

Tech Talk

Winggeom: A No Cost Alternative for Computer Aided Geometry

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1 Dynamic Geometry Software

Microprocessor technology (primarily personal computers and graphing calculators) has had a dramatic effect on the teaching of geometry (Jones, 2001). Software packages like the Geometer's Sketchpad (GSP) from Key Curriculum Press and Cabri Geometry (Cabri) from Cabrilog for the computer and Cabri Jr. for the graphing calculator allow students to effectively make and test conjectures, construct examples, and experiment with geometric objects in ways that were not possible using traditional paper-and-pencil calculations.

The Geometer's Sketchpad (at the time of this writing the current version is 4.07) is available for both PC and Mac format computers and a quick check of prices shows that it is available for about \$130 to an individual user. It is easy to install and comes with extensive examples and documentation. Cabri II Plus available from Cabrilog, Inc. of Grenoble, France, similarly comes in both PC and Mac formats and costs \$162 (120 Euros) for an individual copy. It is also easy to install and comes with extensive examples and documentation.

A free alternative to these commercial products is available through the work of Dr. Richard Parris who teaches at Phillips Exeter Academy in New Hampshire. This software is called **Winggeom** and it is part of a larger offering of free software authored by Dr. Parris called **Peanut Software** which is available for free download from the website:

(<http://math.exeter.edu/rparris/>). His software is not to be confused with the desktop theme creation software by the same name. This software is currently only available for PCs running some version of the Windows operating system.

Peanut software (part of whose name comes from the acronym formed by taking the first letter's from **Phillips Exeter Academy**) began with some investigative programming by Dr. Parris around 1985. The original programming was done in PASCAL, but later versions came to be written in C++. The first geometry program was called GEOM. The idea for the geometry program came from Dick Brown (now an emeritus professor at Exeter Academy), who had seen Judah Schwartz's "Geometric Supposer" for the Apple II (Schwartz, 1987).

After writing his own version of this software, Dr. Parris met Judah Schwartz at the Anja S. Greer Summer conference held yearly at Exeter and got further ideas for refining his work. Although GEOM was primitive, the user could construct just about anything, and yes it was dynamic --- even though there was no mouse yet, all movement was controlled by the arrow keys!

Through the years, Dr. Parris has had the support of a "users group", which initially consisted of Anja S. Greer Summer conference participants (who originally obtained updated versions by sending him floppy diskettes in prepared mailers). Dr. Parris notes that the programs have developed thanks to the steady feedback and suggestions received from his users. With the advent of the WWW, most of the Dr. Parris' input comes from people he has never met, living in countries he has never visited.

Currently there is software for graphing (WinPlot), statistics (WinStat), work with matrices (Winmat), strategy games (Winarc), discrete mathematics (Windisc), and fractals (Winfeed). **Wingeom** is a software package that allows the user to do two- and three-dimensional geometry using a computer similar to GSP and Cabri.

In what follows below we will try to give you a feeling for what the **Wingeom** interface looks like; as well as, an introduction to some of its basic commands for creating points, lines, circles, for making measurements, and for producing transformations like translations and rotations. We also provide information about ancillary materials available for **Wingeom**.

2 Wingeom 2-D geometry interface—Points and Lines

Unlike its commercial counterparts **Wingeom** has built-in capabilities to work on both two- and three-dimensional geometry. In this introduction we will only explore the two-dimensional aspects of the software. **Wingeom** opens in its own window and its basic interface is a blank screen. A blank sketch for two-dimensional geometry can be opened using the *F2-key* (also available in the *Window* pull-down menu).

Before we begin let's make sure that **Wingeom** is ready to do what we want to do. Make sure that the *Segments (LB)* tool is selected under the *Btms* pull-down menu (see Figure 1 below). On a blank two-dimensional sketch you can add points using the *Right-Click* or *Right Mouse* button. (Note that by default **Wingeom** puts the label for a point directly over the point that is drawn). Figure 2 below shows a sketch with three points drawn on it.

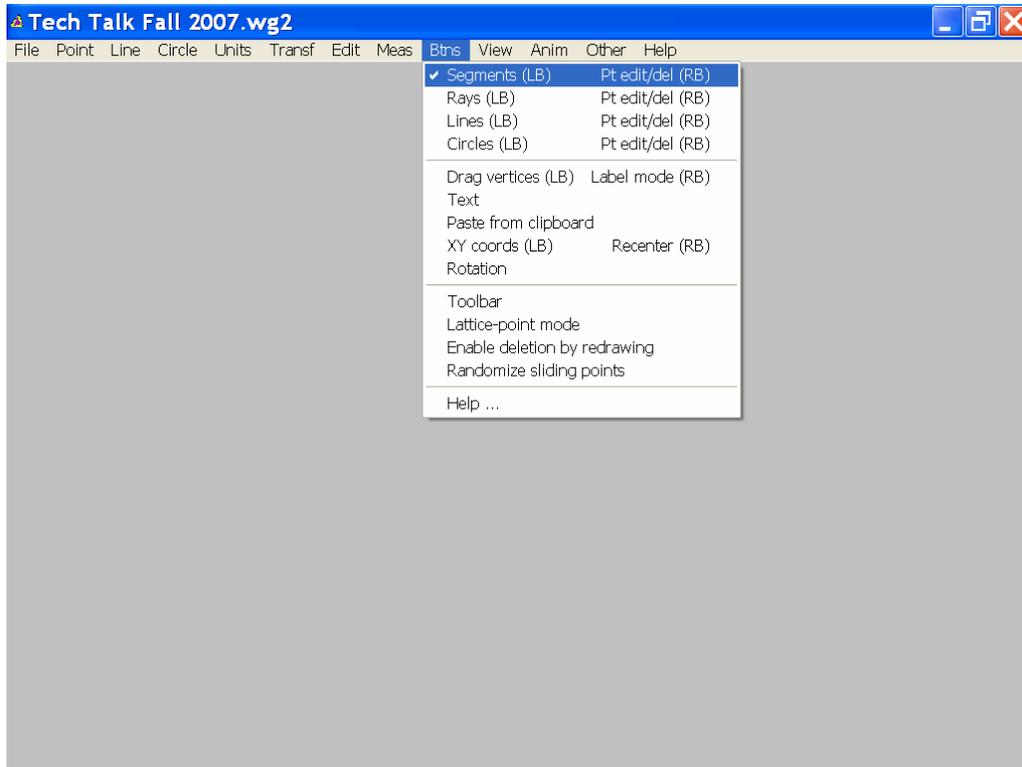


Figure 1: Select *Segments (LB)* on the *Btms* pull-down menu

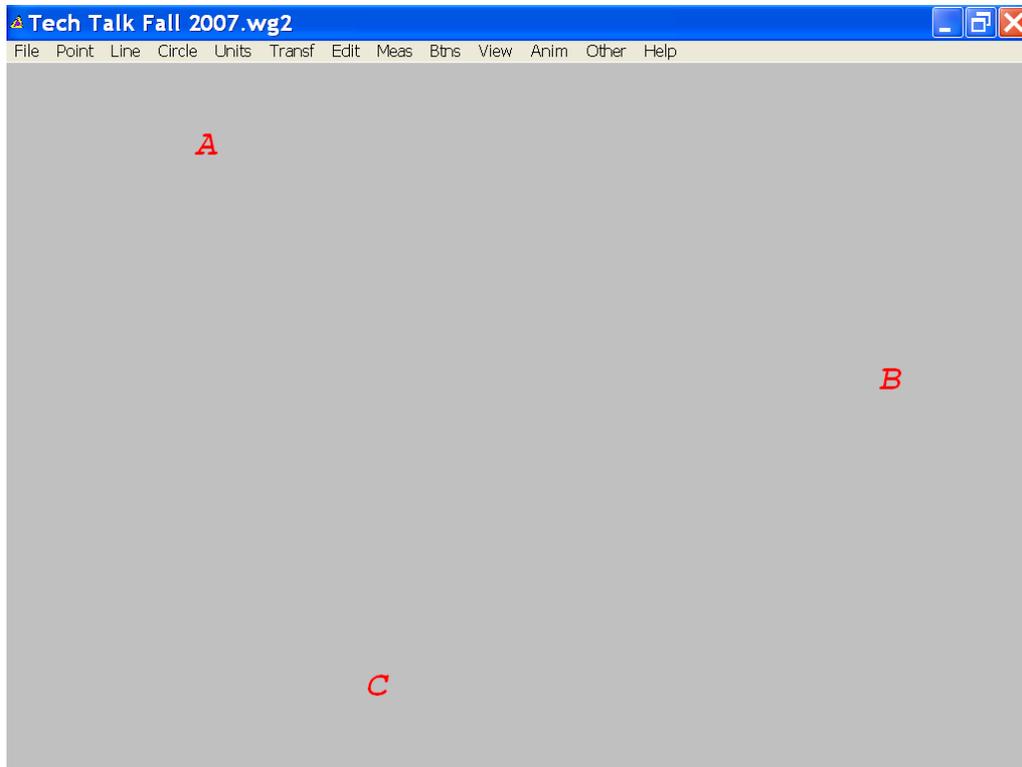


Figure 2: Three random points

Making sure that the *Segments (LB)* tool is selected under the *Btms* pull-down menu (see Figure 1) you can create a segment connecting each pair of points in the previous diagram. With this button selected, put the cursor over one of the points, now hold down the *Left-click* or *Left Mouse* button and drag the cursor over to the second point that will define the segment. As you drag your cursor you should see a line segment following your cursor. If you release the *Left-Mouse* too soon (you should release directly overtop of the second point defining the segment) no line segment will appear (see Figure 3 below).

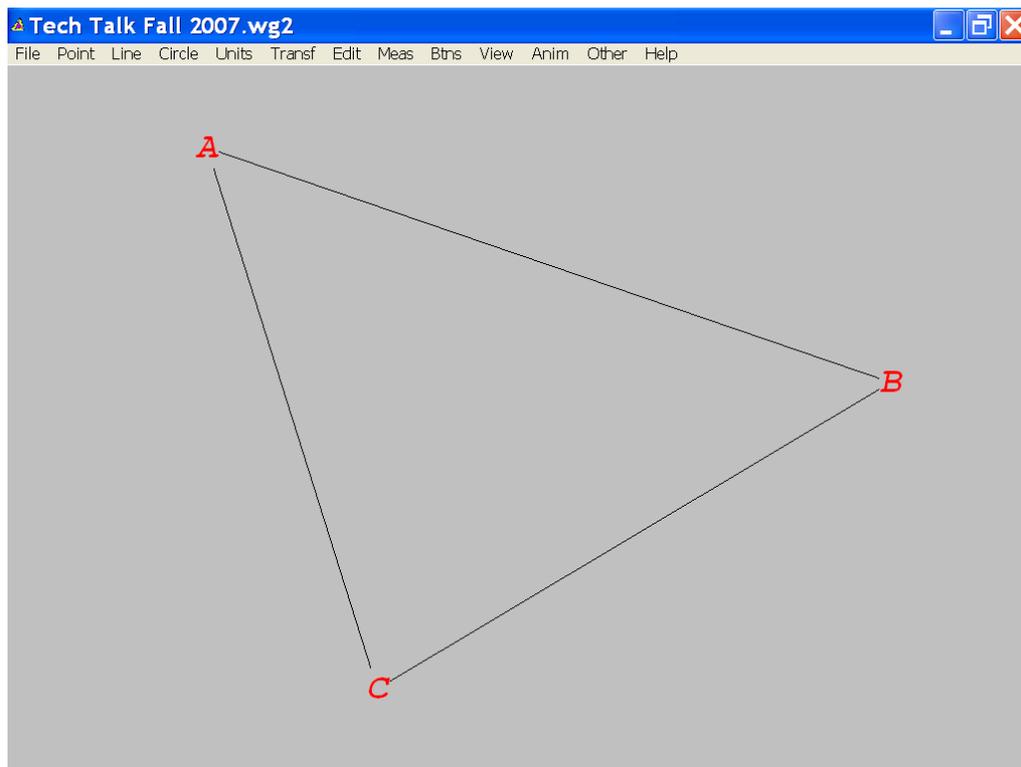


Figure 3: Three segments drawn using *Left-click*, drag and drop

Alternatively, we could add the three segments directly using the pull down *Lines* | *Segments* pull-down menu dialogue box by typing in that you want segments AB, BC, and CA as shown in Figures 4 & 5 below and selecting the *ok* button in the *new segment* dialogue box (Figure 5). Note that once you have chosen the *ok* button in the dialogue

box that the lines appear and the dialogue box disappears—in Figure 5 we have drawn the lines already and the *new segment* dialogue box appears as an illustration for you to follow along with as you read.

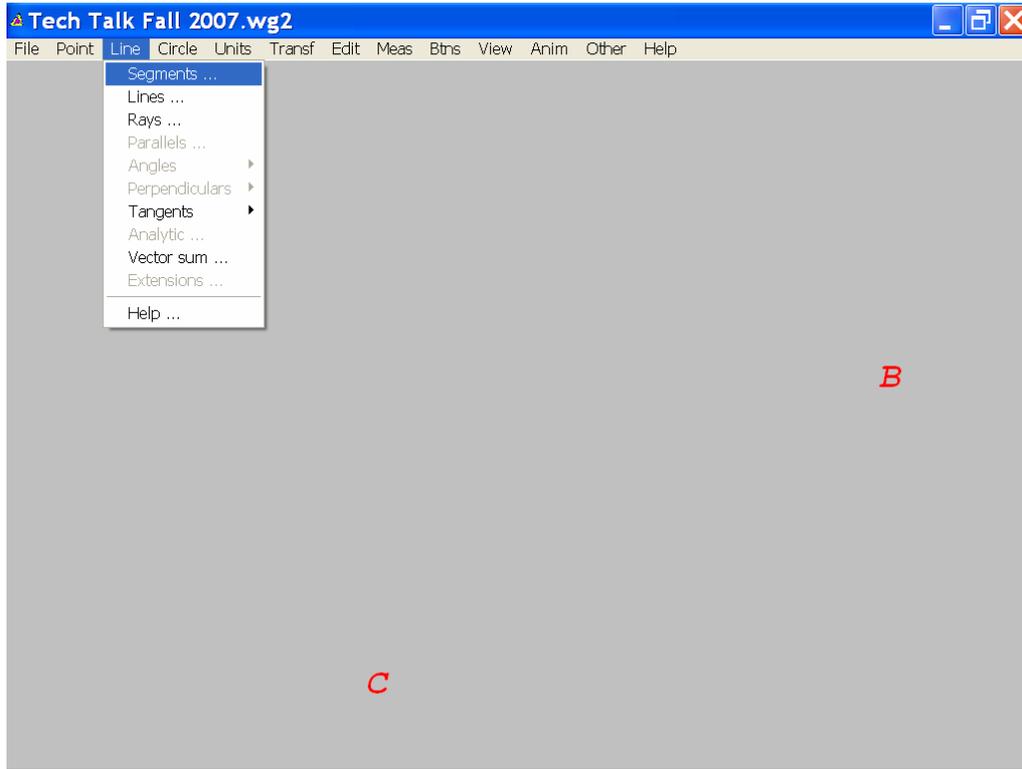


Figure 4: Selecting the *Line / Segments* menu

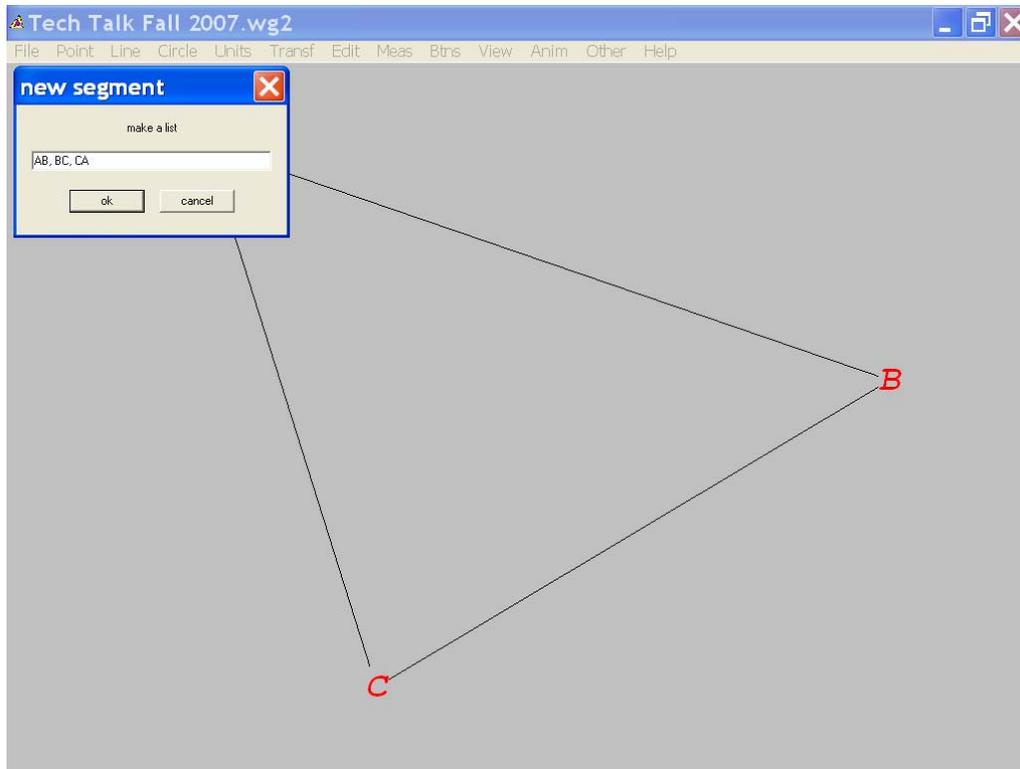


Figure 5: Segments using the *Lines / Segments* tool and *new segment* dialogue box

We can add points to objects like lines in two ways: (a) a point may be added to a given segment using the *Point / on Segment* pull-down menu (Figures 6 & 7) which gives you control over the precise location of the new point on the new segment (in the example below we have chosen to put point D as the midpoint of BC, that is it is $\frac{1}{2}$ of the way from B to C) and secondly (b) a point may be placed on a segment by “dropping” it using the *Right-click* or *Right Mouse* button and putting your cursor over the segment in question (Figure 8). In the figure below we have dropped point E on segment CA.

Using the first method the relative location of the point on the segment is fixed and in the second method we may “drag” or move the new point to any location we would like along the segment.

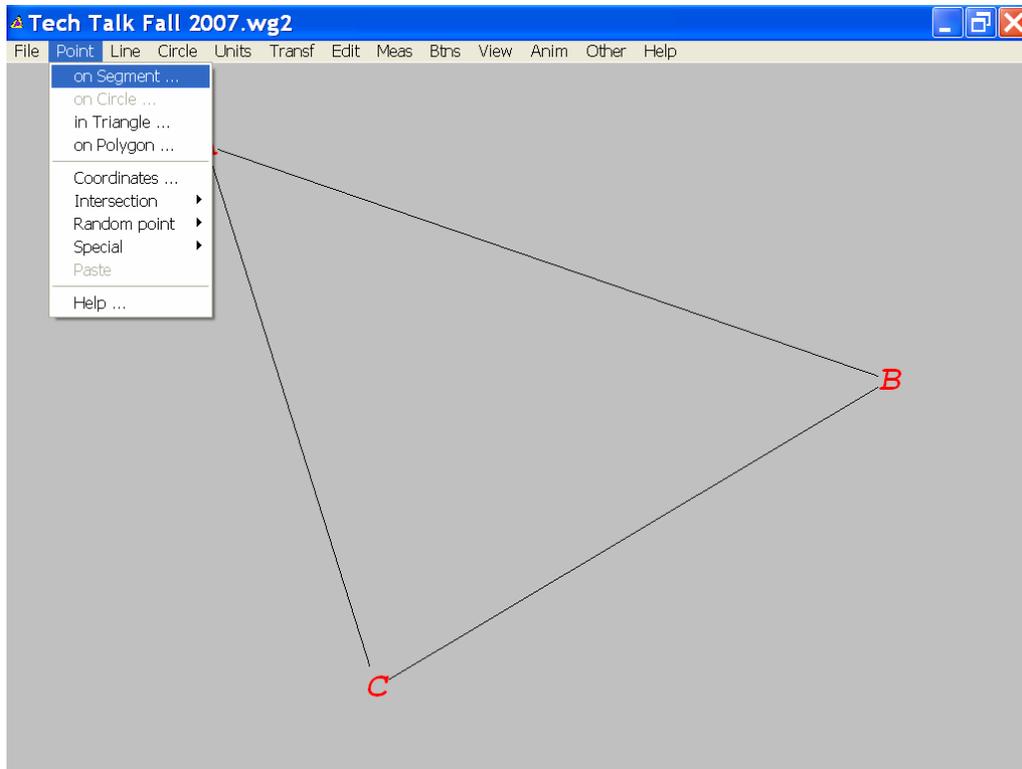


Figure 6: Selecting the *Points / on Segments* menu

To move points first we must make sure that the *Drag vertices (LB)* is selected on the *Btns* pull-down menu as shown in Figure 9. Then if you position your cursor over this (or any other point that is free to move) and hold down the *Left-click* or *Left-Mouse* it will turn green and move within its limitations as you drag the cursor. In our example point E will move freely along segment CA and point D will not move (what happens when you try to move it?). Note that you can also drag the vertices of the triangle if you wish (see Figure 10).

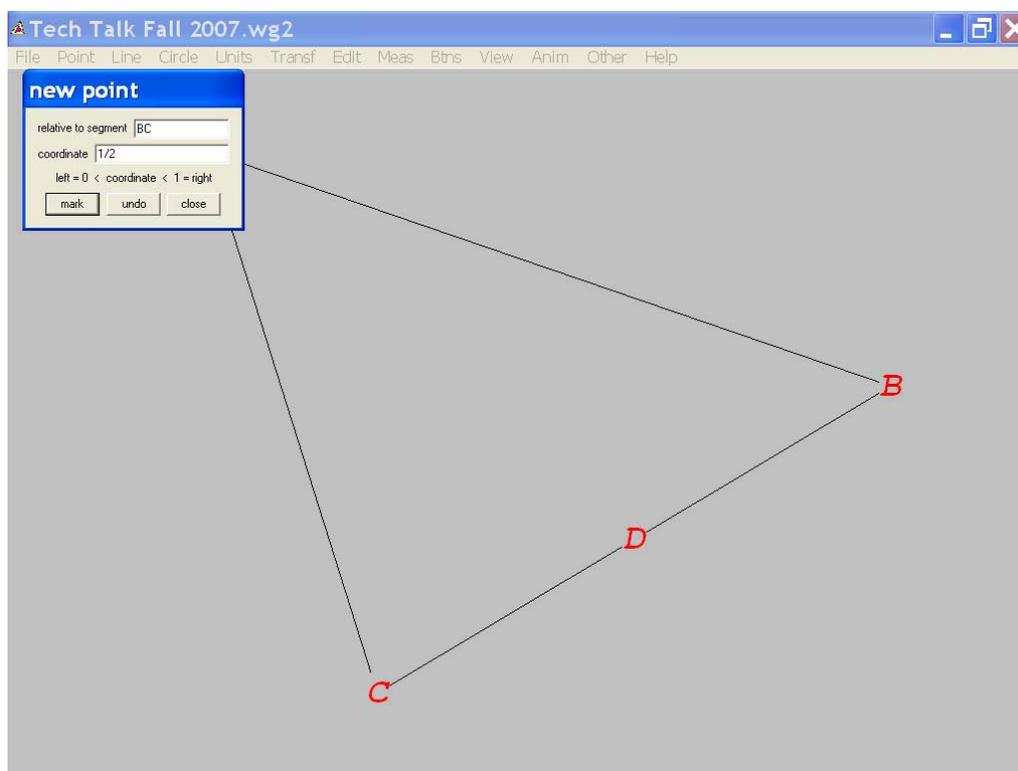


Figure 7: Adding the midpoint D to BC using *Points / on Segments* tool and *new point* dialogue box

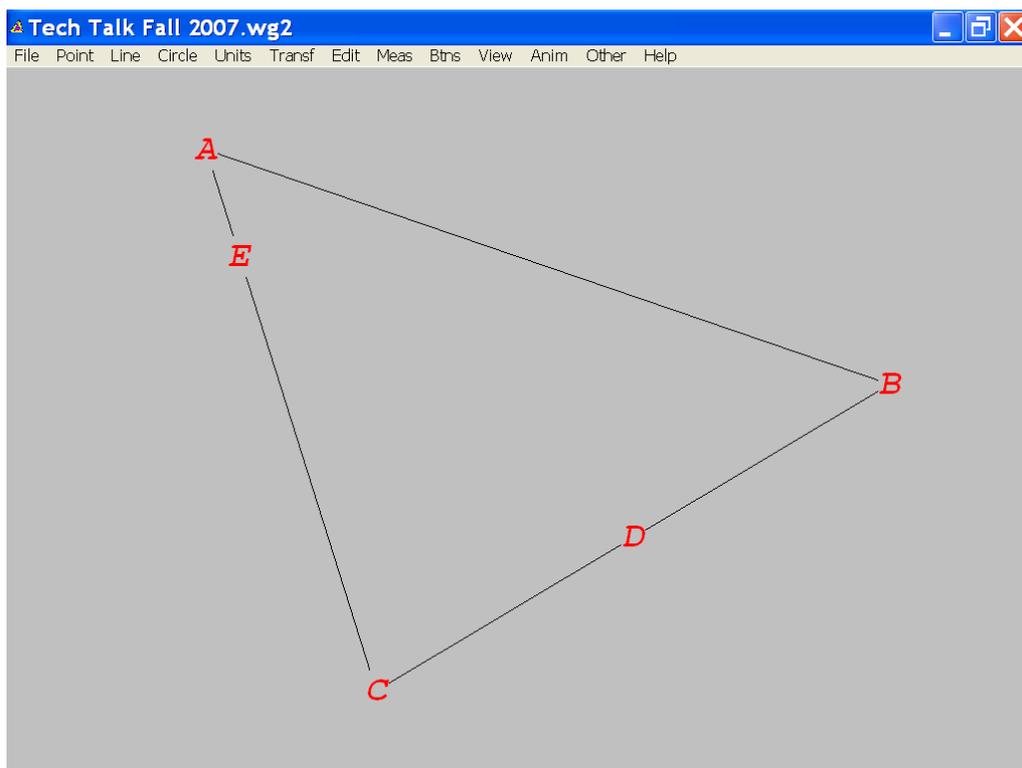


Figure 8: Point E added to segment CA by *Right-Click*

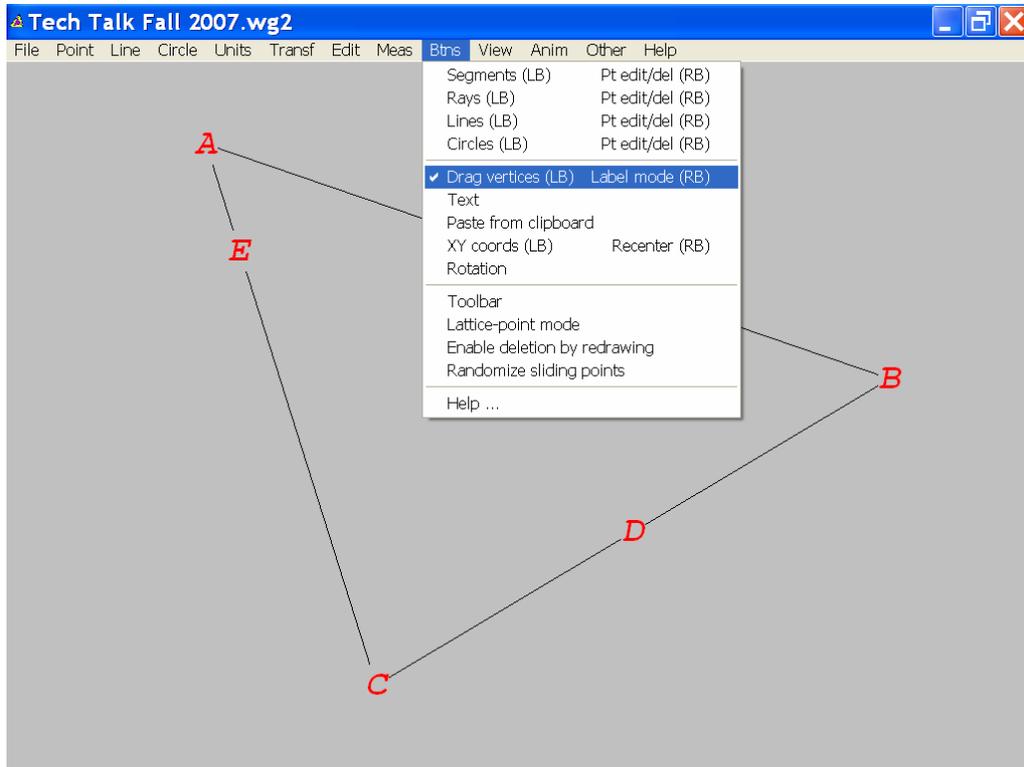


Figure 9: Drag vertices (LB) option selected on the Btms menu

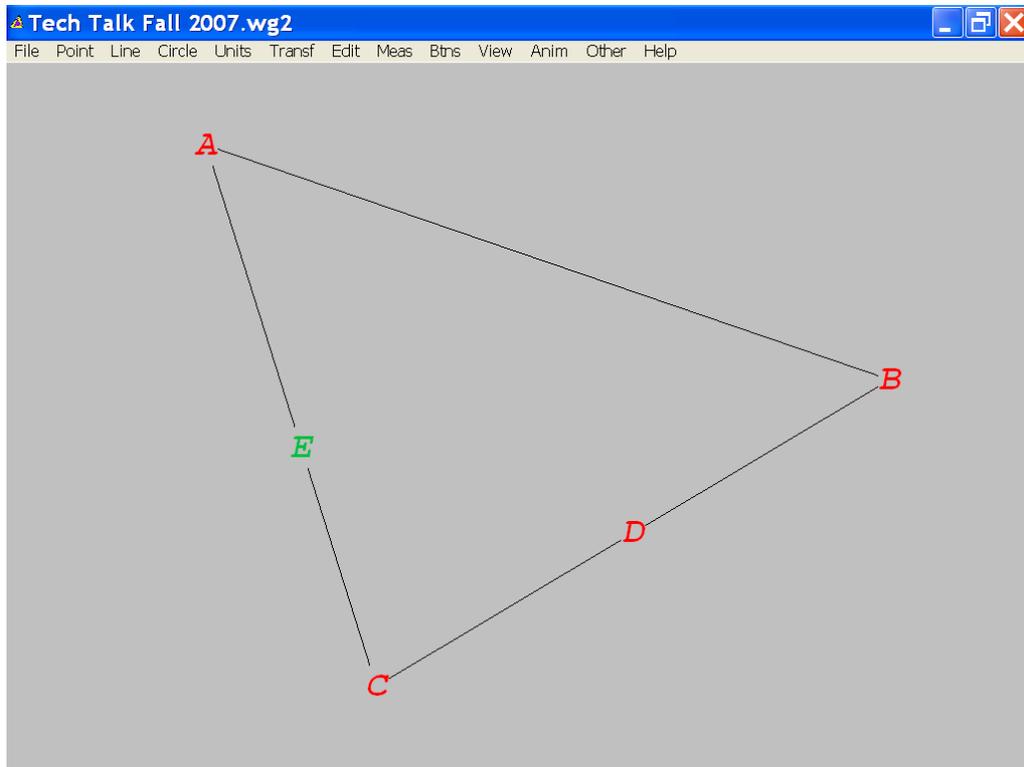


Figure 10: Point E has been moved along segment CA

3 Winggeom 2-D geometry interface—Circles and Measurement

Of course **Winggeom** has many features for doing basic geometry and we only have time to illustrate a few. In this section we will see how **Winggeom** can draw a circle and how it makes some measurements.

Selecting the *Circle / Radius-center* pull-down menu (see Figure 11 below) we get a new dialogue box: *draw circle or arc*. In Figure 12 we have entered the point E as the center of the circle and after checking the radio button for *circle through* we have entered D to insure that our circle will pass through the point D. Once these choices have been entered we select the *draw* button in the dialogue box and our circle appears.

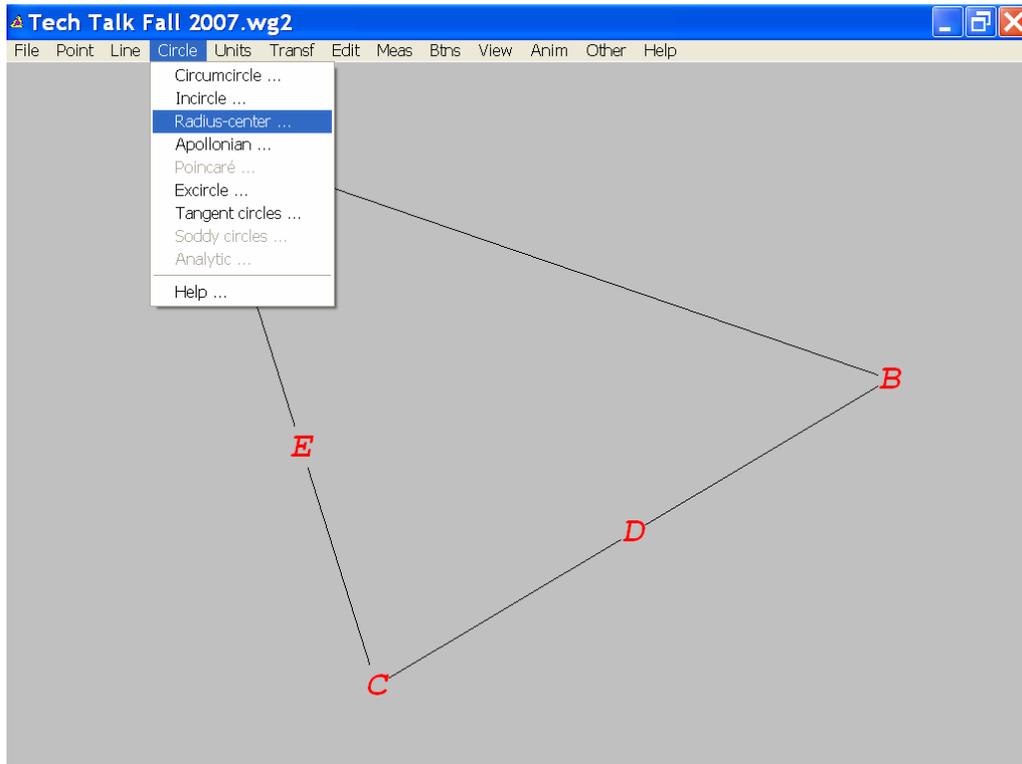


Figure 11: Selecting the *Circles / Radius-center* menu

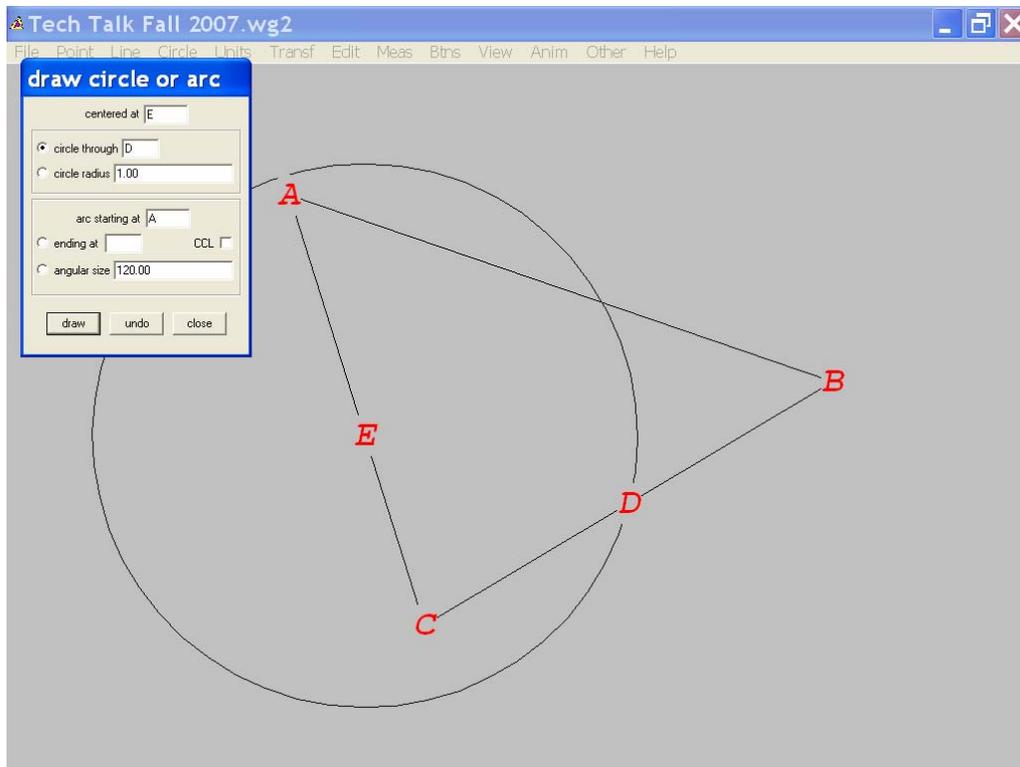


Figure 12: Drawing a circle centered at E and passing through D

using the *Circles / Center-radius* tool and the *new point* dialogue box

Before making any measurements let's add the radius ED to our circle. First, make sure that the *Segments (LB)* tool is checked in the *Btms* pull-down menu (see Figure 1 for help). Once this tool is selected position your cursor over the point E, then press and hold the *Left-Click* or *Left Mouse*; finally drag the cursor to the point D and release. This should give you a picture like the one shown in Figure 13 below. To begin making some measurements select the *Meas* pull-down also indicated in Figure 13.

A new dialogue box (*measurements*) will appear on your screen when you have selected the *Meas* pull-down. Before typing, please select the *display* button on the dialogue box. This is a toggle-switch that puts a copy of the measurement on the screen after you type in what is to be measured and enter that information.

One at a time we have typed in ED, $\angle EDC$ (\angle is the *Shift-comma* keystroke on a standard computer keyboard), and CD and after typing each into the *measurements* dialogue box we have pushed *Enter*. Note that as you type each one and press *Enter* the measurement will be displayed on your screen as in Figure 14.

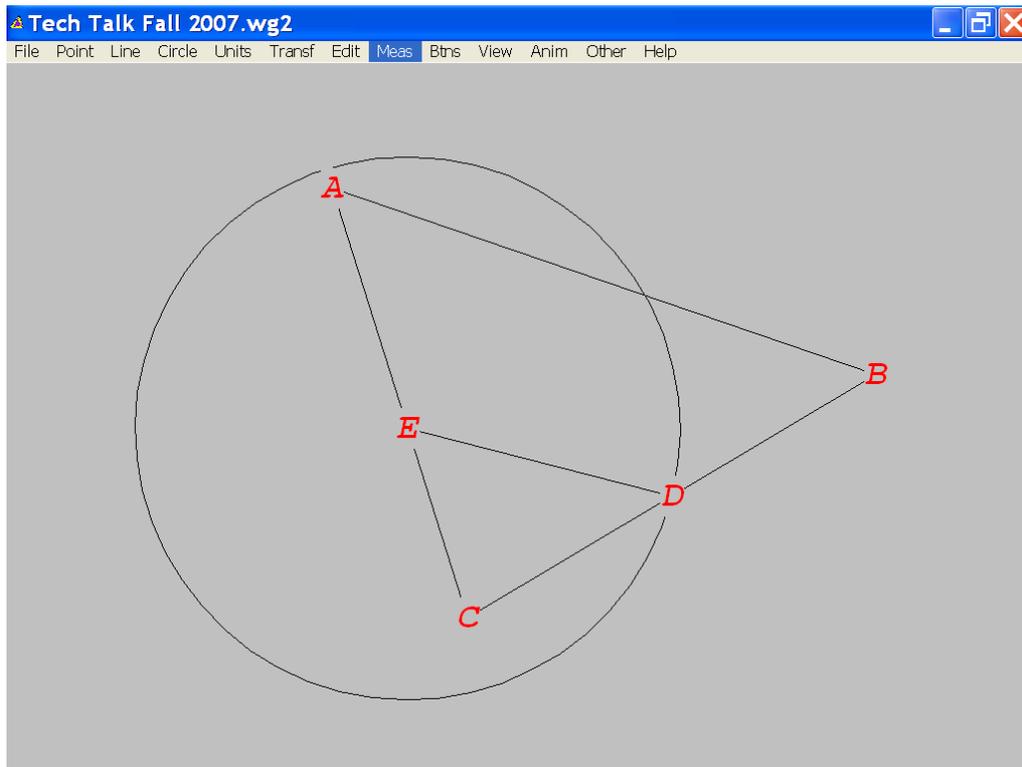


Figure 13: Circle ED with radius shown

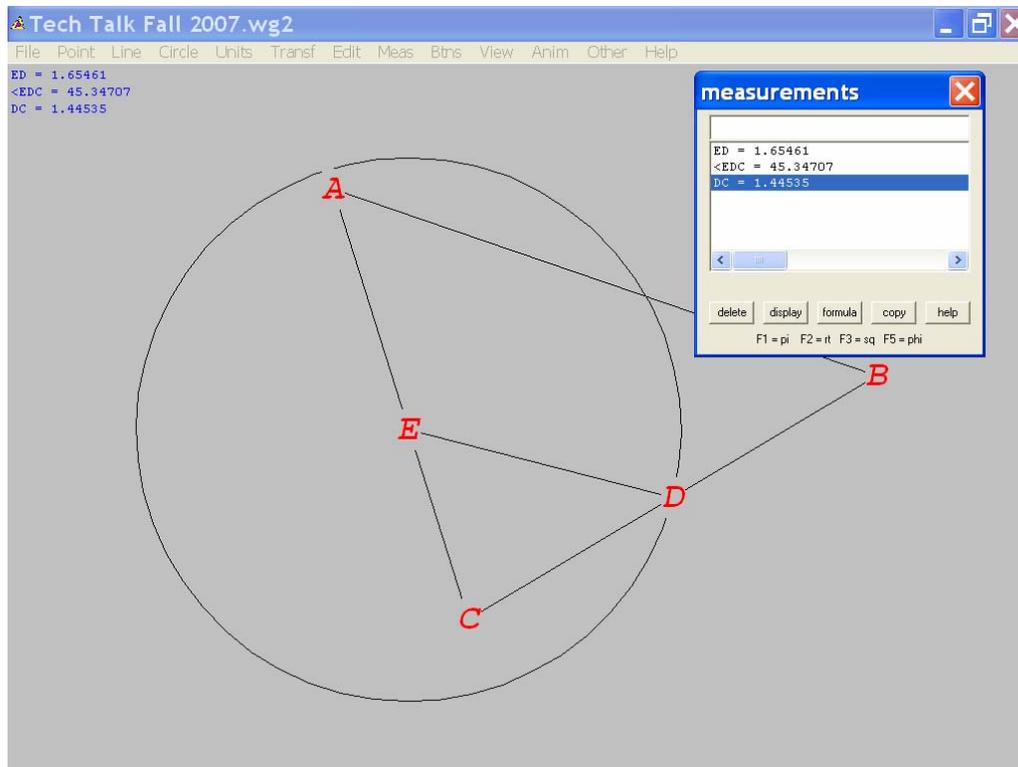


Figure 14: Measurements of ED, angle EDC, and DC displayed

Before proceeding you must close the measurement dialog box. The measurements just added to the display are dynamic in the sense that if we change one of the geometric objects upon which the measurement is based the corresponding measurement will change. To see this you will have to make sure that the *Drag vertices (LB)* is selected on the *Btms* pull-down menu as shown in Figure 9 (above). After you have made these changes try changing the position of point E and observe that the corresponding measurements change (see Figure 15 below for an illustration).

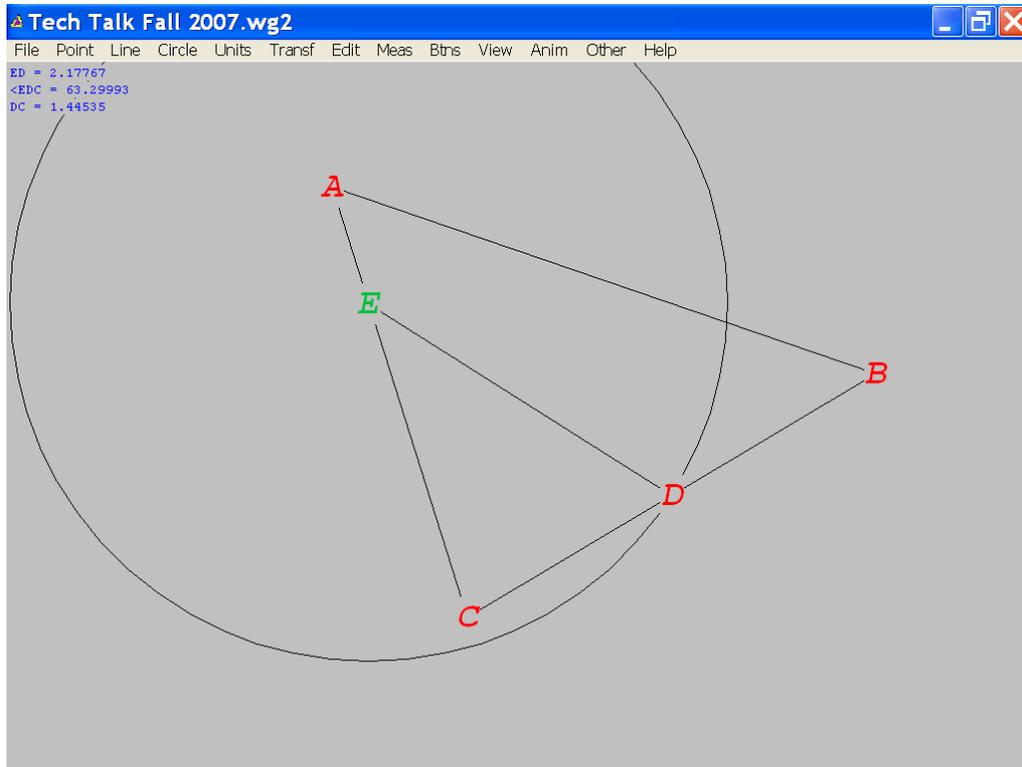


Figure 15: Measurements respond to the movement of point E

4 Winggeom 2-D geometry interface—Transformations

We will conclude our look at **Winggeom** by considering some of its basic features concerning geometric transformations. In this section we will look at how **Winggeom** handles translations and rotations. In this section we will begin with a “new” blank sketch which may be started using *File / New* pull-down menu or *Ctrl+N* key sequence.

Let’s begin by creating an object to be translated. We will use the *Units / Polygon / Isosceles Trapezoid* pull-down menu (illustrated in Figure 16 below) to build an isosceles trapezoid onto our sketch. This pull-down menu creates the *SAS* dialogue box (see Figure 17 below): here we enter the parameters that will define our isosceles trapezoid and then press the *ok* button (letting the sides be 5 and 3 and the angle 60 degrees will be used in the illustration, see Figure 18 below).

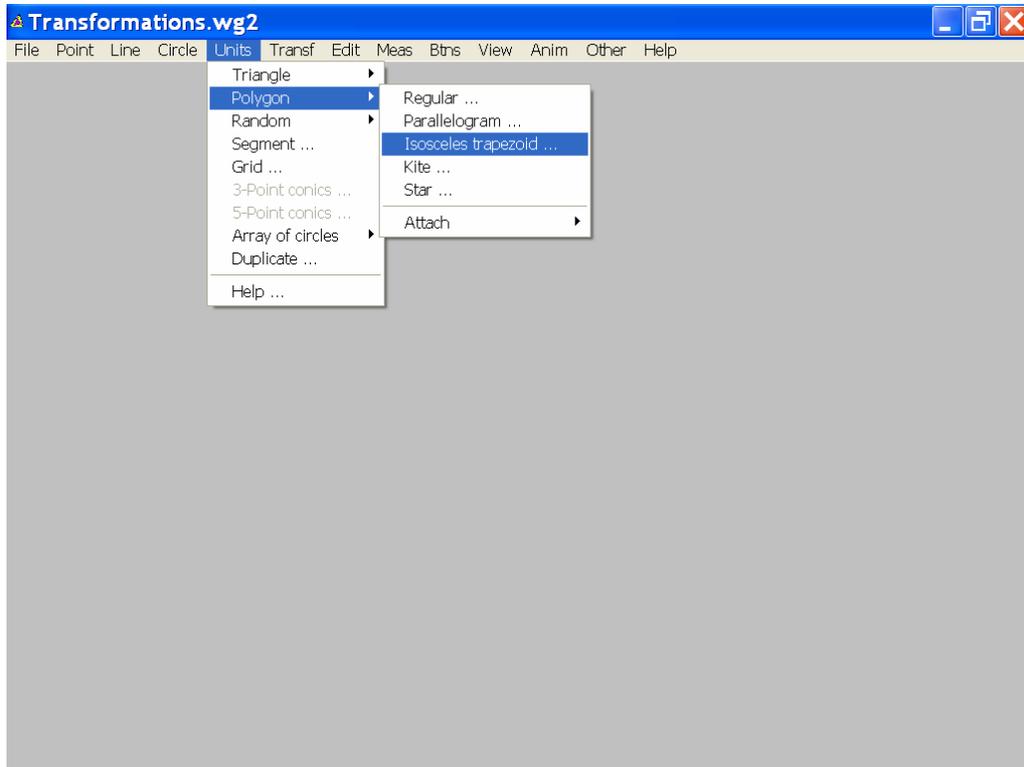


Figure 16: The *Units / Polygon / Isosceles Trapezoid* pull-down menu

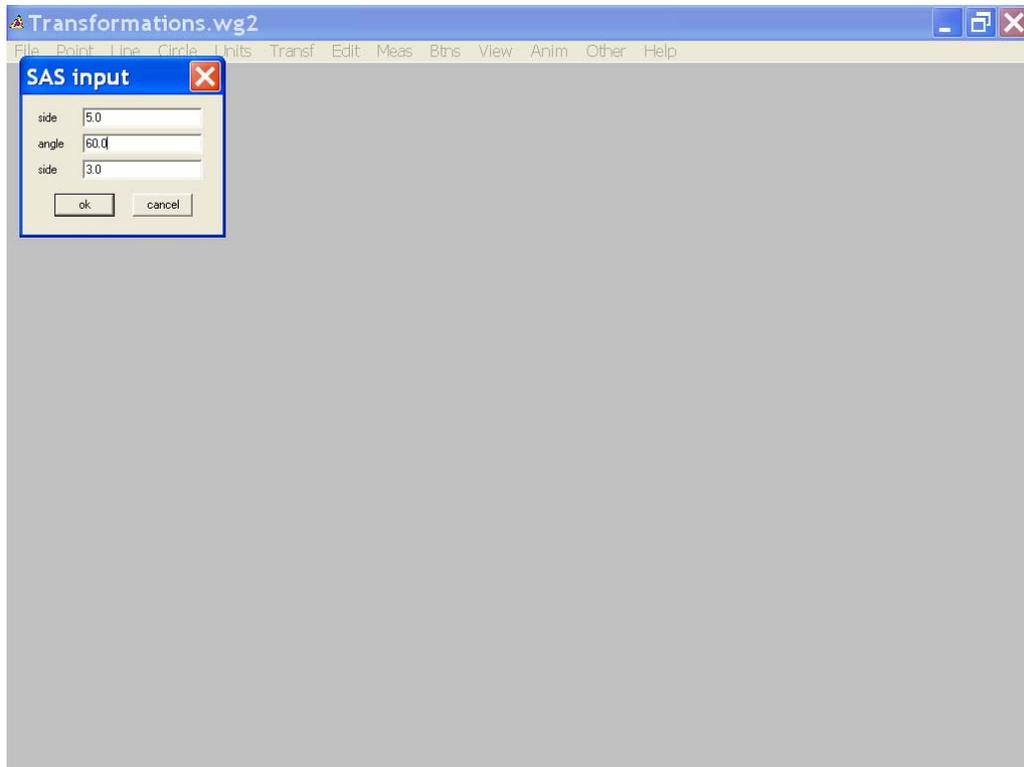


Figure 17: The *SAS* dialogue box

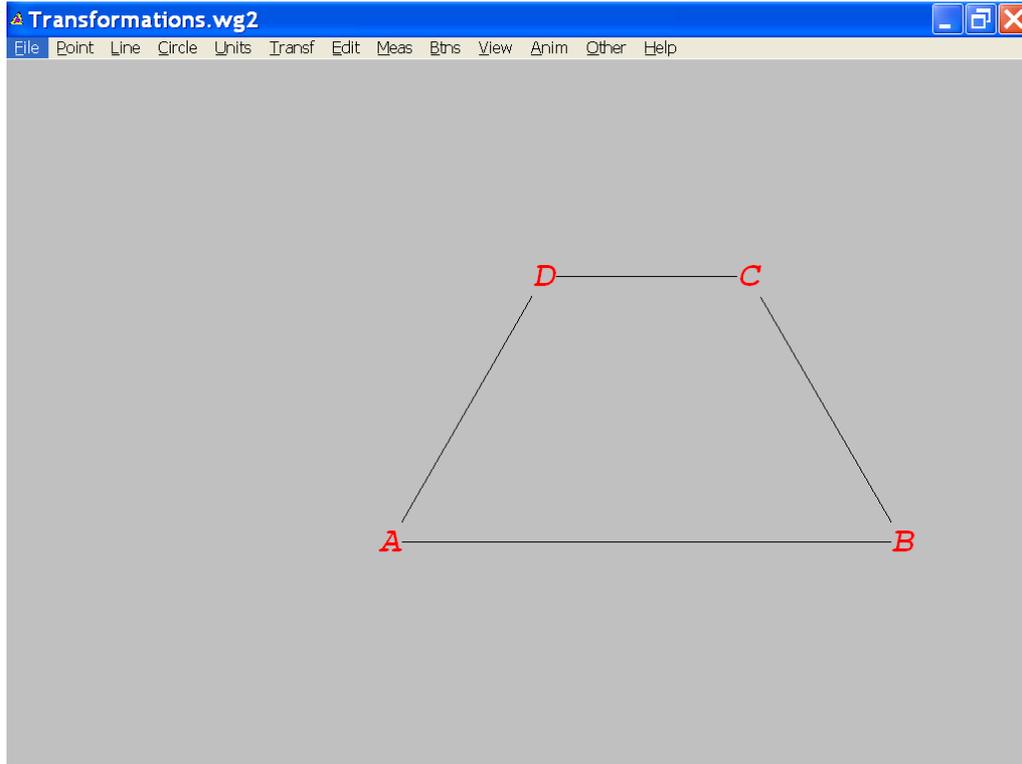


Figure 18: Isosceles Trapezoid ABCD

Next we will use the *Transf / Translate* pull-down menu which is illustrated in Figure 19 below. This creates the *slide* dialogue which is shown in Figure 20 below. In the *slide* dialogue box we have chosen the vertices A through D to be translated using the vector AB (one time—this is indicated by the multiple being chosen to be 1.0). After entering this information into the dialogue box choose the *ok* button and the trapezoid will be translated as is shown in Figure 21 below.

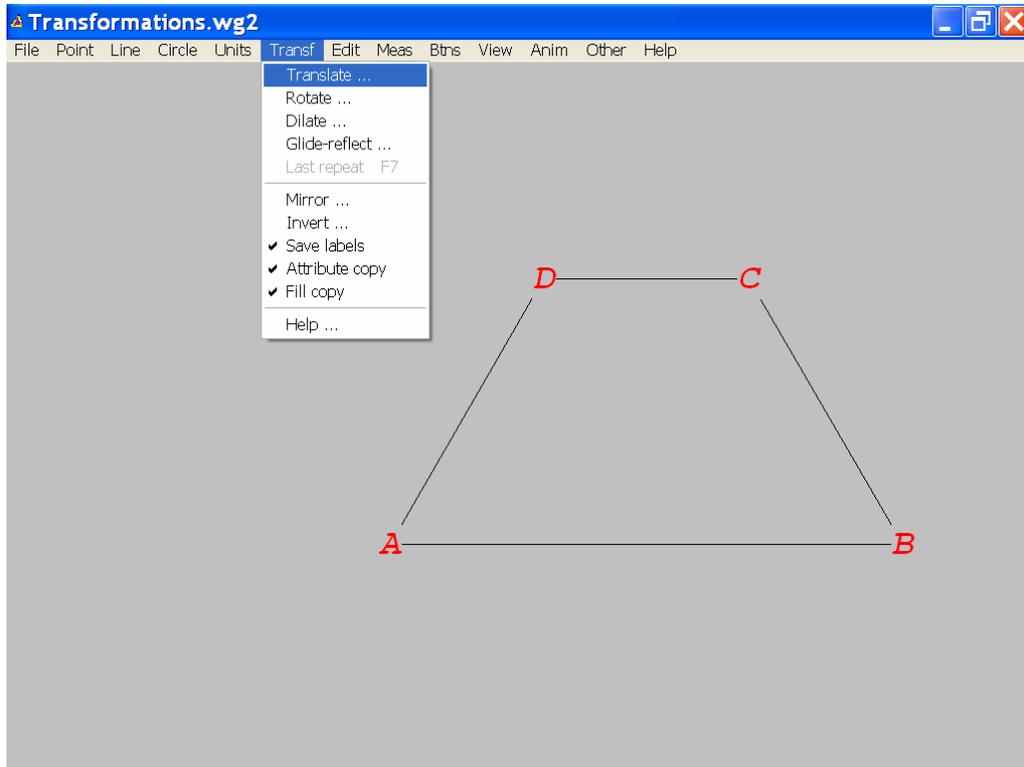


Figure 19: The *Transf* / *Translate* pull-down menu

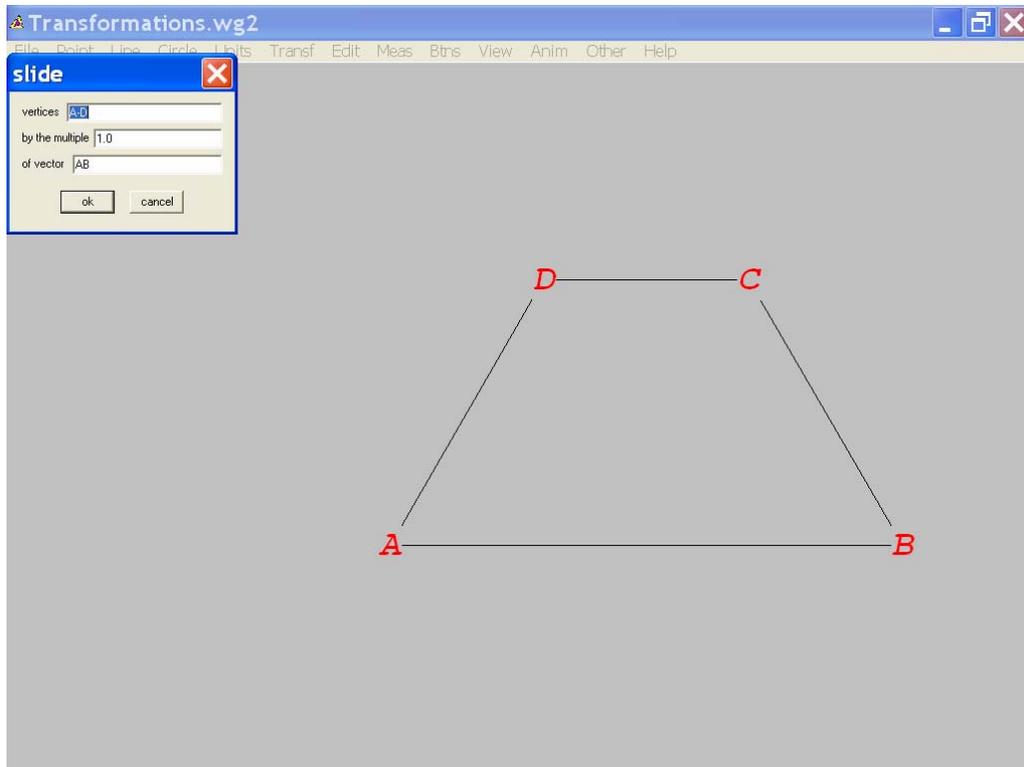


Figure 20: The *slide* dialogue box

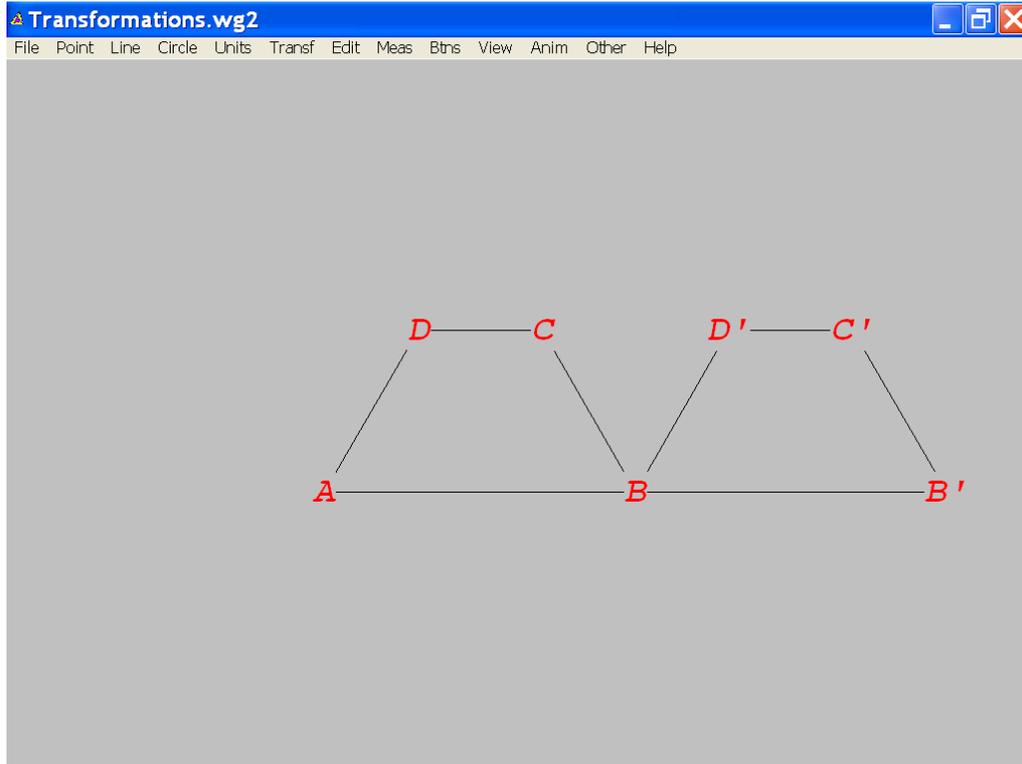


Figure 21: Translation complete

Finally we will use the *Transf / Rotate* pull-down menu which is illustrated in Figure 22 below. This creates the *rotate/dilate* dialogue which is shown in Figure 23 below. In the *rotate/dilate* dialogue box we have chosen the vertices A through D' to be translated using the center A, through an angle of size 90 degrees, with a 1.0 dilation factor (i.e. no dilation). After entering this information into the dialogue box choose the *ok* button and the figure will be rotated as is shown in Figure 24 below.

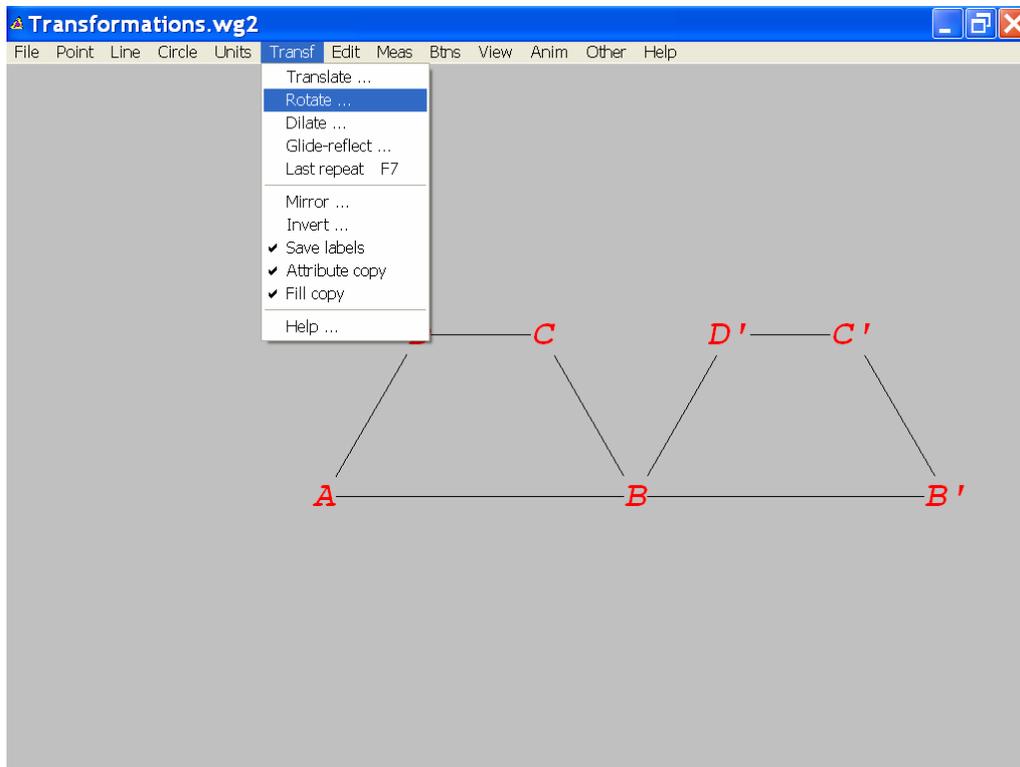


Figure 22: The *Transform / Rotate* pull-down menu

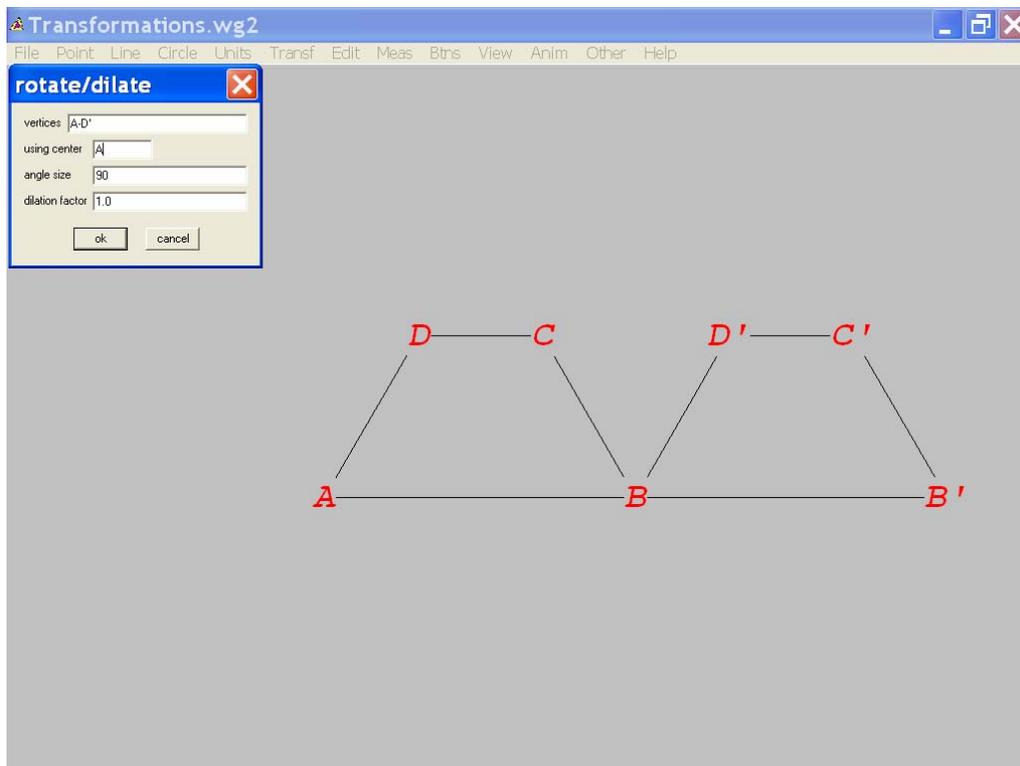


Figure 23: The *rotate/dilate* dialogue box

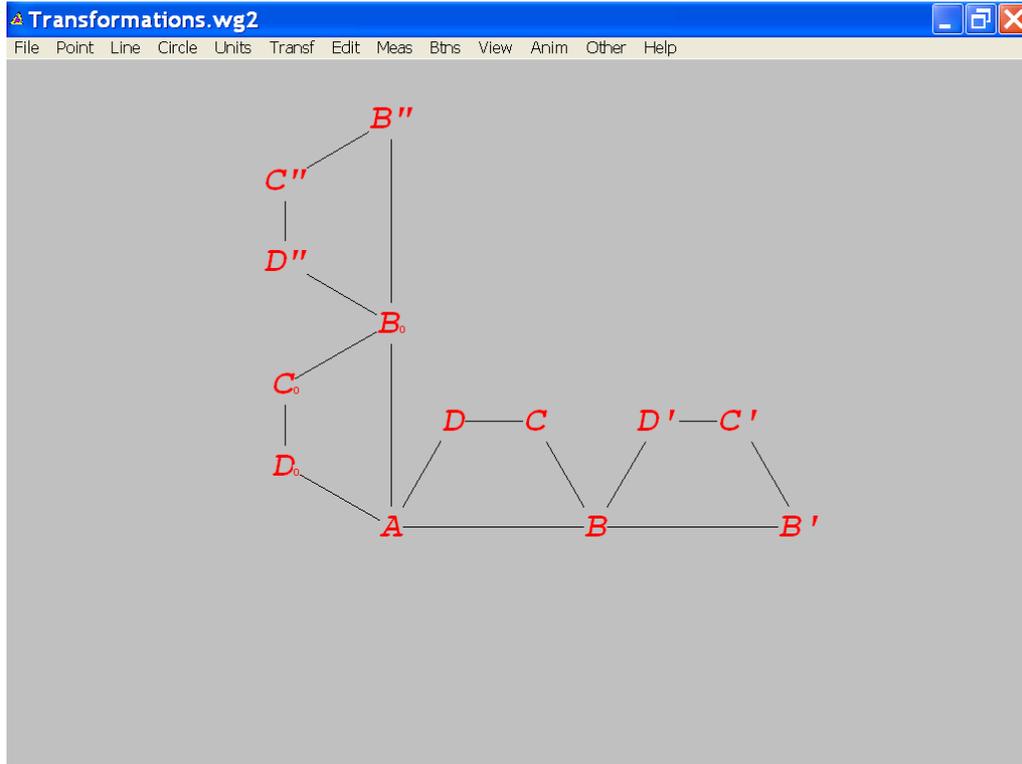


Figure 24: Rotation complete

5 *Winggeom Support*

Winggeom has an assortment of support and ancillary materials available to the user. Many of these materials can be found directly from a Peanut Software webpage devoted to support for this software: <http://math.exeter.edu/rparris/wgsupp.html>. There you will find an excellent tutorial on the 2-dimensional features of **Winggeom** in PDF format, as well as, a nearly 50 page “laboratory” manual (also in PDF format) ready to be used by learners.

A cursory search of the WWW using Google revealed a number of sites where **Winggeom** users have shared their ideas and creations:

1. <http://members.optusnet.com.au/~pjhickey1/>

(ZIP files illustrating many geometric configurations)

2. <http://www2.spsu.edu/math/Dillon/Peanutdocs/GeometrywWinGeom.PDF>

(Examples of investigations with some illustrated using Wingeom that might be given to students)

3. <http://www.wiu.edu/users/mfjro1/wiu/stu/m303/handouts/wingeom-ideas.htm>

(Ideas for Wingeom investigations)

In addition, there is a Peanut Software discussion group hosted by Yahoo; currently it has 444 members: http://groups.yahoo.com/group/peanut_software/

It is through this group that users share their ideas and report bugs concerning the software. Dr. Parris also uses the group as a way to alert users to updates of his software products.

Finally, one of the most interesting aspects of **Wingeom** in particular, and Peanut Software in general, is that Dr. Parris is open to feedback from his users. Through his Yahoo group, and I'm sure many email conversations, Dr. Parris solicits feedback and suggestions for improvement/inclusion in his software packages. Having a nearly direct link to the author and a dedicated group of users is invaluable as you begin to learn how to utilize this software in a learning environment.

References

Jones, K. (2001), Learning Geometrical Concepts using Dynamic Geometry Software. In: Kay Irwin (Ed), *Mathematics Education Research: A catalyst for change*. Auckland: University of Auckland. pp. 50-58.

Judah L. Schwartz, Michal Yerushalmy, The Geometric Supposer: An Intellectual Prosthesis for Making Conjectures, *The College Mathematics Journal*, Vol. 18, No. 1 (Jan., 1987), pp. 58-65

Lagniappe

The simplest "automatic" way to place labels is directly over the points, but some might prefer to offset them from the points. Thus the *Edit / Labels / Offset* switch which is illustrated in Figures 25 & 26 below (note Font size was decreased here to make points appear more clearly).

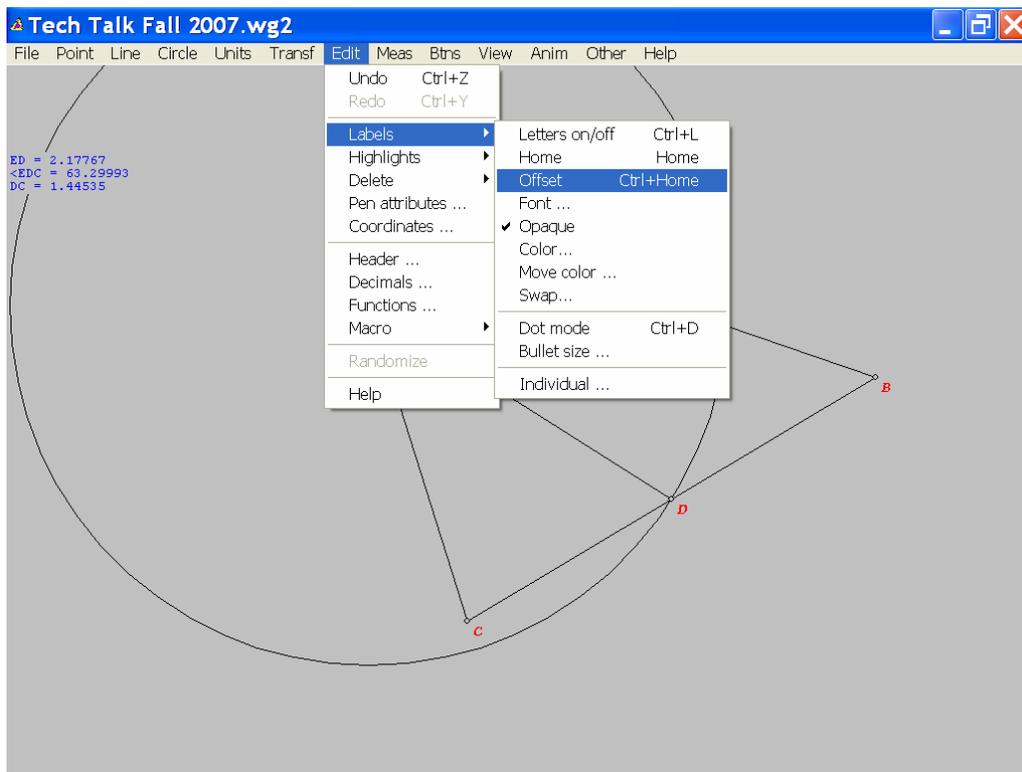


Figure 25: The *Edit / Labels / Offset* switch

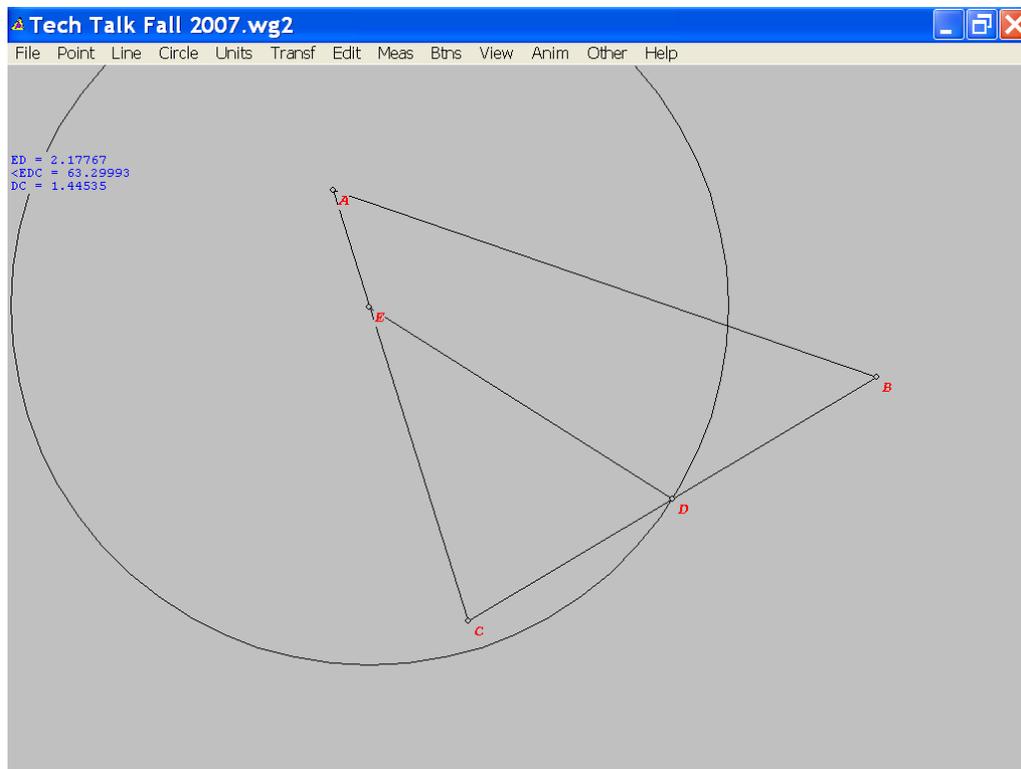


Figure 26: Points with their labels offset

Many users prefer having a "toolbar" in view, so that they do not have to pull down the *Btns* menu every time a new tool is selected. Putting a toolbar into view may be done using the *Btns / Toolbar* switch as illustrated in Figure 27 below. Note that now many of the moves described above may be done using the radio buttons in the "toolbar".

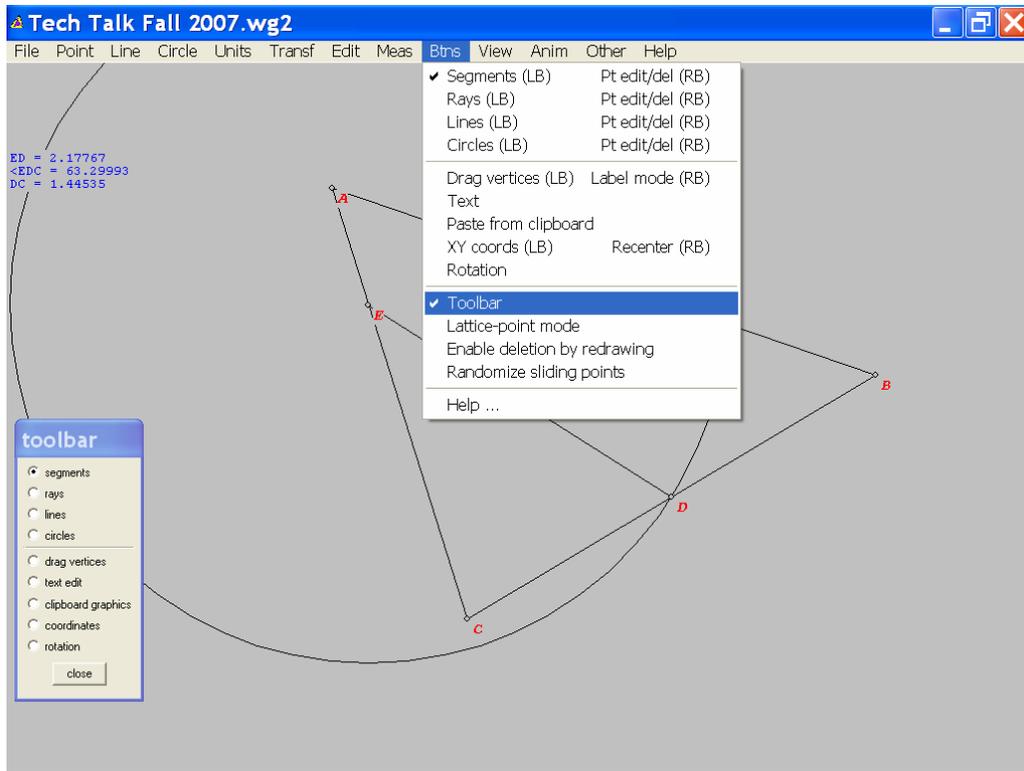


Figure 27: Bringing a “toolbar” into view