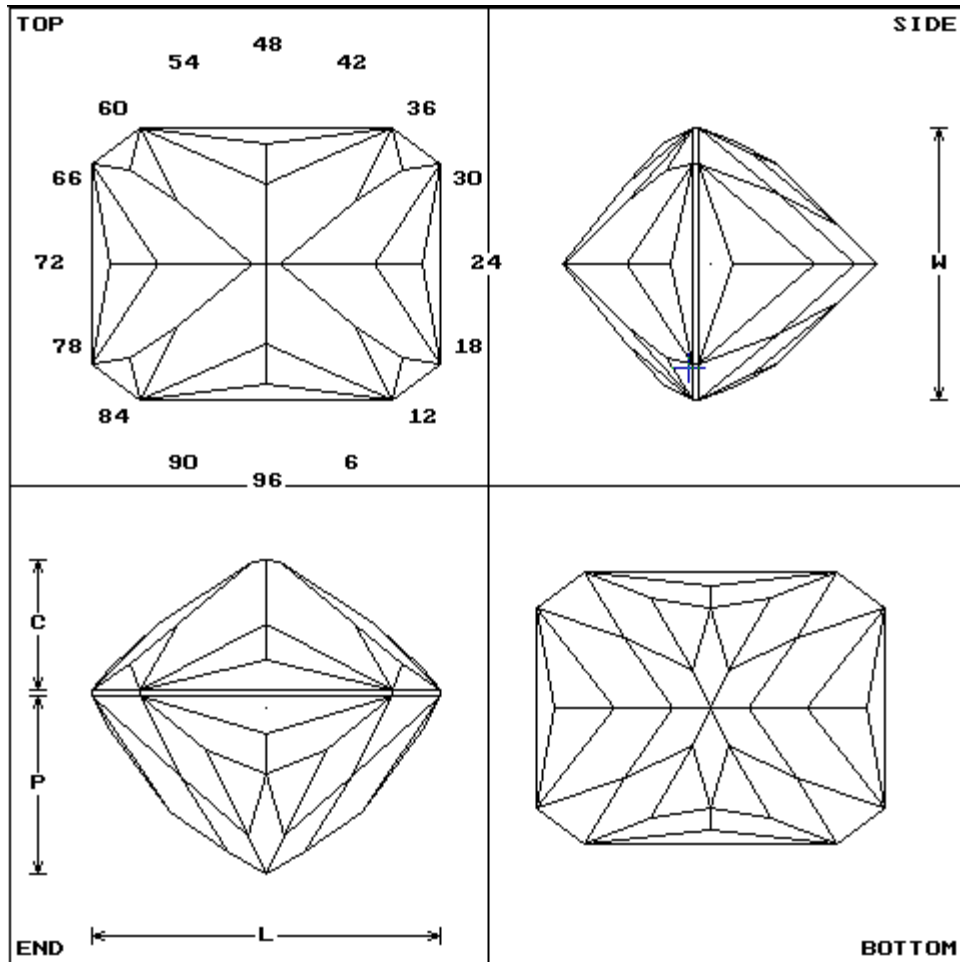
**Angle (a) 38.31**

**Index (i) 7**

Move the cursor back to the point shown in Figure 34 if it is not already there.

**Meet pt (m)** and confirm with  $y$

Four facets will be cut at 07-41-55-89, and your display should look like Figure 35.



**Figure 35.**

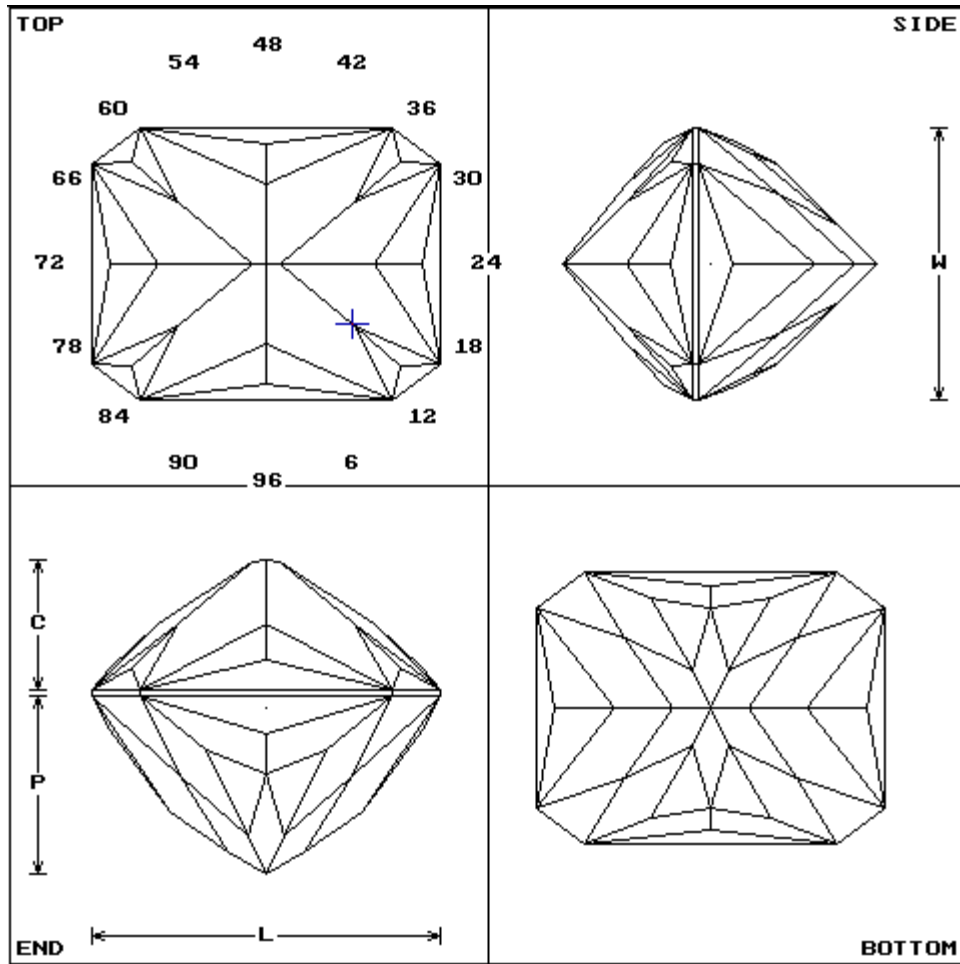
Move the cursor to the location indicated by Figure 35. (If you don't see it, look again; it's in the Side View near the girdle line.)

**Meet pt (m)** and confirm with  $\gamma$

**Angle (a)** 35.82

**Index (i)** 14

Four facets will be cut at 14-34-62-82, and your display will look like Figure 36. Now we are ready to cut the table.

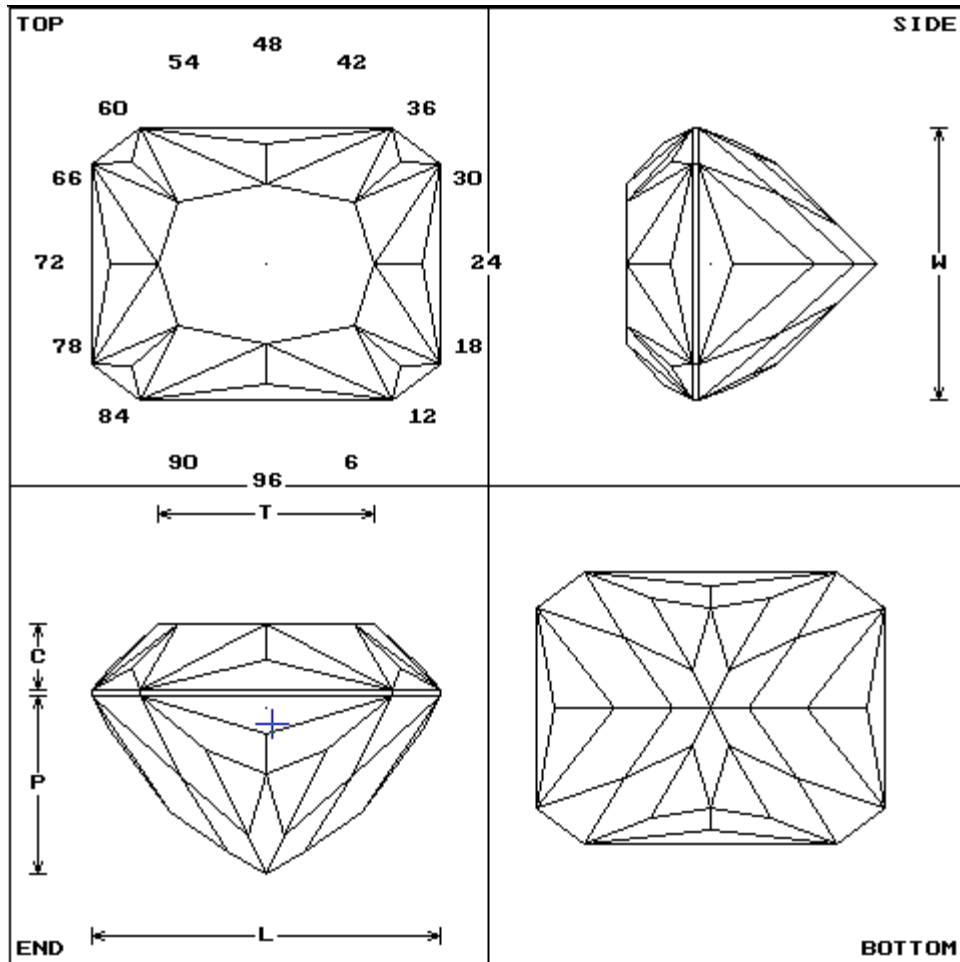


**Figure 36.**

**Angle (a)** 0 (There is no need to specify an index for the table.)

Move the cursor to the location shown in Figure 36.

**Meet pt (m)** and confirm with  $\gamma$



**Figure 37.**

GemCad will cut the table, and your display will look like Figure 37. The crown is now complete. The stone might appear too low in the End View, so let's move it up a bit. Change to the **Cut Menu** and move your cursor to the location shown in Figure 37. Press the **Center (c)** key, and GemCad will ask you whether you want to slide the stone along the *x*, *y*, or *z* axes. Enter *z*, and GemCad will scoot the stone up. (The *z* axis is the dop axis.) To use the **Center (c)** command, you place the cursor inside the stone in the End View at where you want the stone to be centered, press the **Center (c)** key, and enter *z*. If the cursor is below the center of the view, GemCad will move the stone *up* to make the center of the view at the height on the stone where your cursor was. The stone should be positioned as in Figure 38.

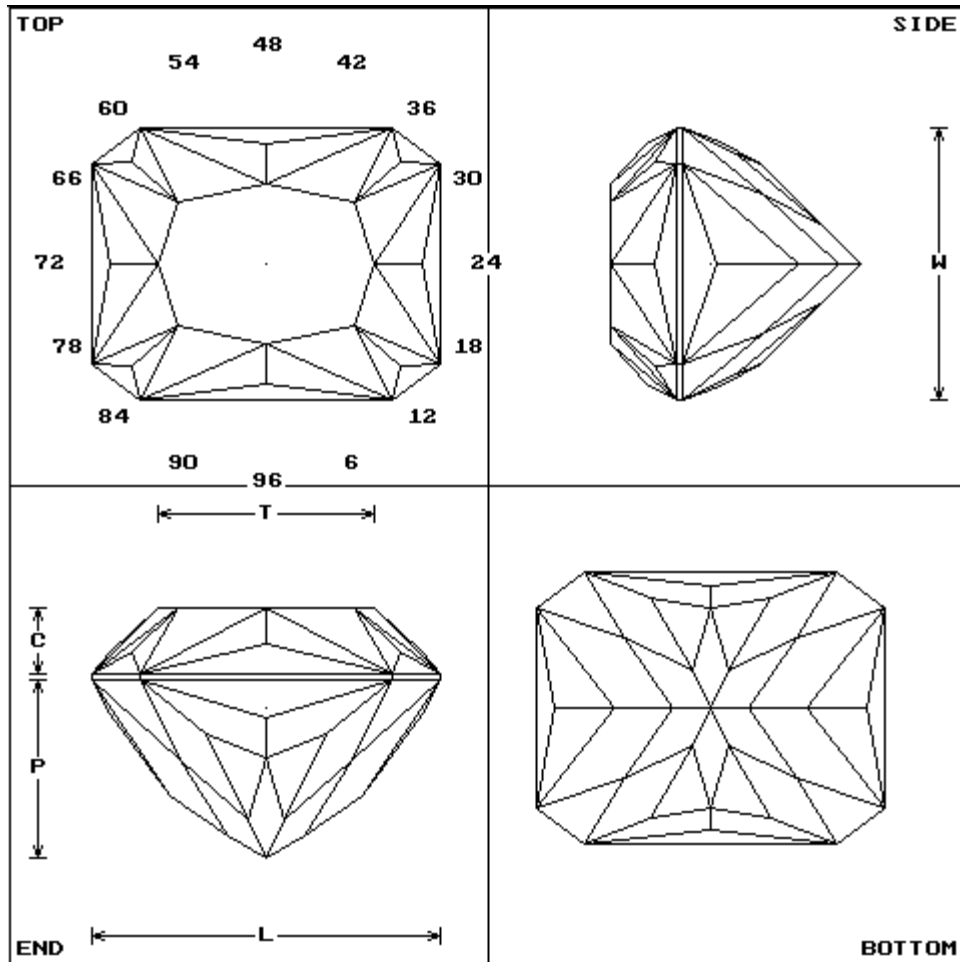


Figure 38.

Now, change to the **Diagram Menu** and let's name (label) the facets. Move the cursor inside one facet and press the **Name (n)** key. GemCad will highlight the facet and ask you for its name. Do this for each facet in turn. (To name a girdle facet, you must be inside the girdle facet in the Side or End View. Its name will be shown in the Bottom View, however.) Now press the **List to screen (l)** key to view the cutting sequence. Check to make sure each step has its name in the left column of the listing. If you wish, you may add cutting instructions for each step with the **Gloss (inst) (G)** key. The **Heading (H)** key command allows you to enter a heading of up to four lines. This is used to provide a title, designer, and date. The heading will show up at the top of the listing. The completed design should look like Figure 39.

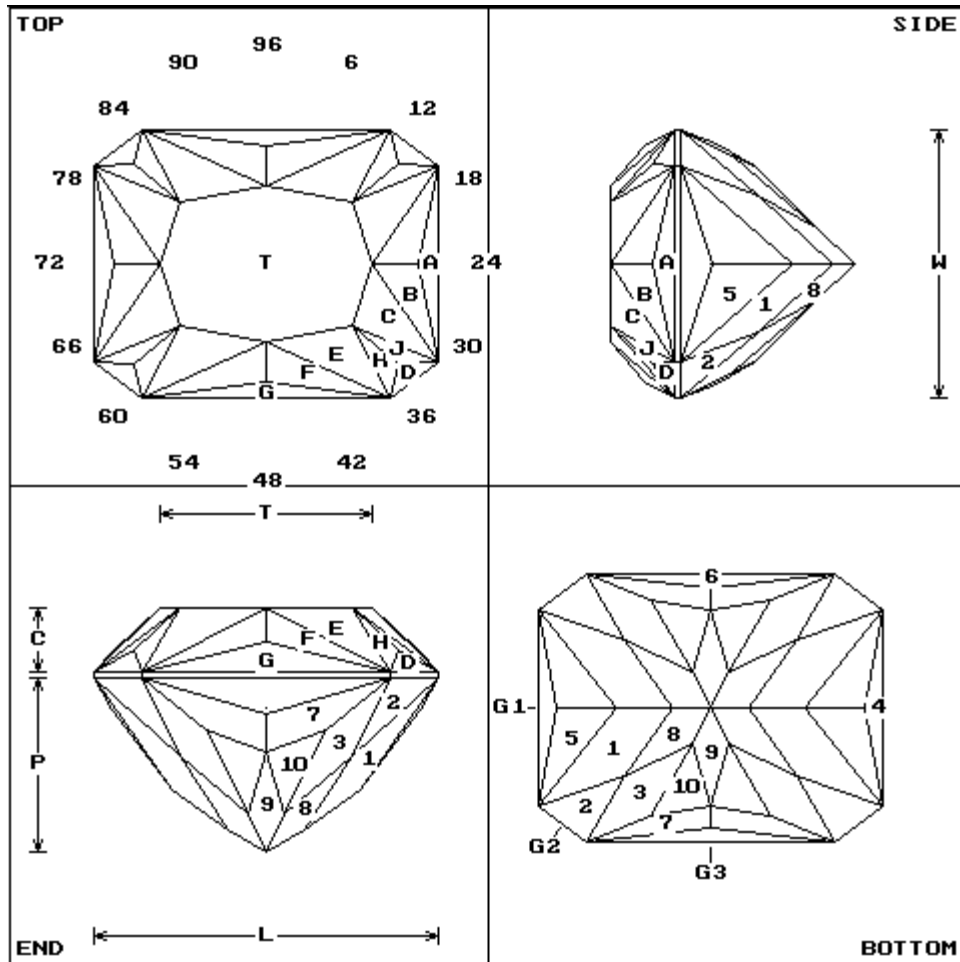


Figure 39.

I suggest that you try to cut the Formée Cross Rectangle from the faceting diagram included in the center of this manual. Once you can cut the design from the faceting diagram without referring to the manual, you should be well prepared to cut from other published diagrams.

This completes the tutorial section of the manual. The next section is a reference manual that describes each GemCad command in detail.

## GemCad Reference Manual

### The File Menu

The commands in this menu are to read and write disk files. GemCad deals with three types of files. There are a pair of commands to read and write each type.

\command{\bOpen (O)}Open an existing project: read from a binary file

The **Open (O)** command is used to open an existing GemCad project file. Such a file is a binary file saved previously with the **Save (s)** or **Save as (S)** command. GemCad will prompt you for

the name of the file. You may either type in the file name or just press the `Enter` key to use the file picker. If you type in the file name, the file must be in the current directory, or a full or relative path must be given (such as `C:\CUTS\bril.gem` or `..\QUARTZ\cut.gem`). If there are already facets cut, GemCad will ask permission to trash them before asking you for the file name.

If you press the `Enter` key to use the file picker, GemCad will print a list of all of the files in the current directory whose extension begins with "G." Subdirectories of the the current directory are also shown. The list of subdirectories follows the list of files. You can distinguish the two because directory names are followed by the `\` backslash character. The directory `..\` is the parent of the current directory.

One of the selections will be in reverse video and will have a small arrow to its left. You may use the cursor keys or mouse to change which item is highlighted. You make a selection by pressing the `Enter` key or a mouse button. If you select a file name, GemCad will try to open the file. If you select a directory, GemCad will change to the new directory and display all of the files matching the wildcard and all of the subdirectories in the new directory. (A wildcard is a pattern that matches file names with certain characteristics.) There is also a special selection labeled `file spec`. This allows you to change disk drives or the wildcard. The default drive is the drive where you were when you started the program. The default wildcard `*.G*` matches any file name whose extension starts with G. The `?` character matches any one character, and the `*` matches an arbitrary string of any length.

If you get into the file picker by accident, you can abort by pressing the `ESC` key or by selecting empty space. This leaves the previous design intact. If you select a directory, it becomes the new working directory.

`\command{Save (s)}` Save the project as a binary file with the existing project name

The **Save (s)** command saves the design to disk as a binary file. If the project doesn't yet have a name, GemCad will ask you for one. The name must be a valid DOS file name (eight or fewer characters and an optional three character extension). If you don't provide an extension, GemCad will automatically add `.GEM` to the end. If you don't want an extension, end the file name with a period. Note that an extension beginning with G will make the file picker much easier to use.

The binary file is not readable by a human (you'll get hearts and clovers and all sorts of stuff if you type it), but can be read quickly by GemCad. If the file you specify already exists, GemCad will ask your permission to write over the file.

`\command{Save (s)as}` Save the project as a binary file with a new project name

The **Save as (S)** command is similar to the **Save (s)** command, except that GemCad will prompt you for a file name even if the project already has a name.

`\command{New (N)}` Begin a new cut: TRASHES EXISTING PROJECT

The **New (N)** command is used to start over from scratch. This command deletes all facets. GemCad will ask your permission to trash the existing design before it does so.



\command{**Read (R)**Read a project from a text file (such as made by the W command)

The **Read (R)** command reads the project from an ASCII text file such as made by the **Write text (W)** command. If facets have been cut already, GemCad will ask you for permission to trash them. This command can be slow if your machine doesn't have a numeric co-processor. See the **Write text (W)** command for details about the file format.

\command{**Write text (W)**Write the project as a text file

The **Write text (W)** command is used to write the project as an ASCII text file. GemCad will prompt you for the name of the ASCII file. If you don't supply an extension, GemCad will add .ASC to the name.

The **Write text (W)** command makes a file that is free format.

The ASCII files have two main uses. The first is to archive designs. The ASCII files have no information about the vertices that make up the facets but only have information about the plane of each facet. This means that the ASCII format is very compact. The other main use is to extend--or subvert--the capabilities of GemCad. You can edit the resulting file with a text editor or word processor, make changes, and then read it back in again with the **Read (R)** command. You can use this technique to combine the pavilion and crown from separate files. The text file has one line per tier of facets (unless there are more than 16 facets on one tier). With a text editor, you can interchange lines to alter the cutting order.

A text editor is a program that allows you to make changes to text files. Text editors differ from word processors in that they don't add any formatting information to the file. The EDLIN program that comes with all versions of MS-DOS and the EDIT program that comes with DOS 5.0 are examples of text editors.

\command{**L&S import (M)**Import project from a Long & Steele format file

The **L&S import (M)** command reads a project from a file compatible with the programs written by Robert Long and Norman Steele. Long and Steele have compiled a vast library of facet designs, and GemCad can import these files directly. These files are text files and have names that typically end with the .P3D, .C3D, or .B3D extensions (for pavilion, crown, or both). GemCad will prompt you for the name of file. If you just press the Enter key, GemCad will bring up the file picker with the wildcard \*.?3D. It will then scan the file and draw the stone on the screen. Next, GemCad will prompt you for the symmetry of the stone just as in the **Symmetry (y)** command.

GemCad will name each tier with a number in the same order as it appeared in the data file. GemCad will make the I.D. position of the index gear at the top of the screen. If the stone is longer than tall, you might have to scale it down with the **Scale (X)** to make it fit on the screen. GemCad will print an error message if it encounters a facet with less than three sides. Any error messages pertaining to the data file will begin with the line number in the data file at which the error was encountered.

\command{**L&S export (E)**Export project to a Long & Steele format file

The **L&S export (E)** command makes a disk file compatible with the programs written by Robert Long and Norman Steele. GemCad will prompt you for the name of the data file. The name you enter should end with the .P3D, .C3D, or .B3D extension depending on whether your design is just a pavilion, just a crown, or both pavilion and crown, respectively. If you don't supply an extension, GemCad will add .B3D to the name.

There are several caveats to this translation process. The names of facets and the refractive index will be lost, and the cutting order will be changed to make the crown first in the data file. The orientation of the index gear will be changed to I.D. position at the top since that is the orientation that the Long & Steele programs expect, but the direction of indexing will be preserved. The  $z=0$  plane will be made to coincide with the girdle line. This command might take a long time on machines without numeric co-processors.

`\command{Quit (Q)}`Quit GemCad

The **Quit (Q)** command is used to exit GemCad. You can also use the `ESC` key to quit. If you have not saved the current design since making a change or addition, GemCad will ask you if it is OK to quit anyway.

`\command{Help (h)}`Print out help for next command instead of doing next command

The **Help (h)** command shows up in every menu. The **Help (h)** command prints out a one- or two-line description of the next key that you press. The command corresponding to the key you press is not executed, however.

`\command{Print Screen (F12)}`Print what's on the screen

Function key `F12` performs a screen dump. (If your keyboard does not have `F12` or it doesn't work, you may use `Shift-F2` instead.) This command shows up in every menu. This print screen function is completely independent of ordinary keyboard key labeled `Print Scrn` that invokes the DOS print screen function so it is *not* necessary to load the `GRAPHICS.COM` program for the `F12` screen dump to work. GemCad supports IBM compatible dot-matrix printers and Hewlett-Packard LaserJet and DeskJet printers. See the configuration section of this manual to find out how to specify the printer type.

`\command{{Crosshairs (Spacebar)}`The spacebar draws or erases the dotted crosshairs across the screen that intersect at the cursor.

The `Crosshairs (Spacebar)` command doesn't show up in any menu but is always available. The crosshairs are convenient for lining things up vertically or horizontally. It also serves to tack down the cursor if you use the mouse to pick items from the menu bar. If the command you plan to use requires a point, you can tack down the cursor with the spacebar. Then when you select the item from the menu bar, GemCad uses the location of the crosshairs and does not ask you to set a point.

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## The Cut Facets Menu

The commands in this menu are for cutting new facets. The basic philosophy behind the cutting of new facets is that GemCad will cut a tier of facets as soon as you have given it enough information to specify one of the facets of a tier. (Facets on the same tier are cut at the same angle and depth and have indexes related to each other through the symmetry of the stone.) The section on the **Symmetry (y)** command gives more information on symmetry.

To determine the plane of a new facet, GemCad needs three pieces of information. There are several different combinations of three pieces of information that will determine the plane of a new facet:

One point, the index, and the angle

Two points and the index

Two points and an angle of 90°

Three points

The commands in this section allow you to give GemCad the angle or index of a facet to be cut. GemCad will cut the facet immediately after you give it the last piece of information needed to specify the facet. Sometimes you might not recall what information you have already specified. The status box in the lower-left-hand corner of the screen shows a summary of the information GemCad has for new facets. There are fields for the angle, index, and the number of points entered so far. If you have not given GemCad any information about a new facet, GemCad will display in the box the number of facets cut so far. To correct information in this field, the **Draw (d)** command will redraw the stone and clear this field and cause any pending information about new facets to be discarded.

`\command{Angle (a)`Set the angle of a new facet

GemCad will prompt you at the top of the screen for the bearing angle (in degrees) of the new facet. Pressing the `Enter` key without entering an angle will abort the command. To correct an incorrectly entered angle, simply repeat the command and enter the correct angle. The new angle will replace the old.

`\command{Jam angle (A)`Set the angle of a new facet to be the same as that of the facet surrounding the cursor

GemCad will search its database of facets and will find the facet surrounding the cursor. It will then duplicate the angle as if you had entered it with the **Angle (a)** command. This can be quite convenient when cutting step cuts with lot of facets cut at the same angle.

`\command{Index (i)`Set the index of a new facet

GemCad will prompt you for the index. Indexes may be fractional. Pressing the `Enter` key without entering an index will abort the command. To correct an incorrectly entered angle, simply repeat the command and enter the correct index. See the **Index gear (g)** command to find out how to change the number of teeth on the index gear.

`\command{Jam index (j)`Set the index of a new facet to be the same as that of the facet

surrounding the cursor

GemCad will search its database of facets and will find the facet surrounding the cursor. It will then duplicate the index as if you had entered it with the **Index (i)** command. This can be quite convenient when cutting step cuts.

\command{**Change (C)**Change the facet surrounding by the cursor: next new facet will replace it

The **Change (C)** command is used to recut a tier of facets. It is similar in action to killing a tier of facets with the **Kill tier (K)** command and then recutting the facet with two exceptions. First, the index of the old facet is rounded off to the nearest integer, and entered just as if you had entered it with the **Index (i)** command. (The index can then be changed to something else with the **Index (i)** command.) Second, after the new tier of facets is cut, the cutting order remains the same. (Killing a tier and cutting it again makes the new tier last in the cutting order.) The change command disables several other commands. The auto-backup feature is turned off until the facets are recut. Thus, the **Undo (u)** command will get you back to the point just before you executed the change command regardless of any other changes to the stone. Only one tier of facets may be changed at a time.

When a change is pending, an asterisk \* will follow the index printed in the status box in the lower-left-hand corner of your display. If you discard the index with the **Draw (d)** command, GemCad will print the previous index in parentheses in the status box.

A problem can arise if you are cutting a design that has mixed symmetry, that is, some tiers of facets are cut with one type of symmetry and others are cut with another type of symmetry. GemCad does not keep track of which facets were cut with which symmetry setting. So, if you use the **Change (C)** command to change a tier of facets, make sure you set the symmetry properly for the changed tier.

\command{**Draw (d)**Draw the stone again, discard set points

The **Draw (d)** command is used to redraw the stone. As you cut new facets, GemCad only redraws the facets that change. Sometimes in the process of redrawing, facet labels (see the **Name (n)** command) and index labels can become partially erased. Redrawing the stone cleans up the display. The **Draw (d)** command also discards any pending information about facets to be cut (angle, index, or points) and clears the status box in the lower-left-hand corner of the screen. Thus, the **Draw (d)** command is also useful for correcting input errors.

The **Draw (d)** command also places dimension lines on the drawing of the stone. Each dimension is given by a single character L, W, P, C, or T corresponding to the length, width, pavilion, crown, and table. The relative values of these dimensions are listed with the **List to scrn (l)** or **List to file (L)** commands. If a facet is changed or a new facet is cut that changes the dimensions of the outline or table, the dimension lines will *not* be updated on the screen until the **Draw (d)** command is executed.

\command{**Zoom (z)**Zoom in on the view surrounding the cursor or zoom back out again

The **Zoom (z)** command enlarges the view containing the cursor to fill the entire screen. The zoom command toggles between two magnifications--the command doesn't do arbitrary

magnifications. If one view fills the screen, the zoom command will zoom back out to the four views.

\command{**Undo (u)**Undo the last command that changed the stone

The **Undo (u)** command undoes the most recent change to the stone. Before each change to the stone, GemCad saves the stone to disk in a file called `gemcad.bak` in the current directory. The undo command simply reads in this file. Undo only undoes the previous command--repeated undos have no effect. If you are running the program off a diskette, it must not be write-protected. If you exit GemCad without saving the changes with the **Save (s)** command, if (forbid!) the program crashes, you have a power failure, or if your toddler pushes the red button on your tower system, you can get back to one step before the disaster by restarting the program and pressing the **Undo (u)** key as the first command.

---

### The Point Menu

The following commands are used to set points that will be used to cut a new tier of facets. Whenever you enter one of the point commands, GemCad will draw cross-hairs intersecting at the point you specified. (If the command picks a point relating to facets already cut, there might be a slight delay while GemCad does the search.) GemCad will then print the coordinates of the point and ask you if you want to use the point (as a piece of information for the cutting of a new tier of facets) or discard it. Any answer beginning with `y` will be taken as yes, and anything else (including just the `Enter` key) will be taken as a no. If you are using a mouse, the left button is equivalent to a `y`, and the right button is equivalent to the `Enter` key. Thus, pressing the left and then the right buttons is equivalent to a yes response, and pressing just the right button is equivalent to a no response. The number of points set so far is displayed in the box in the lower-left-hand corner of the screen. The following section describes each point command in detail.

\command{**Meet pt (m)**Set a point of a new facet at the existing meet point nearest cursor

GemCad will search its database of vertexes (meet points of three or more facets) and find the one nearest the cursor in the "Manhattan sense" (sum of vertical and horizontal distances). The cursor will "snap" to the meet point and GemCad will ask you if you want to use the point. Since the exact meet point is determined by the equations for the planes of the facet, the point is set to much finer precision than the resolution of the display you are using. When the cursor is visible, the left mouse button is equivalent to the **Meet pt (m)** command.

\command{**Pt on edge (e)**Set a point of a new facet on the edge of an old facet nearest cursor

GemCad will search its database of edges of facets (the intersections of two facets) and find the one nearest the cursor in a vertical or horizontal direction. The cursor will snap vertically or horizontally on the screen to the nearest edge, and GemCad will print the  $x$ - $y$ - $z$  coordinates of the point and ask you if you want to use the point. Only one of the  $x$ - $y$ - $z$  coordinates depends on the screen resolution; the other two depend on the equations of the two facets that form the edge. When the cursor is visible, the right mouse button is equivalent to the **Pt on edge (e)** command.

`\command{Pt on facet (f)}`Set a point of a new facet on the interior of an old facet at cursor

GemCad will search its database of facets and determine which facet surrounds the cursor. GemCad will then project the line of sight through the cursor and calculate the point of intersection of this line and the facet. GemCad will print the  $x$ - $y$ - $z$  coordinates of the point and ask you if you want to use the point. Since GemCad determines two of the three coordinates from the cursor position, the resolution of this command is limited to that of your particular display. Even with CGA resolution, however, this is seldom a serious limitation unless cutting designs with small "floating" facets. When the cursor is visible, the center button on a three-button mouse or pressing both buttons of a two-button mouse are equivalent to the **Pt on facet (f)** command.

`\command{Z-axis incpt (Z)}`Set a point where the plane of the facet surrounding the cursor intersects the  $z$  (dop) axis. }

This command is useful if you are cutting several facets to a common centerpoint. It's also an easy way to cut two facets at the same angle and mast height. Place the cursor inside an existing facet. If the facet encloses the centerpoint of the Top View, GemCad will pick this point of intersection. Otherwise, GemCad will project the plane of the facet and compute the point of intersection with the  $z$  (dop) axis. GemCad will ask you if you want to use the point.

`\command{Pierce zero (p)}`Set a point of a new facet where the cursor pierces the zero plane

This is the probably the most difficult of the point commands to understand, but it is seldomly used. Each of the four views shows a projection of the stone onto one of the three coordinate planes. The Top View is the projection of the stone onto the  $x$ - $y$  plane. (The  $z$  axis is the axis of rotation of the dop.) In the Top View, the  $p$  command will set the  $x$  and  $y$  coordinates to those of the cursor, and the  $z$  coordinate will be set to zero. In the End View, the **Pierce zero (p)** command sets the  $x$  and  $z$  coordinates, and the  $y$  coordinate is zeroed. In the Side View, the **Pierce zero (p)** command sets the  $y$  and  $z$  coordinates, and the  $x$  coordinate is zeroed. As with the other point commands, GemCad will draw cross-hairs, print the  $x$ - $y$ - $z$  coordinates of the point and ask you if you want to use the point.

The **Pierce zero (p)** command is useful for making a preform from a sketch. One method is to sketch or photocopy a sketch of the stone on a transparency and tape it to your screen. Zoom in on the Top View (with the **Zoom (z)** command) and center the dop axis on the dot at the center of the Top View. The sketch should have the girdle outline divided into line segments. Enter an angle of 90 degrees and set two consecutive points on the girdle outline with the **Pierce zero (p)** command. GemCad will cut the resulting facet. If you go all the way around the girdle outline in this fashion, you will cut a preform of girdle facets at 90° with the same outline as your drawing.

The indexes of the resulting facets will not be whole numbers, however. You can use the **Change (C)** command to change the index of each facet to a whole number. You then cut facets around the stone to a temporary center point, working in the Side and End Views. These facets must be at the same indexes as the girdle outline facets to make a level girdle. (You can use the **Jam index (j)** command to duplicate the index of the facet surrounding the cursor.) This makes what is commonly referred to as a C.A.M. (Centerpoint Angle Method) Preform.

`\command{Query user (q)}`Query user for  $x$ ,  $y$ , and  $z$  coordinates of a point of a new facet

If you know the  $(x, y, z)$  coordinates of a point on a new facet, the **Query user (q)** command allows you to enter the numerical values of the coordinates directly from the keyboard. GemCad will prompt you for each of the three values in turn. When cutting a C.A.M. preform, it's sometimes best to start with the point  $(0, 0, 1)$ .

For convenience, the **Draw (d)**, **Zoom (z)**, and **Undo (u)** commands are also found in the **Point Menu**. They are described above in the section on the **Cut Facets Menu**.

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## The Edit Menu

Most of the commands in the **Cut Menu** change the stone in some way.

`\command{Xfer (x)}`Transfer the stone

The **Xfer (x)** command is used to transfer the stone. The stone will be turned upside-down. What was in the Top View will be in the Bottom View. You will find it easiest to do most cutting in the Top View. This is because the Top View aligns horizontally with the Side View and vertically with the End View.

`\command{Kill facet (k)}`Kill the facet surrounding the cursor

The **Kill facet (k)** command deletes a single facet. The facet is erased and the facets it used to share an edge with are recomputed and redrawn. This can be a slow process on machines without numeric co-processors.

`\command{Kill tier (K)}`Kill a tier of facets, one of which surrounds cursor

The **Kill tier (K)** command kills an entire tier of facets. The facets are erased, and each facet that shares an edge with one of the killed facets is recomputed and redrawn. This command can be quite slow on machines without numeric co-processors.

`\command{Center (c)}`Center the current view about the cursor

The **Center (c)** command is used to center the stone about the cursor in the view containing the cursor. Let's consider the End View. The End View shows a projection of the stone in the  $x$ - $z$  plane, with  $x$  increasing to the right and  $z$  increasing up the screen. Let's say that your stone positioned too far up in the End View and you want to move it down. Move the cursor inside the stone to its approximate center by eye and press the **Center (c)** key. (Only the vertical position of the cursor is important.) The cursor should be above the dot at the center of the End View. GemCad will ask which coordinate you want centered. Enter  $z$ . GemCad will redraw the stone, sliding the stone *down* so that the position you specified is at the center of the End View. GemCad will slide the stone down the vertical distance from the cursor to the center dot.

The center command can also be used to shift the center of the dop axis by centering the  $x$  or  $y$  coordinate in the Top or Bottom Views. This is useful for pears and other stones with 1-fold symmetry.

You will get an error message if the coordinate you specify has its axis perpendicular to the view containing the cursor, or if the stone is already centered about the cursor. For instance, if you tell GemCad to center in the  $z$  direction while the cursor is in the Top View, GemCad will tell you that you are in the wrong view to center that coordinate since the  $z$  axis is perpendicular to the Top View.

When GemCad cuts a facet it conceptually cuts the stone in two at the plane of the facet and discards one part of the stone and keeps the other. How does GemCad know which part to keep and which part to discard? The rule is that GemCad keeps the part of the stone containing the point (0, 0, 0) and discards the other part. The (0, 0, 0) point is marked by a dot at the center of each view. If you are cutting a skinny stone such as a marquise and you are having problems with GemCad cutting a facet in the wrong place, cutting away most of your stone, GemCad could be cutting off the part you really want it to keep. The solution to this problem is to use the center command to slide it up or down so that the center dot is contained in the part you want GemCad to keep.

`\command{Rotate/Tilt (r)Rotate/tilt the stone; will prompt for what fraction of a revolution`

The **Rotate/Tilt (r)** command will rotate the stone clockwise in the view containing the cursor. Thus, if the cursor is in the Side or End View, the stone will be tilted. If the cursor is in the Top or Bottom View, the stone will be rotated about the axis of the dop. GemCad will prompt you for the numerator and denominator of the fraction of a revolution you want to rotate or tilt the stone. Thus, if you want to rotate the stone, say, 10 degrees, enter 10 for the numerator and 360 for the denominator. To rotate the stone one-half revolution, enter 1 for the numerator and 2 for the denominator.

`\command{Tan ratio (T)Tangent ratio scale top or bottom keying off of facet surrounding cursor`

The **Tan ratio (T)** command is used to change all of the angles of one side of the stone to adapt a design to a different index of refraction. GemCad will search its database of facets to find the facet surrounding the cursor. The angle of the facet will be printed and GemCad will prompt you for the new angle of this facet. The entire side of the stone containing the selected facet will be scaled by the ratio of the tangents of the two angles. If the stone does not have a level girdle, the junction of the pavilion and crown might be distorted. If this is the case, the **Playback (P)** command can be used to recompute all facet edges and make the facets meet properly.

`\command{Waywace (w)Trace a light ray from cursor into stone and back out of stone`

The **Waywace (w)** command traces a single way--ahem!--traces a single ray of light through the stone. This is the only command in the **Cut Menu** that does not change the stone. It was placed in the **Cut Menu** to be close to the **Tan ratio (T)** command. The light ray will enter the screen perpendicular to the cursor, bounce around in the stone and then exit the stone. The ray is shown in all four views. This is a single-shot sort of a deal--one ray of light per command. A separate program (see the `READ.ME` file on your GemCad distribution diskette) is used to make ray-traced images of your design. You can note the leaky spots in the design and use the **Waywace (w)** command to find out the cause of the leak. The **Refr index (I)** command is used to change the index of refraction. Rays are drawn in complement mode--shooting an identical ray



a second time will erase it. A good ray should enter and exit crown facets.

\command{**Scale (X)**Scale the stone: change angles, shrink, enlarge, stretch, etc.

The **Scale (X)** command is used to stretch or shrink the stone in one direction. The command has several variations. GemCad will ask you

Code (all, top, bot, x, y, z)?

The scale command has several uses. If your response begins with an a or A, GemCad will scale the entire stone. GemCad will prompt you for the numerator and denominator of the factor by which the stone is to be multiplied. The stone is enlarged if the numerator is larger than the denominator or shrunk if the denominator is larger than the numerator. No angles or indexes are changed.

A response beginning with x or X will stretch or shrink the stone horizontally in the Top View. You can use this, for instance, to turn a round design into an elliptical one. A response beginning with y or Y will stretch the stone vertically in the Top View. In either case, GemCad will prompt you for the numerator and denominator of the scale factor. Angles and indexes will be changed. Indexes will probably not be whole numbers; the **Change (C)** command may be used on each tier to make its index a whole number. Facets that used to be at the same index and depth before the scale command might be at different angles and depths after scaling.

The x or y options will also cause GemCad to re-tier the stone. This process might take a while on slower machines. The re-tier operation groups together facets cut at the same bearing angle and depth regardless of their relationship through symmetry. To force the re-tier operation without otherwise changing the stone, scale the stone in the x (or y) direction by a factor of 1 over 1. After the stone is re-tiered, GemCad will prompt you for the new symmetry of the stone just as if you had entered the **Symmetry (y)** command. This new symmetry applies only to facets yet to be cut.

If your response begins with a t or T, GemCad will scale the side of the stone currently in the Top View, be it the pavilion or crown. If your answer begins with a b or B, GemCad will scale the side of the stone in the Bottom View. A response beginning with z or Z will stretch or shrink the stone vertically in the End View thus scaling both the pavilion and crown by the same factor. All three variations perform Tangent Ratio scaling. In most cases, however, the **Tan ratio (T)** command is easier to use. GemCad will prompt you for an old angle and a new angle. GemCad will scale the stone such that a facet which was formerly at the old angle will be at the new angle. This will change the angles but not the indexes. If your stone does not have a level girdle, the girdle line might be distorted somewhat after the stone is scaled. This can be fixed with the **Playback (P)** command.

The **Undo (u)** command is also duplicated in the **Cut Menu**. It is described in the section on the **Cut Facets Menu** above.

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## The Parameter Menu

The commands in the **Parameter Menu** are used to set parameters or switches.

\command{**Index gear (g)**}Change the index gear

The **Index gear (g)** command is used to change the number of teeth of the index gear. GemCad defaults to a 64 tooth gear when first run. After you press the **Index gear (g)** key, GemCad will prompt you to enter the number of teeth on the index gear. GemCad has provision for clockwise and counter-clockwise orientations. Gears with positive numbers of teeth increase counter-clockwise, and gears with negative numbers of teeth increase clockwise. Next GemCad will ask you for the offset. This is the index which will appear at the *bottom* of the circle of numbers in the Top View. An offset of zero causes the I.D. position to be at the bottom, and an offset of half the number of teeth of the gear cause the I.D. position to appear at the top. Pressing `Enter` without entering an offset also makes the I.D. position to appear at the bottom. The number of teeth must be a whole number, but the offset may be fractional.

\command{**Symmetry (y)**}Change the degree of radial symmetry and whether mirror-image symmetry

The **Symmetry (y)** command allows you to tell GemCad how many facets make up a tier and are cut at the same angle and cutting depth (mast height). GemCad will prompt you for the degree of radial symmetry and whether or not the stone has mirror-image symmetry. The stone and index gear will then be redrawn.

The degree of radial symmetry is the minimum number of facets which will be cut at once. Facets at an angle of zero are the only exception to this rule since they can be cut at any index. If the stone has mirror-image symmetry, twice as many facets as the degree of radial symmetry can be cut at once. The exceptions are facets that are mirrored by themselves--facets whose indexes are integer multiples of the number of teeth on the gear divided by twice the degree of radial symmetry. Consider an example. A standard round brilliant has eight-fold radial and mirror-image symmetry. If enough information is given to cut one of the break facets, GemCad will cut all sixteen break facets at once. It knows, however, to cut only eight mains and stars because these facets are mirrored by themselves.

What about other symmetries? If the stone is put at the center of a pie, the degree of radial symmetry is the maximum number of *identical* wedge-shaped pieces into which the stone can be cut. If it can't be cut into at least two pieces, the degree of radial symmetry is one. If each of the identical pieces has bilateral symmetry (if it can be folded in two along its centerline) then the stone also has mirror-image symmetry. Consider some examples. A snowflake has six-fold, mirror-image symmetry. It can be cut into six identical pieces, and each of the six pieces can be folded in two. A pear-shaped stone has no radial symmetry, but has mirror-image symmetry so it has one-fold, mirror-image symmetry. A stone whose outline is a parallelogram has two-fold radial symmetry but does not have mirror-image symmetry. An emerald cut has two-fold, mirror-image symmetry. Most triangular stones have three-fold, mirror-image symmetry.

Eight-fold, mirror-image is the default when GemCad is first run. The default can be changed when configuring GemCad. The symmetry of the stone is saved when the project is saved with the **Save (s)** or **Save as (S)** commands. You can change the symmetry in the middle of a design. For instance, you can cut a pavilion with one type of symmetry and a crown with another. Only

the current symmetry is listed by the **List to screen (I)** or **List to file (L)** commands.

If the number of teeth on the index gear is not an integer multiple of the degree of radial symmetry, GemCad will round off indexes to the nearest tooth. This allows you, for instance, to cut a seven-sided stone on a 64 index gear.

\command{\bfr index (I)}Index of refraction: change it and print the critical angle

The **Refr index (I)** command is used to change the index of refraction for the **Waytwace (w)** command. GemCad will tell you the old index of refraction and will prompt you for the new one. GemCad will then print out the critical angle in the upper-left-hand corner of the display. A null response (just the `ENTER` key) causes the R.I. to remain unchanged, but the critical angle is displayed again. When you save a design GemCad saves the R.I. with the facet data. When GemCad is first run, the refractive index is set to 1.54 for quartz. This default can be changed when you configure GemCad.

\command{\time-lapse (t)}Turn time-lapse on/off

The **Time-Lapse (t)** command affects how the stone is redrawn as facets are cut. If time-lapse is on, only facets changed by the addition of a new tier of facets are redrawn. If time-lapse is off, the entire stone will be redrawn after the tier of facets is added.

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## The Utility Menu

\command{\blink facet (b)}Recompute the facet surrounding the cursor

The **Blink facet (b)** command erases the facet surrounding the cursor, recomputes it, and then redraws (blinks) it. This is the quickest way to find out the angle and index of a facet: they are printed in a box at the upper-left-hand corner of the screen.

\command{\blink tier (B)}Recompute a tier of facets, one of which surrounds cursor

The **Blink tier (B)** command recomputes an entire tier of facets. GemCad searches its database of facets and finds the one surrounding the cursor. All facets belonging to the same tier as the specified facet are recomputed and redrawn (blinked).

\command{\meas vector (v)}Display distance, angle and index of line joining last two points

A vector is a quantity with magnitude and direction. The **Meas vector (v)** command is used as a measuring stick. It gives the length and direction of the line joining two points. To use the **Meas vector (v)** command, pick two points, typically with the **Meet pt (m)** command (or the left mouse button). When GemCad asks you to use the points, enter "n" or just press `ENTER`. Then press the **Meas vector (v)** key. GemCad will print the distance between the two points projected along each axis and also give the true length of the line joining the two points. Next, GemCad will print the bearing angle and index of the line joining the two points. One use for this feature is to figure out the minimum angle needed to cut off an edge.

`\command{Set vector (V)}`Set units for **Meas vector (v)** command

The **Set vector (V)** command is used to set the length of the measuring stick used for the **Meas vector (v)** command. The main use of this feature is to allow you to measure the ratio of two lengths without having to divide the numbers yourself. Let's say you want to measure the length of a feature on a design as a fraction of the width of the design. First, pick two points on opposite sides of the stone with the **Meet pt (m)** key. (But tell GemCad not to use the points for a new facet.) Next, press the **Set vector (V)** key. GemCad will print the length and direction of the line joining the points as in the **Meas vector (v)** command. GemCad will then ask you along which axis you want the distance to be set and how many units long you want this segment to be. For instance, if you want your measuring stick set such that the width of the stone is one unit and your stone is longer than it is wide, pick two points opposite one another at the widest point of the stone. Press the **Set vector (V)** key. Press `Enter` twice to acknowledge the length and direction in the old units. GemCad will then ask you along which axis the length is measured that to you wish to set. Next it asks how many new units long to set this distance. In most cases, you will probably want to set this distance as one unit long.

`\command{Playback (P)}`Recut the stone

The **Playback (P)** command is used to recut the stone. The stone is shown at every stage as it is recut. GemCad will ask you if you want it to wait for you to press a key between facets. If your answer begins with a "y" GemCad will cut facets one at a time, waiting for you to press any key or mouse button. Otherwise, GemCad will ask you how long to wait between facets. A value of 0.5 seconds slows things down enough to see each facet as it is cut. The default is not to wait at all. Since the playback can take a long time on machines without numeric co-processors, pressing the `ESC` key will abort the playback. The overall effect of the playback is to show an animation of the stone as it is cut. The playback command also recomputes the stone and can sometimes improve the appearance of meet points or edges. You should use the **Playback (P)** command after the **Tan ratio (T)** command to improve the accuracy of the computed meet points.

`\command{Demo (D)}`Recut the stone repeatedly to demonstrate GemCad

The **Demo (D)** command repeatedly executes the **Playback (P)** command in an endless loop. As with the **Playback (P)** command GemCad will ask you how long to pause between facets. After the stone is recut, GemCad will pause for five seconds. The demo will continue until you interrupt it with the `ESC` key.

`\command{Constr line (-)}`First time starts at cursor, second time draws to cursor

The first time you press the **Constr line (-)** key, GemCad does nothing except to save the last location of the dotted cross-hairs (or the cursor if the cross-hairs are not on). The second time you press the minus key, GemCad will draw a dotted construction line from the saved point to the new location of the crosshairs (or cursor). You can get crosshairs at the cursor by pressing the space bar.

`\command{Dos (!)}`Execute a DOS command

The **Dos (!)** command allows you to executes one or more DOS commands. GemCad will

prompt you with `DOS>` at the top of the screen, and you may enter a one-line DOS command which will be executed in a text screen. After DOS executes the command, GemCad will ask you to press any key to redraw the stone.

If you want to escape to a DOS session to execute several commands and then return to GemCad, simply press the `Enter`g at GemCad's `DOS>` prompt. This will start new DOS session in a text screen. When you finish the DOS session, you must use the `EXIT` command of DOS to return to GemCad.

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## The Diagram Menu

`\command{List to scrn (I)}`List cutting schedule of angles and indexes to screen

The **List to scrn (I)** command lists the cutting schedule to the screen. Facets are listed in the order they were cut. GemCad will wait for you to press any key or mouse button at the bottom of each full screen of text. If you have used the **Heading (H)** command to enter the design name and author, the listing will begin with the heading. The relative length, width, table length, and pavilion and crown heights are shown next. These dimensions are those called out on the diagram. The facets visible in the Top View are labeled "Crown," and those in the Bottom View are called "Pavilion."

Each tier of facets is given by one or more lines in the listing. The tier begins with its name (see the **Name (n)** command) if it has one. Next comes the bearing angle in degrees. Next come the list of index positions separated by hyphens. This might take several lines. The rightmost column contains the cutting instructions if you have entered them with the **Gloss (inst) (G)** command.

If you have used the **Footnote (F)** command to enter a footnote, the note will be at the bottom of the listing.

`\command{List to file (L)}`List cutting schedule of angles and indexes to printer or file

The **List to file (L)** command lists the cutting schedule to a file or printer. The format is basically the same as with the **List to scrn (I)** command. GemCad will prompt you for the name of the file, which must be a valid DOS file name. If the file exists, GemCad will ask for your permission to write over the file. Entering the file name `PRN`, or a port name such as `LPT1` or `COM1`, whichever is appropriate on your system, will list the cutting schedule to the printer. The file that is written is a flat ASCII text file. You may use your favorite text editor or word processor to annotate the cutting instructions and print them out.

The format of the **List to file (L)** command is somewhat different than that of the **List to scrn (I)** command. The heading and dimensions are set off in an indented block by themselves. The cutting instructions follow. When you configure GemCad, you can specify the margins, the height of the header and how much the header is indented.

`\command{Name (n)}`Name or label the facet surrounding the cursor

The **Name (n)** command searches the database of facets to find the facet surrounding the cursor.

GemCad then prompts you for the name of the facet and labels the facet with the name. Names can be up to three characters, although only one or two character names will fit in any but the largest facets. The names will also appear in the cutting schedule (made by the **List to scrn (I)** and **List to file (L)** commands). Naming a facet that already has a name renames the facet, but a null name (just the `Enter` key) will erase the name. If two facets in the same tier of facets (same angle and depth) are named different names, only one name will appear in the cutting schedule.

`\command{Gloss (inst) (G)}`Provide cutting instructions for facet surrounding the cursor

A gloss is a brief explanation or annotation. The **Gloss (inst) (G)** command allows you to provide brief cutting instructions for a tier of facets, one of which surrounds the cursor. The cutting instructions will be printed on the listing made with the **List to scrn (I)** or **List to file (L)** commands to the right of the indexes that make up the tier.

`\command{Heading (H)}`Enter a heading including title, designer, date, etc.

The **Heading (H)** command allows you to enter up to four lines of text that show up at the top of the listing with the **List to scrn (I)** or **List to file (L)** commands. If you have already used the **Heading (H)** command to enter a heading, subsequent times allow you to edit the heading. You may use the `Insert`, `Delete`, `End`, and `Home` keys. The purpose of this text is to allow you to enter the name of the design, the designer, the date and reference.

`\command{Footnote (F)}`Enter a footnote

The **Footnote (F)** command allows you to enter up to four lines of text that are printed at the bottom of the listing made with the **List to scrn (I)** or **List to file (L)** commands. If you have already used the **Footnote (F)** command to enter a footnote, subsequent times allow you to edit the footnote. You may use the `Insert`, `Delete`, `End`, and `Home` keys.

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## Configuring GemCad

When you first run GemCad it will print out a Copyright notice, tell you where it got its current configuration, and ask you press `c` to configure or any other key to start the program. If you press the `c` or `C` key, GemCad will enter its configuration mode. This allows you to change the default parameters such as index gear and symmetry. It also allows you to specify parameters relating to your printer. This configuration is stored in a file named `GEMCAD.CFG` in the current working directory.

When GemCad is first run, it tries first to find a file called `GEMCAD.CFG` in the current working directory. If it cannot find such a file, it looks in the same directory in which the `GEMCAD.EXE` resides for a file named `GEMCAD.CFG`. If it can't find either configuration file, it just uses the defaults built into `GEMCAD.EXE`. You can therefore make a generic configuration in the same directory where GemCad resides and then make different directories for special situations.

The questions about margins and headers pertain to the format of the listing produced with the **List to file (L)** command. The **List to file (L)** command is set up to make a listing that can be printed with the diagram produced with the `GemPlot`, `GemJet`, or `GemDot` programs. These

programs produce publication-quality diagrams on various printers from your GemCad files. They do not print the cutting instructions, however. Since the margins, character pitch and line spacing vary with the type of printer, GemCad allows you to adjust the print position of various parts of the diagram.

The first part of the listing is the header. It contains the heading as entered with the **Heading (H)** command, a tally of the number of facets, some parameters, and the dimensions of the stone. The header is indented more than the cutting instructions that follow. Blank lines follow the header so that the cutting instructions always begin on the distance from the top of the page regardless of the length of the header.

The four parameters that you can set are:

Top margin: The number of blank lines from the top of the listing to the first line of the header.

Left margin: The number of spaces before each line of the cutting instructions.

Top header: The maximum number of lines in the header, or the number of lines from the top margin to the beginning of the cutting instructions.

Left header: The extra number of spaces that the header is indented.

If you set these four parameters to zero, the format of the **List to file (L)** command will be identical to the format of the **List to scrn (I)** command.

The default choices for these were tested with the GemDot program with Epson LQ510 printer using its Courier typeface. You will have to experiment with the margins to adapt the listing format to your printer.

GemCad can print a copy of the screen on HP DeskJet, LaserJet, or IBM or Epson printers. All of the HP printers need the information in one format and the IBM and Epson printers need it in another. If you select the IBM compatible printer, GemCad will ask you for the aspect ratio of your printer. For most 9-pin printers, enter 1.2. For most 24-pin printers, enter 1. GemCad will print only the square plotting area of the screen. Make a test plot with one of the suggested values above and measure the square to make sure its width is the same as its height. If not, reconfigure GemCad and multiply the aspect ratio by the ratio of the width to the height. If you select the HP compatible printer, the aspect ratio is ignored since all of the HP printers have square pixels.

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## Error Recovery

What if you press a key that executes a command that you didn't intend to? Let's say you pressed the **Angle (a)** key by mistake. GemCad will ask you to enter the angle. If you just press the `Enter` key or the right mouse button, GemCad will abort the command.

What if you enter an angle incorrectly and don't realize it until after you have pressed the `Enter` key? Just press the **Angle (a)** key again, this time entering the angle correctly.

What if you enter an angle when you meant to enter an index? If you redraw the screen with the **Draw (d)** key, GemCad will discard all data pertaining to new facets and will clear the status box in the lower-left-hand corner of the screen.

What if you accidentally gave GemCad enough information to cut a facet that you really didn't want to cut? You can wait until GemCad finishes and then use the **Undo (u)** key. What if you tell GemCad to cut a facet that starts hacking away at your stone? If a facet is cut off, GemCad will tell you so in an error message telling how many facets were cut off. You must then press any key to acknowledge the error message. You may then use the **Undo (u)** key to uncut the facet. If GemCad seems to be taking a long time to compute the new facets, you may interrupt it by pressing the `Escape` key. This immediately does an undo. The `Escape` key will also interrupt the **Kill facet (k)** or **Kill tier (K)** key commands.

If a new facet misses the stone entirely, GemCad will sometimes draw a "stone within a stone." The way out of this is with the **Undo (u)** key. What if you've already changed the stone so that the undo key doesn't get rid of the "phantom" facets? You can position the cursor inside the phantom facet, press the **Blink facet (b)** key and make sure only the phantom facet blinks, and then kill the facet (or tier) with the **Kill facet (k)** or **Kill tier (K)** keys. It might be necessary to move to a different view or to rotate the stone with the **Rotate/Tilt (r)** key to specify the phantom facet unambiguously. Again, before using the **Kill facet (k)** or **Kill tier (K)** keys to kill a phantom facet, check first with the **Blink facet (b)** key to make sure GemCad will kill the facet you want it to kill.

Last resort: If things are totally hopeless, if your two-year-old has pressed the red reset button, or if there has been a power failure, there is still hope. Restart your computer, change directories to where you were when you last ran GemCad, run GemCad and execute the **Undo (u)** key. This will read in the file `GEMCAD.BAK` and get you back to one step before the catastrophe. It is important to do this before reading in any other file or cutting any new facets since any command that changes the stone will overwrite the file.

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### Using GemCad with a Mouse

Versions 2.0 and later of GemCad support a Microsoft or compatible mouse (most are). The interface program supplied with your mouse (such as `MOUSE.COM`) must be loaded before running GemCad. This is most commonly done in the `AUTOEXEC.BAT` file, but may be done anytime at the DOS prompt. (GemCad does not work with device-drivers such as `MOUSE.SYS` that are loaded in the `CONFIG.SYS` file.)

You can use the mouse to position the cursor and to execute commands. If you move the mouse pointer into the menu label area at the left of the screen, you can highlight a particular menu choice. Pressing any of the mouse buttons while a choice is highlighted will select that choice. This is equivalent to pressing the corresponding function key with one exception: if the command you selected refers to a point, GemCad will print "Set a point" in the upper-left-hand corner of the screen. The selected menu choice will then remain lit until you move the cursor into the drawing area, position the cursor at the point you want and then press a mouse button. The command will then be executed just as if you had pressed the corresponding function key while



the cursor was at the point you set.

When the cursor is positioned in the drawing area and a menu choice is *not* highlighted, the mouse buttons are mapped to commands in the Point Menu. The left button is mapped to the **Meet pt (m)** command, and the right button is mapped to the **Pt on edge (e)** command. If you have a three-button mouse, the center button is mapped to the f (point on facet) command. (On a two-button mouse, pressing both buttons simultaneously will also perform the **Pt on facet (f)** command.)

When GemCad is prompting you for input at the top of the screen, the left mouse button is mapped to the `y` key and the right button is mapped to the `Enter` key. Thus, to answer yes to a yes or no question, press the left and then right mouse buttons. To answer no, enter a null response by pressing just the right mouse button. The center button (if present) is mapped to a backspace.

Consider an example. To set a meet point and use it to add a new facet, move the mouse near the meet point, press the left button (mapped to the **Meet pt (m)** command). GemCad will then ask you if you want to use the point. Press the left button (mapped to `y`) and then the right button (mapped to `Enter`). You can set meet points, points on edges, and points on facets without touching the keyboard.

The cursor keys work exactly the same way with a mouse as they do without. They are convenient for moving the cursor vertically or horizontally from another point on the screen.

There are two environment variables that pertain to the mouse when used with GemCad. If your mouse seems to move two or more pixels in one axis or if the cursor keys don't seem to work in one of the four directions, read further. If you type "SET MXDIV=2" at the DOS prompt prior to running GemCad, the program will divide the X mouse ticks by two. This makes the mouse half as sensitive horizontally as before. Similarly the variable MYDIV divides the vertical mouse ticks. You can put one or both of these commands in your AUTOEXEC.BAT file. If you get a DOS error message like "Out of environment space," you must place the SET commands near the top of your AUTOEXEC.BAT file. Most of the newer mouse drivers have adjustable resolution, and you should fix the problem there.