The Bad Ellipse: Circles in Perspective
The Minor Axis is the Key

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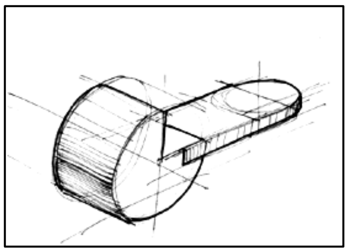
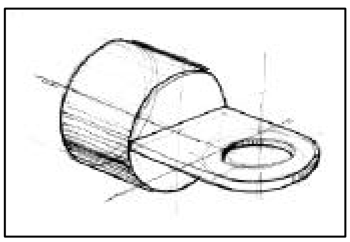
Has the eruption of computer rendering eliminated the need of drawing a visually correct circle in perspective, an ellipse? No. Even with computer aided design and all the drawing programs, the need for a designer to sketch will never go away. Designers still need sketch and sketch accurately. The need to draw a visually correct ellipse is important, regardless if it is with the aid of an ellipse template or a freehand thumbnail sketch. The content of this paper is not a debate of traditional drawing methods versus computer-aided drawing. It is a presentation of a method that can be used to determine if an ellipse is visually correct, and it needs to be shared with educators and designers.

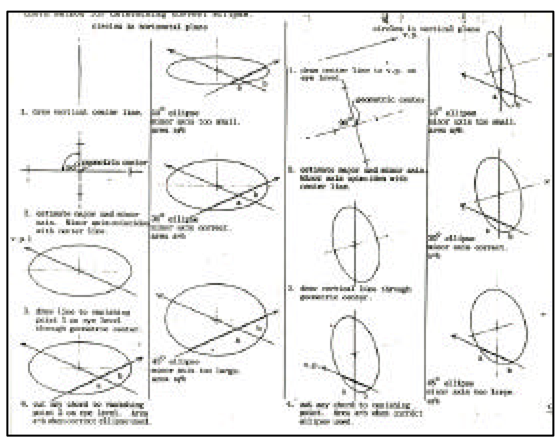


This method begins with the assumption that you can sketch an ellipse freehand or draw an ellipse with a template and that you know the difference between a major and minor axis. The method will be referred to as the Chord Method and a key ingredient is the alignment of the minor axis..



This Chord Method was taught to me in college by Professor William Bullock during a perspective theory drawing class. Professor Bullock picked up the technique will working for Baugh-Deines Design, Wichita, KS. Robert Deines explained the Chord Method and Professor Bullock developed the concept in to a class handout. The image below is a copy of the original handout I received in 1977.

During my career in industry I showed this technique to several designers and all of them marveled at the method. Many wished they had been taught the Chord Method in school. I used the technique for seventeen years before I proved the method through photographic images and overlays. I have expanded the technique beyond drawing knobs on a radio or wheels on a car. I will explain the method for determining the visually correct ellipse on horizontal, vertical, and angled surfaces.

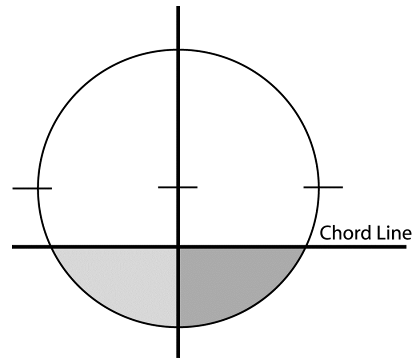


Drawing cylindrical forms in perspective is often a bit of guesswork. Ellipse templates are helpful; however it is often difficult to determine the proper ellipse for a drawing. The degree or angle of the ellipse is often determined by sight: what looks right. The Chord

Method is simple quantitative method for determining the proper degree of an ellipse. This removes much of the guesswork from drawing circles in perspective. A student, professional or educator will benefit from knowing this technique and will be able to draw a correct ellipse with confidence.

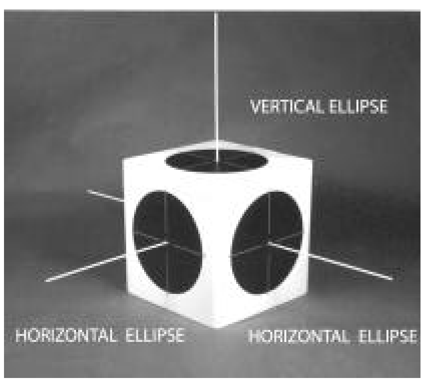
The Chord Method: Definition.

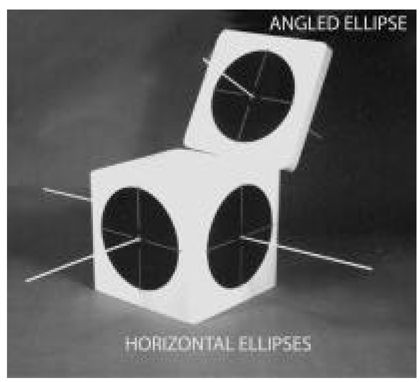
A chord is a straight line joining two points on a curve. The chord line is used in this method to assist in determining a visually correct ellipse. As shown in the image to the right, a circle has been divided into two equal halves: left and right sections. A line, a chord line, crosses the circle horizontally, below the center point, creating two equal (shaded) sections. Any line drawn horizontally that intersects the circle will create two equal sections.



The Chord Method: Ellipse Position

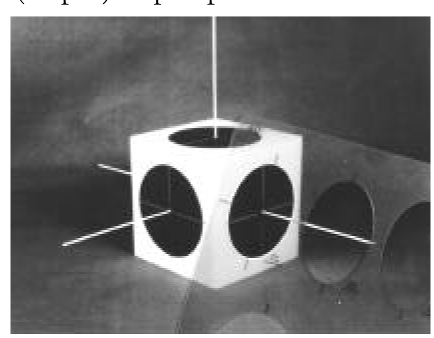
In order to fully understand the Chord Method, a few basic terms need to be defined. Circles in perspective have three basic orientations. These orientations are best described in reference to the given plane on which they appear: vertical, horizontal, or angled planes. The photographs of the white cube show the different orientations of the ellipses. The sides of the cube represent horizontal planes and the top of the cube is a vertical plane.





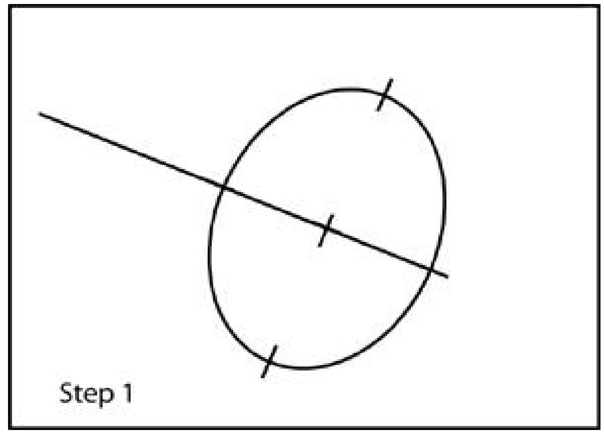
Obviously, the circles on the sides and top of the white cube appear as ellipses. Every ellipse has a major and minor axis, and the minor axis orientation is the key ingredient to drawing a visually correct circle (ellipse) in perspective.

By overlaying an ellipse template on the photograph of the white cube, the minor axis orientation is determined. The minor axis lines-up with the opposite vanishing point of the horizontal plane. If the circle is on the right side of the cube (right-horizontal plane) the minor axis of the ellipse aligns with left vanishing point.

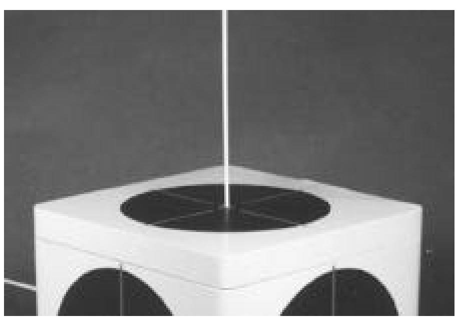


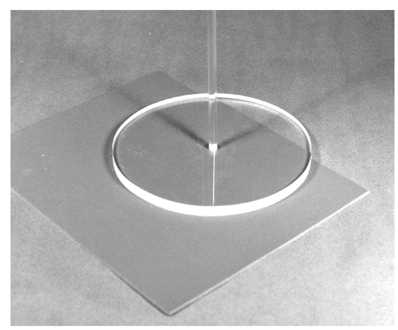
When I was taught that the minor axis aligns with the opposite vanishing point I took if for the truth, but several years ago a student challenged me and I couldn't explain the reason, even though I had confidence that the minor axis did align with the vanishing point I could not prove it. So, I developed the white cube as a teaching-aid to help illustrate the minor axis orientation. The white rods penetrating the center points of the black circles represent the minor axis. Photographing the white box and then overlaying the prints with ellipse templates proved the minor axis alignment method.

The key is the minor axis. To help my students remember this I tell them that the minor axis is the major factor for aligning an ellipse and the major axis has no purpose in this method, except to help locate the center point. The minor axis is major and major axis is minor. Regardless of the ellipse orientation the minor axis alignment is always in the position that would visually allow the ellipse to rotate around an imaginary axis, like a wheel. The imaginary axis is always perpendicular to the plane of the ellipse and it penetrates the center point.

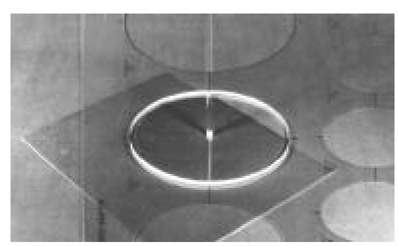


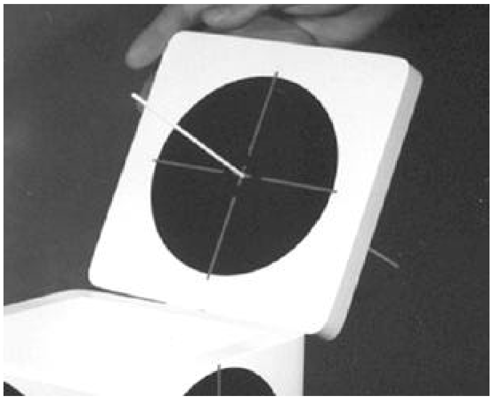
With this knowledge of the minor axis orientation we can transfer it to a vertically positioned circle in perspective. The vertically oriented circle in perspective is an ellipse with the minor axis position vertically. In this orientation the vanishing lines are not used to align the minor axis of the ellipse, a vertical line through the center is used. Again, I used photography to prove this minor axis orientation. The white rod penetrating the center of the black disc in the photograph below depicts the vertical line through the center of the ellipse and the minor axis orientation.





As indicated in the photograph of the clear plastic disc the minor axis is shown with the alignment of the ellipse template. The ellipse template has been placed over a photograph of the disc, which shows the minor axis orientation in a vertical position.

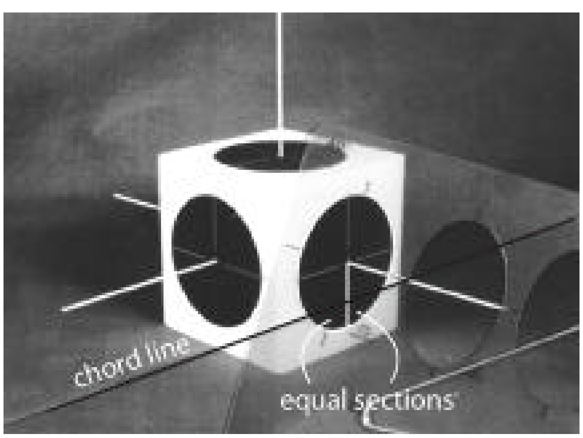




Now that we know the minor axis orientation for the horizontal and vertical circle in perspective, we will now determine the angled ellipse orientation for the minor axis. An angled ellipse uses the minor axis for alignment, too. This orientation takes a little more visual judgment than an ellipse in the horizontal or vertical orientation. A visual key that helps to align angled ellipses is to remember that the minor axis and the imaginary axis are perpendicular to the plane of the ellipse. The white plastic rod depicts the imaginary axis and represents the minor axis orientation. In order to prove this point, make an enlarged photo copy of this page: set the photo copier enlargement for 150 percent. You will need the center the image on the copier and set the mode to photo. Locate a 50 degree ellipse template and overlay the ellipse with a 1 .75 size, 50 degree ellipse. Be sure to align the minor axis with the white plastic rod. As you will notice, the minor axis indication marks on the template align with the white rod. Make photocopies of other images in this paper and use other ellipse templates to check the alignment. The enlargement size may need adjusting. Also, most ellipse templates are graduated in 5 degree increments, so select the degree that best matches the ellipse. Ellipse size will be a factor, too.

The Chord Method: Application

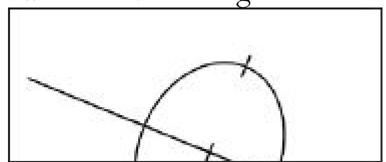
Now that we know the correct ellipse orientation, the minor axis direction, we now need to determine the correct ellipse degree. So far, the images that have been shown in this paper have all been the correct ellipses; because the majority of the ellipses shown are actual photographs of circles or discs. The Chord Method is used to help determine the visually correct ellipse. At the beginning of this paper a chord was defined and an image was shown with a line, a chord line, dividing the circle into two equal sections. This technique is applied to circles in perspective, ellipses, to determine two equal sections.



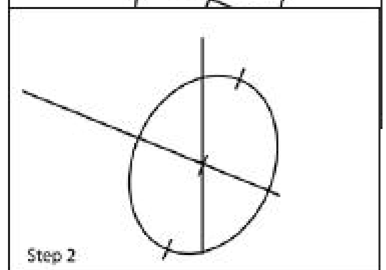
A photograph of the white cube has been overlaid using an ellipse template and triangle, which indicates a chord line. The chord line created by the triangle has divided the bottom part of the ellipse into two sections. The two sections should appear visually equal. In order to explain how to apply the Chord Method we will start with a horizontal ellipse and I will use a step by step approach.

The Chord Method for Horizontal Oriented Ellipses

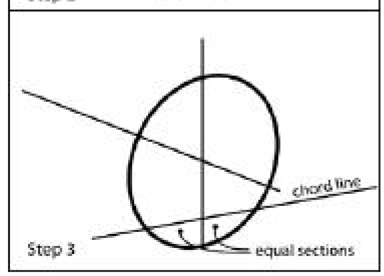
Step 1: Draw any line to a vanishing point. The line shown in Step 1 vanishes to the left vanishing point. Then draw an ellipse with the minor axis inline with the vanishing line. The degree of the ellipse is relevant at this time.



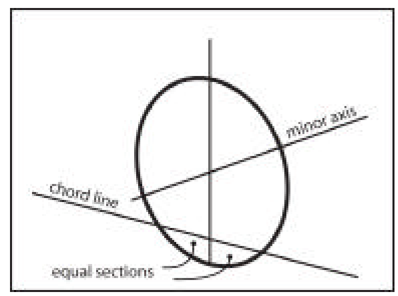
Step 2: Draw a vertical line through the geometric center of the ellipse. This divides the perspective circle, an ellipse, into two visually equal halves.



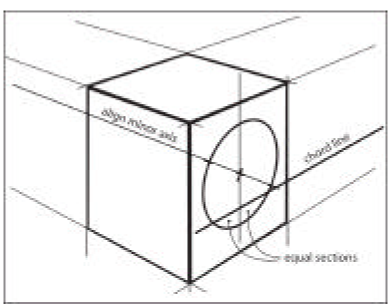
Step3: Draw a line through the lower section of the ellipse that vanishes to the right vanishing point, as shown in Step 3. This line is called a chord line. The two sections that are created by the chord line should appear visually equal, if the correct degree of ellipse is used.



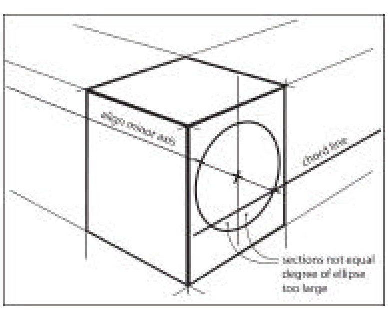
If the minor axis of the ellipse is aligned to right vanishing line then you strike a chord line to the left vanishing point and check the two sections for equality. As you can see from the image, the two sections are equal. Remember, the equal sections are based on visual equality, not physical volume. This question should be asked: Do they appear equal?



In the illustration below, a box has been created with an ellipse (a circle in perspective) shown on the right side of the box. Also, perspective guide lines are shown to help establish the minor axis line and the chord line. This illustration shows the correct ellipse.



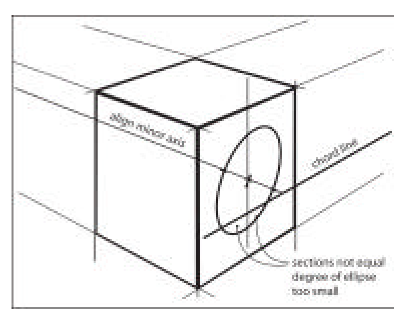
The following examples show ellipses that are not correct. As you can see the two sections created by the chord line are not equal. In the first image the ellipse is too large; the degree of the ellipse is large. Remember, the size of the ellipse is determined by the major axis and the degree is determined by the minor axis. Here, the minor axis distance, the degree, is too large.



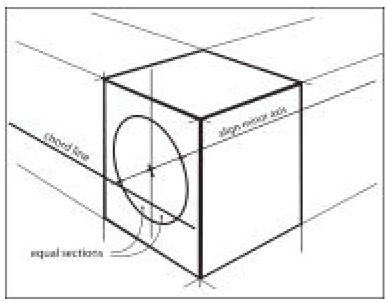
The section to the right of the horizontal line, which intersects the geometric center of the ellipse, is larger than the section left of the horizontal line.

If both sections are visually equal then the correct degree of ellipse is used.

In the image to the right shows the degree of the ellipse is too small. The section to the right of the horizontal line is smaller than the section to the left. In both images the minor axis orientation is aligned with the left vanishing point and the chord line is drawn to the right vanishing

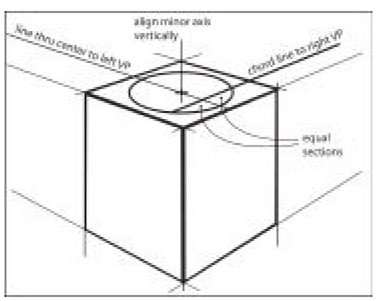


point. It is important to remember the chord line is to drawn to the opposite vanishing point as the minor axis is aligned.



This same technique and information is used on the left side of the cube, also. If a circle in perspective, an ellipse, is drawn on the left side of the cube then the minor axis is to be aligned with the right vanishing point. And the chord is drawn to the left vanishing point (see the image to the left). Changing the degree of the ellipse, which is direct relationship with the minor axis distance, will result in an ellipse that is not visually correct. I have found that when using ellipse templates that the degree of the minor axis can be either five degrees small or five degrees large without affecting the visual correctness. It is when the minor axis is ten degrees or greater, either large or small, that the ellipse appears off.

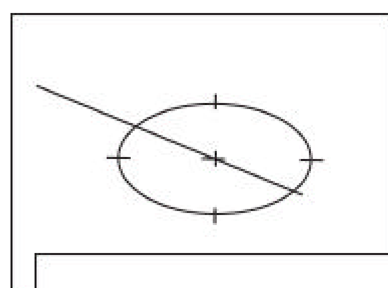
Now that we have reviewed circles (ellipses) on the flat horizontal sides of a cube, let's look at circles on the top of the cube, those that are vertically oriented. Ellipses drawn in this orientation are different from those shown previously. The minor axis is still the key, but in the vertical orientation the minor axis is always aligned vertically. The chord method can be applied to ellipses in this orientation, but the technique differs slightly from the horizontally oriented ellipses.



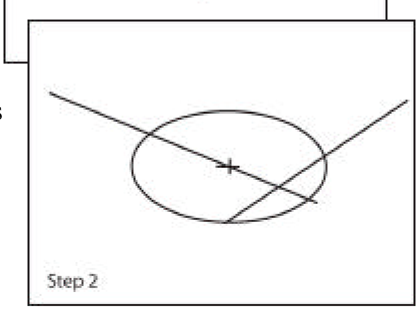
The image to the left illustrates the use of the chord method for vertically oriented ellipses. If the incorrect degree ellipse template is used or if a free ellipse is too thin or too thick the sections created by the chord will not appear visually equal. In the following images the chord method for vertical ellipses is explained.

The Chord Method for Vertical Oriented Ellipses

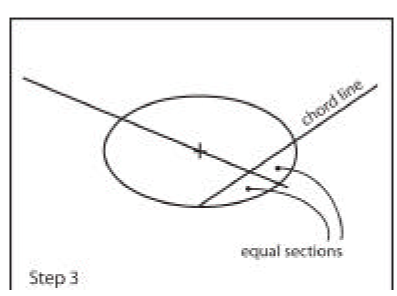
Step 1: Draw any ellipse with the minor axis aligned vertically. Draw any line through the geometric center of the ellipse to either the left or the right vanishing point. In this image the line is drawn to the left vanishing point.



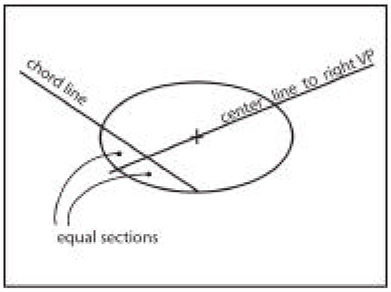
Step 2: Draw a line through the ellipse to the opposite vanishing point of the previous line. Make sure that the line starts on the bottom part of the ellipse (as shown). This line will intersect the first line, which will create two sections.



Step3: Check the sections to verify that they are visually equal. If they are not, adjust the thickness of the ellipse so that the sections are visually equal. The thickness of the ellipse is controlled by the degree, which is directly related to the minor axis.

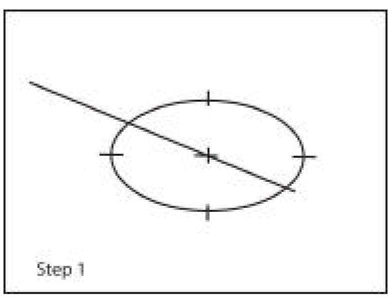


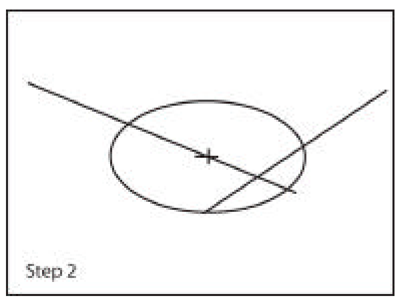
As stated in Step 1, the line drawn through the center can be drawn to either vanishing point and then the chord line is drawn to the opposite vanishing point. The image below provides an example of the line drawn through the center and vanishing to the right vanishing point. The chord line is drawn though the ellipse, intersecting the line drawn through the center, and vanishing to the left vanishing point. Notice that the two sections created by the intersecting lines are to the left side of the ellipse. Applying the Chord Method to vertically oriented ellipses can be checked by either technique described above.

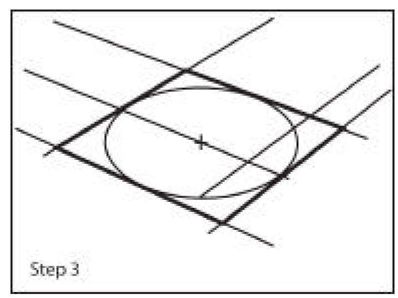


The Chord Method can also be used as a tool to help set up a quasi perspective grid. This can be achieved by starting with an ellipse that orients the minor axis vertically. Draw a line through center in the general direction of either the left or right vanishing point. Then draw a chord line to the opposite vanishing point that creates two visually equal sections.

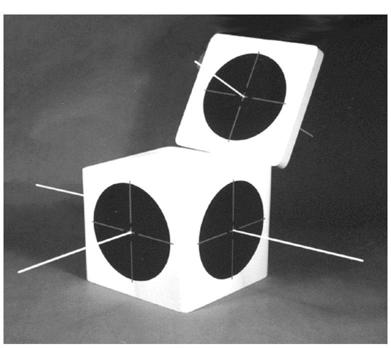
Now, you have established both vanishing point directions. Create a box around the ellipse that vanishes to the right and left. Make sure that the lines touch the sides of the ellipse. This will create a square in perspective, which can be used a basis for a perspective sketch. See the images below. This technique can be applied to ellipses that are horizontally oriented, too.





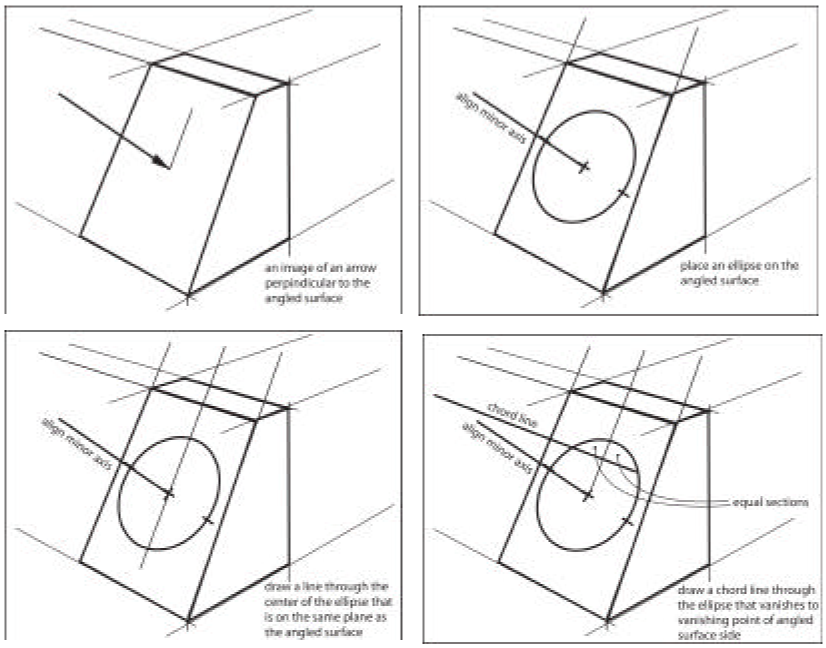


The final use of the Chord Method is for angled circles; ellipses that have there minor axis oriented in different directions other than to the left or right vanishing point and vertically. This application is for those cylindrical objects that are on angled surfaces. This technique was developed through my teaching experiences and was not part of the original handout that I received form Professor Bullock.



As shown in the photograph, the minor axis is visually perpendicular to the surface that the ellipse is on. This is true for all circles in perspective. Two help me visualize this I imagine that an arrow is penetrating the center of the circle. Another way to envision the perpendicular line is to imagine that there is an axle that the circle (ellipse) would rotate about.

The following images explain how to use the chord method for ellipses on angled surfaces.



Draw a line that appears to be visually perpendicular with the angled surface. Draw an ellipse with the minor axis aligned with the perpendicular line. Draw another line through the center of the ellipse that is on the same plane as the angled surface. Next, draw a chord line at the top of the ellipse, which vanishes in the same direction as the angled surface. This lines should intersect the line that is drawn through the center of the ellipse. This will create two sections. If the two sections are visually correct then the correct degree of ellipse has been used.

It should be evident that visually correct ellipses can now be drawn with confidence. The main key is the minor axis alignment and after that has been established the next factor is the proper thickness of the ellipse, which is directly related to the degree of the ellipse. With the information provided, there are a few variations and combinations of this method that can be used in sketching. I suggest that you explore these techniques and master the chord method. Remember, this method still relies on visual judgment, but it should prove helpful when drawing objects with cylindrical forms.