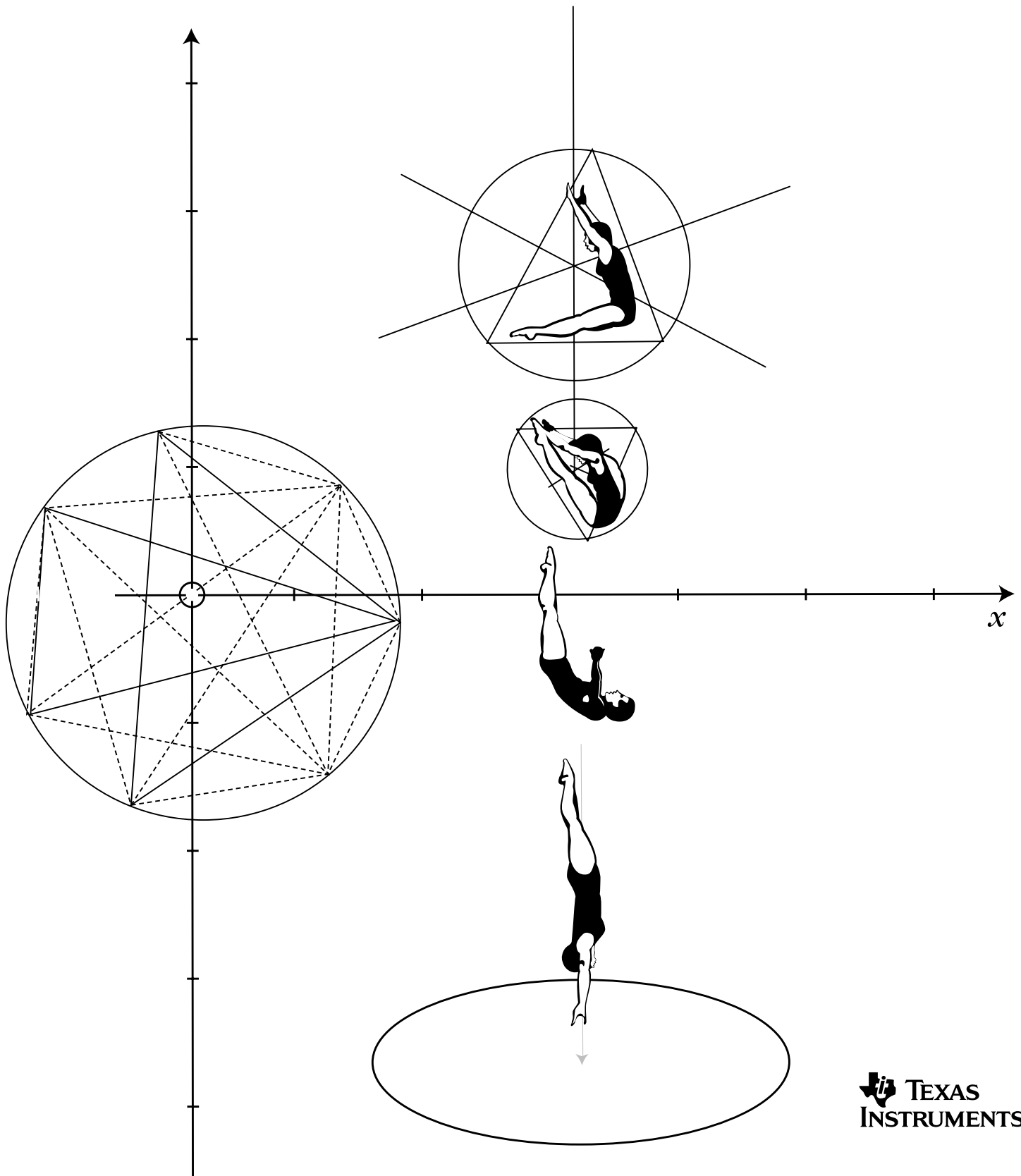


CABRI GEOMETRY® II



 TEXAS
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CABRI GEOMETRY II

Getting Started with Cabri Geometry II for Macintosh[®], Windows[®], and MS-DOS[®]



Dive into Geometry

About Cabri Geometry II

Cabri Geometry II lets you construct and explore geometric objects interactively.

Jean-Marie Laborde and Franck Bellemain developed Cabri Geometry II at the Institut d'Informatique et Mathématiques Appliquées de Grenoble (IMAG), a research lab at the Université Joseph Fourier in Grenoble, France, in cooperation with the Centre National de la Recherche Scientifique (CNRS) and Texas Instruments.

Texas Instruments, the publisher for Cabri Geometry II in the United States and Canada, is pleased to bring computer-based geometry to classrooms. The geometric foundation of this easy-to-use software encourages exploring and conjecturing—from simple shapes to advanced projective and hyperbolic geometry.

About the Developers

Jean-Marie Laborde is founder and Research Director of Laboratoire de Structures Discrètes et de Didactique (LSD2), a research laboratory within IMAG. He graduated in mathematics at École Normale Supérieure in Paris in 1969. He earned a Ph.D. (Thèse d'État) in computer science at the University of Grenoble in 1977. Jean-Marie began work on the Cabri II project in 1981 as an environment for graph theory. He has devoted his research efforts to the use of geometric methods for the study of different classes of graphs, especially hypercubes.

Franck Bellemain earned a Ph.D. in mathematics at the Université Joseph Fourier in 1992. He began work on the Cabri II project in 1986 and is responsible for writing several versions of the software for Macintosh, PC-compatible, and Japanese computers. His research and thesis have been devoted to the use of technology in the classroom.

Cabri Geometry II Features

- Includes interactive analytic, transformational, and Euclidean geometry.
- Allows intuitive construction of points, lines, triangles, polygons, circles, and other basic objects.
- Translates, dilates, and rotates geometric objects around geometric centers or specified points plus reflection, symmetry, and inverse of the objects.
- Constructs conics easily, including ellipses and hyperbolas.
- Explores advanced concepts in projective and hyperbolic geometry.
- Annotates and measures figures (with automatic updating).
- Uses both Cartesian and polar coordinates.
- Provides for user display of the equations of geometric objects, including lines, circles, ellipses, and coordinates of points.
- Allows the user to create macros for frequently repeated constructions.
- Lets the teacher configure tool menus to focus student activities.
- Checks geometric properties to test hypotheses based on Euclid's five postulates.
- Hides objects used in constructions to reduce screen clutter.
- Differentiates objects through the use of paint-like color and line palettes.
- Computes a locus continuously.
- Illustrates the dynamic characteristics of figures through animation.
- Allows the user to save drawings and macros to disk.
- Opens geometry constructions created on the TI-92.
- Provides one square meter of full-size work space, and prints the 8.5 by 11.0 inches (21.59 by 27.94 cm) drawing area.

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Getting the Most from Getting Started

About the Getting Started Guide

The Getting Started guide introduces you to Cabri Geometry II with hands-on exercises. However, it does not cover all features of Cabri II, nor does it demonstrate all the ways to construct any particular object. Getting Started includes the following sections:

First Steps

This section provides system requirements and installation instructions for Cabri Geometry II and briefly discusses the Cabri Geometry II tools.

Checking System Requirements. Describes requirements for Windows, DOS, and Macintosh systems	6
Installing Cabri Geometry II. Explains how to install Cabri Geometry II	6
Starting Cabri Geometry II. Explains how to start Cabri Geometry II	7
Cabri Geometry II Desktop. Briefly describes the Cabri Geometry II screen and toolbar	8
Quick Reference Sheet. Gives a list of the tools under each toolbox in the Cabri Geometry II toolbar	9

Basic Operations

This section provides step-by-step exercises that give you hands-on experience with several features basic to the construction of geometric objects using Cabri Geometry II. To quickly learn Cabri Geometry II, complete these four exercises.

Modeling: Handshakes. Use a circle, points, and line segments to model a real-world problem for pattern recognition	11
Exploring: Transformations in the Coordinate Plane. Construct a triangle, and explore reflection, rotation, and dilation around the x and y axes	18
Exploring: Power (Steiner) of a Point Problem. Construct a point as described by Euclid, and then move the point to calculate various powers and record them in a table	25
Constructing a Macro: Pentagram. Create a pentagram by inscribing pentagons to illustrate some important features of macros.	32

Menu Options and Toolbar Commands

Menu Options. Provides a quick reference and brief description of the menu options	38
Toolbar Commands. Provides a quick reference to the tools available on each toolbar and a brief description about the operation of each tool	40

Note: Most of the illustrations in this guidebook are from the Macintosh version of Cabri Geometry II; several are from the Windows and DOS versions. Due to space limitations, we could not show every illustration for each version. Therefore, some illustrations in this guidebook may be slightly different on your computer.

First Steps

Checking system requirements

Macintosh	DOS
<ul style="list-style-type: none">• Macintosh Classic or better.• System 6.0 or later.• 1 Mb available RAM for a Macintosh Classic. (Memory requirements will be greater for color or larger monitors than on the Classic.)• Hard disk with 1.2 Mb available for program and demonstration files.	<ul style="list-style-type: none">• DOS-compatible computers (PCs), 386 or better, and running MS-DOS 3.3 or later.• EGA, VGA, SVGA video adapter and a color monitor.• 3 Mb RAM (minimum) memory installed.• Hard disk with 2.5 Mb available for program and demonstration files.• Mouse, or an equivalent pointing device.
Windows 3.1	Windows 95
<ul style="list-style-type: none">• 386 PC or better required; 486DX recommended.• PC must be in 386-Enhanced mode with Virtual Memory enabled.• VGA, SVGA video adapter and a color monitor.• 6 Mb RAM (minimum) memory installed.• 7 Mb available hard disk space for program, demonstration files, and system extensions.• Mouse, or an equivalent pointing device.	<ul style="list-style-type: none">• 386 PC or better required; 486DX recommended.• VGA, SVGA video adapter and a color monitor.• 6 Mb RAM (minimum) memory installed.• 2 Mb available hard disk space for program and demonstration files.• Mouse, or an equivalent pointing device.

Installing Cabri Geometry II

Macintosh	DOS
<ol style="list-style-type: none">1. Create a folder named Cabri II on your hard disk.2. Insert the Cabri Geometry II Macintosh diskette in your floppy disk drive.3. Double-click on the Installer on the diskette and follow the directions on the screen.	<ol style="list-style-type: none">1. Insert the Cabri Geometry II DOS diskette in your floppy disk drive.2. At the DOS prompt, enter: A:\INSTALL or B:\INSTALL, and then follow the screen prompts.
Windows 3.1	Windows 95
<ol style="list-style-type: none">1. Insert the Cabri Geometry II Windows diskette #1 in your floppy disk drive.2. From Program Manager, click on RUN and enter A:\SETUP, and then follow the screen prompts.	<ol style="list-style-type: none">1. Insert the Cabri Geometry II Windows diskette #1 in your floppy disk drive.2. Click on START/RUN and enter A:\SETUP, and then follow the screen prompts.

Installing Cabri Geometry II on a network

If you have purchased the network license for Cabri Geometry II, you may run the software on your network. Use network procedures that are compatible with your network to install Cabri Geometry II. See your Macintosh, Windows, or DOS User's manual or your network documentation for more information, if necessary.

Note: Cabri Geometry II is supplied on high-density diskettes. If your computer will not accept these diskettes, call, 1-800-TI-CARES and a service representative will supply you with low density diskettes.

Installing Cabri Geometry II on a network (continued)

Macintosh and DOS

1. Install Cabri Geometry II on the network server using the instructions given on the previous page.
 2. Run the program from the server the first time, and enter the requested information.
 3. To run Cabri Geometry II on each network client, go to the directory on the network server where the Cabri Geometry II application is installed. Macintosh users may double-click on the Cabri II icon; DOS users may run Cabri2.exe to start the program.
-

The procedure described below, for Windows users, allows multiple client computers to run Cabri Geometry II using the application software installed on the network server. Each client computer is provided with the necessary system files to run Cabri Geometry II and a shortcut icon that is linked to the application file on the network server.

Windows 3.1 and Windows 95

1. Install Cabri Geometry II on the network server using the instructions given on the previous page. In the **Select Destination** screen, you must select a directory that will be accessible from each client computer on the network.
 2. Temporarily copy **setup.exe** and **setup.w02** from the installation diskettes to the same directory in which you installed Cabri Geometry II in step 1.
 3. On each network client, go to the directory on the network server that contains **setup.exe** and double-click to on this file to run the setup program.
 4. In the **Select Destination Directory** screen, click on the **Browse** button and select the same directory that you used in step 1. Make sure the correct directory is displayed at the top of the window. You may edit the path, if necessary, and then click on **OK**. Ignore the message that the directory already exists.
 5. In the **Select Components** screen, deselect the first three components. The installation program will determine if the fourth component is necessary for Windows 3.1x users.
 6. When Cabri Geometry II has been installed on all client computers, delete the two files that were temporarily copied to the network server in step 2.
-

Starting Cabri Geometry II

Macintosh

You can use one of four methods to start the software on a Macintosh:

- Use **Open** in the **Finder**.
 - Double-click on the **Cabri II** icon.
 - Double-click on any Cabri Geometry II construction file, tool configuration file, or macro file.
 - Drag and drop any construction file onto the **Cabri II** icon (System 7 users only).
-

DOS

Type CABRI and press ENTER from the DOS prompt directory where the Cabri Geometry II files are located.

(Optional) Add the Cabri directory to your DOS path to open Cabri Geometry II from any directory.

Windows

Double-click on the **Cabri II** icon.



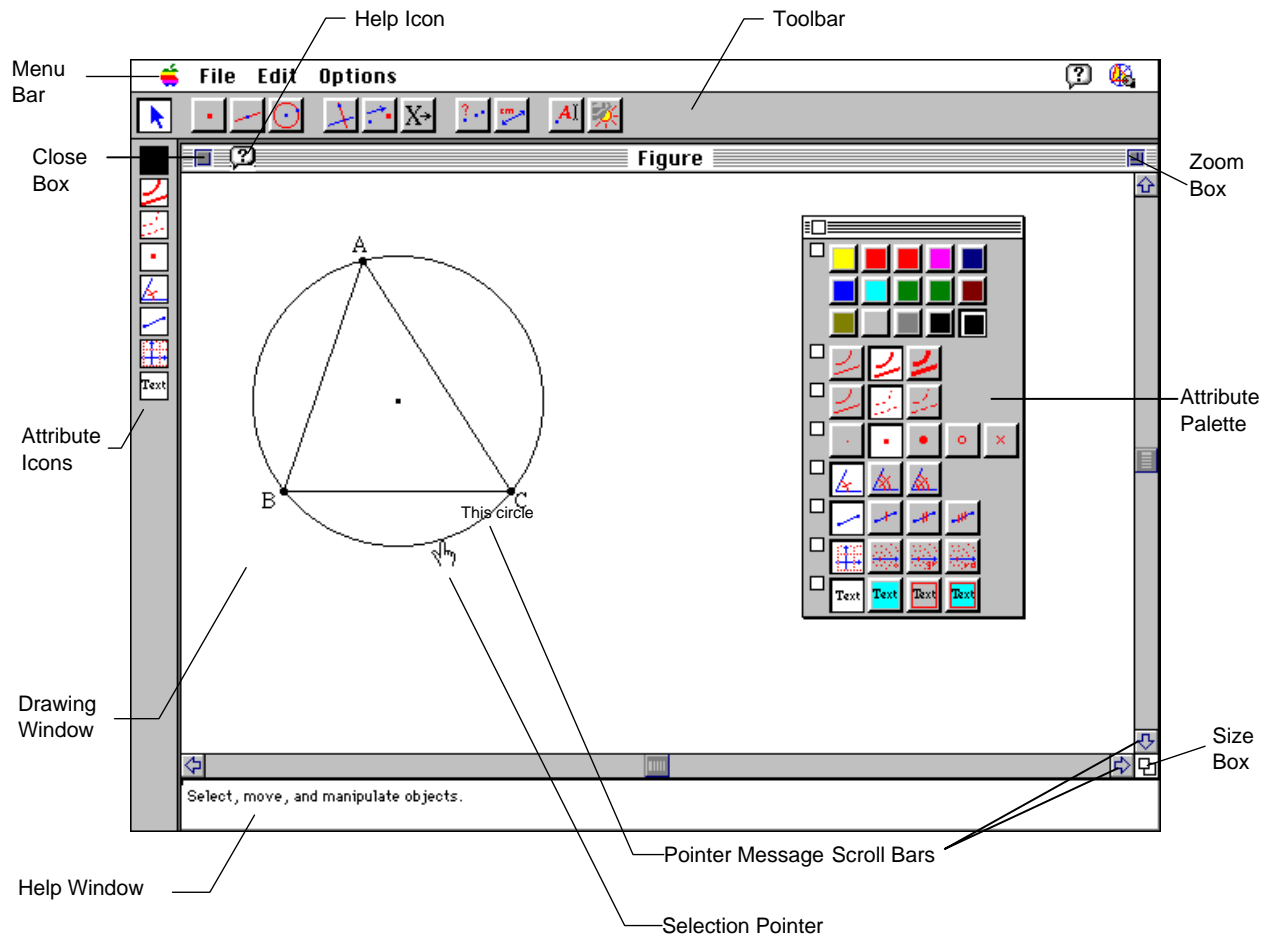
First Steps (Continued)

About Cabri Geometry II Tools

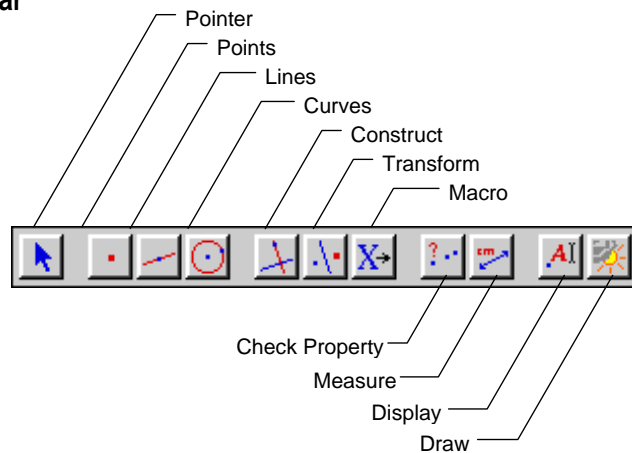
In Cabri Geometry II, you use one construction tool at a time. The tools are displayed as groups of buttons on the toolbar across the top of the screen. The buttons, often called “toolboxes,” are referenced from left to right in the text.

Cabri Geometry II Screen

The screen shown below illustrates the Macintosh version. Screens on Windows and DOS systems are similar but slightly different.

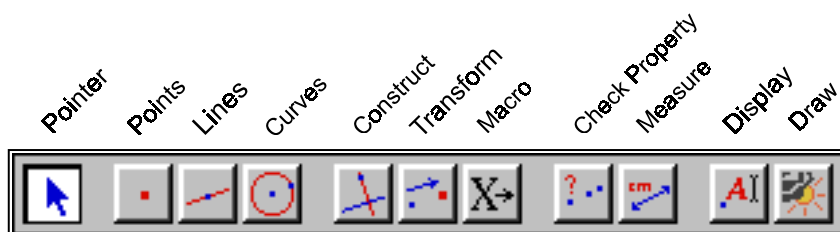


Cabri Geometry II Toolbar



QUICK REFERENCE SHEET: CABRI GEOMETRY II

CABRI TOOLBAR



POINTER

- Pointer
- Rotate
- Dilate
- Rotate and Dilate

POINTS

- Point
- Point on Object
- Intersection Point

LINES

- Line
- Segment
- Ray
- Vector
- Triangle
- Polygon
- Regular Polygon

CURVES

- Circle
- Arc
- Conic

CONSTRUCT

- Perpendicular Line
- Parallel Line
- Midpoint
- Perpendicular Bisector
- Angle Bisector
- Vector Sum
- Compass
- Measurement Transfer
- Locus
- Redefine Object

TRANSFORM

- Translation
- Rotation
- Dilation
- Reflection
- Symmetry
- Inverse

MACRO

- Initial Object
- Final Object
- Define Macro

CHECK PROPERTY

- Collinear
- Parallel
- Perpendicular
- Equidistant
- Member

MEASURE

- Distance and Length
- Area
- Slope
- Angle
- Equation and Coordinates
- Calculate
- Tabulate

DISPLAY

- Label
- Comments
- Numerical Edit
- Mark Angle
- Fix/Free
- Trace On/Off
- Animation
- Multiple Animation

DRAW

- Hide/Show
- Color
- Fill
- Thick
- Dotted
- Modify Appearance
- Show/Hide Axes
- New Axes
- Define Grid

Modeling: Handshakes

Problem: Four friends meet at a party. Each wants to shake hands with the others. How many handshakes take place? A fifth friend enters the room—then a sixth and seventh. How many handshakes are there?

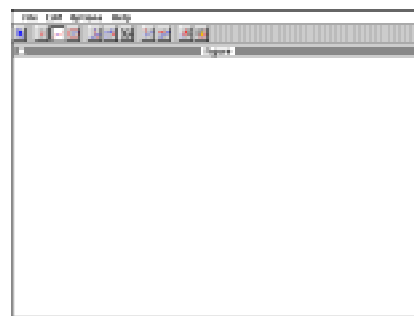
You can use Cabri Geometry II to model this situation by constructing points on a circle to represent the friends and line segments to represent the handshakes.

People	New handshakes	Total handshakes
4		
5		
6		
7		
n		

Step-by-step instructions are given below. Follow the steps and fill in the chart at the right. Do you see a pattern?

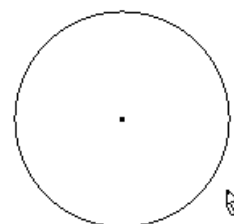
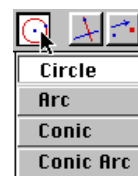
Get ready

1. Start Cabri Geometry Geometry II. Click anywhere in the drawing window to remove the initial screen. The drawing window appears.



Construct a circle to represent the party

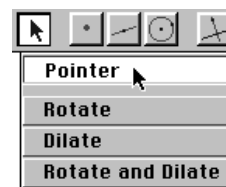
2. The fourth button on the toolbar represents the currently selected tool in the **Curves** toolbox. (The toolboxes have been assigned names for convenience—the names do not appear on the screen.) Click and hold on that tool to pull down the menu of tools used to construct curved lines.
3. Point to and click on the **Circle**. The circle tool is displayed in the toolbox. Notice that this button is lighter than the others and has the appearance of a button that is pushed in. This tells you that **Circle** is the currently selected tool.
4. Move the \blacktriangleright (pointer) toward the center of the drawing window. As you move the \blacktriangleright onto the drawing window, it changes to a \textcircled{p} (pencil) so that you can “draw” a circle. Click and release the mouse button. A dot appears.
5. Move the \textcircled{p} away from the point. (Do not hold the mouse button down.) As you move the \textcircled{p} , a circle appears. Continue to move the \textcircled{p} to change the size of the circle. When the radius of the circle is about two or three inches, click again.



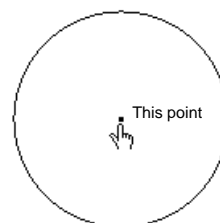
Notice that the **Circle** tool is still highlighted, indicating that you can make another circle immediately, without having to select from the toolbar again.

Move and resize the circle

6. Instead of making another circle, practice moving and resizing the circle. The tools for moving and resizing are in the **Pointer** toolbox, which is the first toolbox on the toolbar. Begin by pulling down the **Pointer** toolbox; then point to and select the **Pointer** tool (↔).



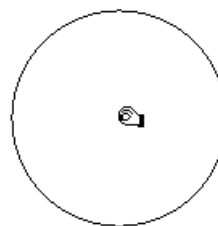
7. Move the ↔ into the drawing window. Notice that the ↔ changes to a + (cross hair). Move the + to the point at the center of the circle. It changes to a ⤴ (pointing hand) and the message **This point** appears.



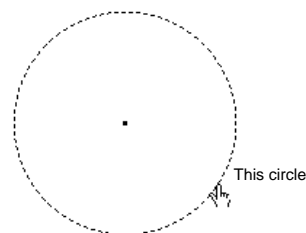
Cabri Geometry II recognizes all the objects you create and informs you when the cursor is close enough to an object for you to select it or perform some other activity.

Click once on the mouse button. The point flashes, indicating that the point is selected.

8. Click and hold the mouse button. The ⤴ changes to a ⤵ (grasping hand) to show that you can move the object. While holding the mouse button down, drag the point toward the right to move the circle. Release the mouse button. (**Note:** You don't have to select a point to move it.)



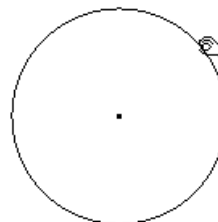
9. Now move the ⤴ away from the center point. It changes back into a +. Move the + toward the circumference until it changes to the ⤴ with the message **This circle**.



Click once on the mouse button. (Do not hold the mouse button down.) The circumference appears to be moving or flashing. This marquee outline indicates that the circumference is selected.

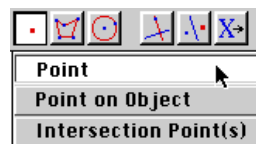
To deselect the circle, move the ⤴ until it changes to a + and then click. The circumference no longer appears to be moving.

10. Move the + near the circumference until the ⤴ appears. Click and hold the mouse button. The ⤴ changes into a ⤵. Enlarge the circle to fill the screen by dragging the circumference. Release the button.



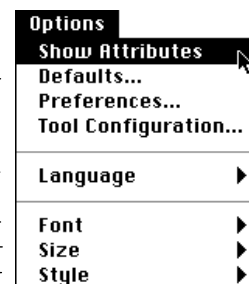
Construct points to represent the four friends

11. The second button on the toolbar shows the currently selected tool in the **Points** toolbox. Pull down the **Points** menu and select the **Point** tool.



12. Pull down the **Options** menu above the toolbar. Select **Show Attributes** (Macintosh, Windows) **Hide/Show Attributes** (DOS).

Macintosh and
Windows only




The attribute icons appear vertically on the left side of the drawing screen. These icons represent tools that let you control the appearance of objects that you create.



13. The fourth attribute icon represents the currently selected **Point** attribute. Click and hold the button to display the choices. You can construct a point as a \bullet , \circ , \odot , or \times .

Select the \circ attribute. Now every point that you construct with the **Point** tool will appear on the drawing screen as a \circ until you change the attribute.



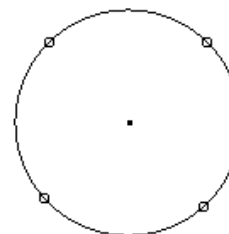
14. Move the  toward the circumference until the pencil changes appearance and the message **On this circle** appears. This message tells you that the defined point will be attached to the circle and that, if you move the circle, the point will move with it.





Click to create a \circ to represent the first friend.

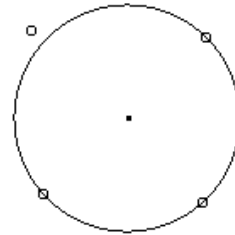
15. Add the other three friends in the same way, evenly spaced around the circle.

To check your work, complete the **Checkpoint #1** instructions on the next page.



Checkpoint #1: The first time you use the tools, you may inadvertently create points that appear to be on the circle but are only very near the circle. To check for this:

- Select the **Pointer** tool () from the **Pointer** toolbox (first button).
- Drag the point at the center of the circle. All points should move with the circle.
- If a point is not on the circle, move the + toward that point until the  appears and then click to select the point. Press the DELETE key. Select the **Point** tool and create a new point on the circumference of the circle.

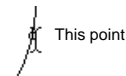


Write the name of a friend next to each point

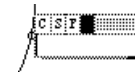
- Select the **Label** tool from the **Display** toolbox (tenth button).



Move the + toward one of the points until it changes to an I (I-beam) and the message **This point** appears.



Click once; the text box appears. (It may take more time than you expect for the text box to appear.)



Type the name of the first friend.

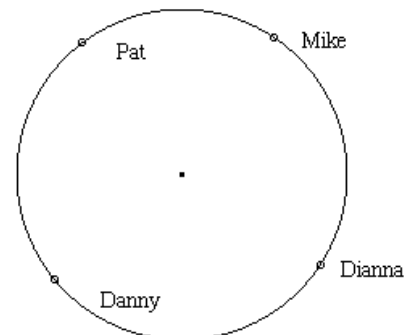
Note: You can resize the text box by dragging the bottom right corner.






- Move the I (which changes to a +) toward another point until it changes back to an I and the message **This point** appears. Click once. Type the second name in the text box.




Repeat for the other friends.


Note: You can use the **Pointer** tool (first button) to drag the labels for better visibility.



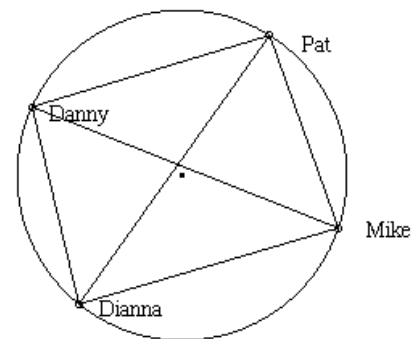
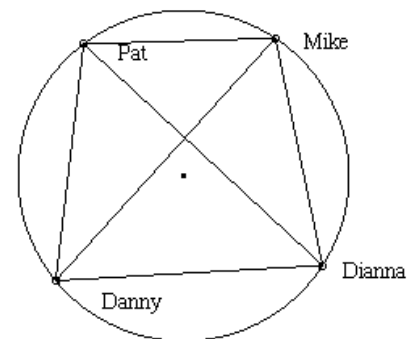
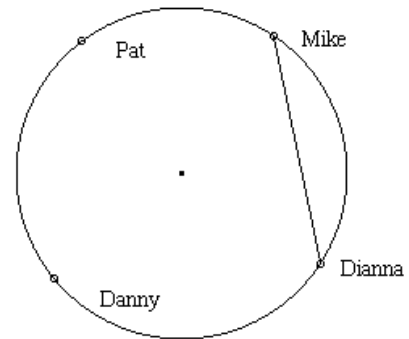
Construct the line segments to represent the handshakes

18. Select the **Segment** tool from the **Lines** toolbox (third button).
19. Move the  near a point representing a friend until the  changes to a  and the message **This point** appears. Click once. (Do not hold the mouse button.)


Move the  away from the point. A line extends from the point. Move the  toward another point until the  and the message **This point** appear. Click again. The line segment (handshake) is defined by the two end points (friends).

Caution: Do not click when the  is displayed with the message **Point on this object** because this will create a new point. If you do create a new point inadvertently, refer to the steps in the **Checkpoint #1** box to delete it.

20. Repeat step 19 to create line segments to model all possible handshakes.



Checkpoint #2: Check to see that you have not inadvertently created new points as the end points of the line segments.

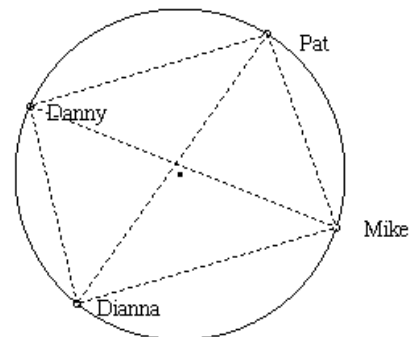
- a. Select the **Pointer** tool () from the **Pointer** toolbox (first button).
- b. Drag one of the points on the circle about one-half of an inch (1.3 cm). The point (and its associated label) should move around the circumference, moving all of its line segments with it.
- c. Repeat for the other points.

Note: If the cursor changes to a magnifying glass and the message **Which object?** appears, you may have created duplicate points and one or more line segments are not attached to an original point. To start over, press **COMMAND+A** (Macintosh) or **CTRL+A** (Windows, DOS) on your keyboard to select all objects on the screen, and then press **DELETE**. A clean drawing window appears. Repeat the exercise. It will go very quickly now that you are familiar with the Cabri Geometry II tools!

Count and record the handshakes

21. To keep track of each handshake as you count it, use the selection feature. Click on the first line, and then press and hold SHIFT as you click on each additional line. The change in appearance of each line helps you keep track as you count.

Enter the number in the chart at the beginning of the exercise. Click outside the circle to deselect the lines.



Open the on-screen attribute palette

22. You can help differentiate new points and handshakes from the old points and handshakes by using the color, point, and line attributes.

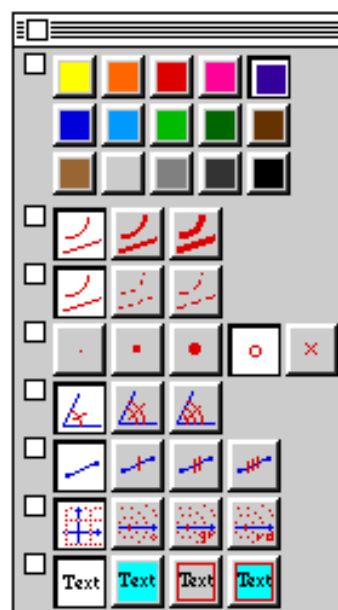
For convenience, you can create a customized on-screen attribute palette of the attribute icons.

Click and hold on the **Color Attribute** toolbox (the top button on the attribute toolbar); however, instead of selecting a color when the palette opens, hold down the mouse button and drag the entire palette onto the drawing window. Release the mouse button.

Click on each of the attribute buttons on the vertical attribute toolbar to add the tools to the on-screen attribute palette. These include color, line thickness, line appearance, point type, and others.

Note: On monochrome systems, the color palette is not available. On these systems, the palette presents varied shades of gray.

You can drag the palette by its title bar to a more convenient location on the drawing window. You can close any unneeded attribute toolbox by clicking on the close box at the left corner of that toolbox.



Add the fifth friend and handshakes

23. Select the **Point** tool from the **Points** toolbox (second button). Notice that \circ and the color red are selected on the palette. (Each time you select a new tool, the palette shows the current settings for that tool.)
24. Select a different color and x as the **Point Attributes** for the fifth friend. Then add the new friend to the circle. Select **Label** from the **Display** toolbox (tenth button). Move to the new point, click once, and type the friend's name. You can use the **Pointer** tool (first button) to enlarge the circle and reposition the points and labels as needed for visibility.

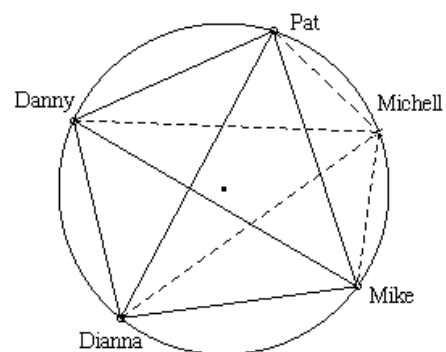
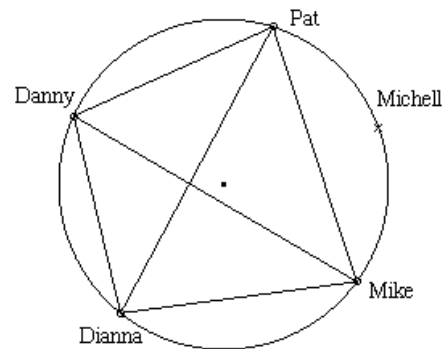
Note: You can label a point when you create it by typing the name on the keyboard immediately after creating the point. However, this labeling method is limited to five characters.

25. Select the **Segment** tool from the **Lines** toolbox (third button).

Choose a different color and a different **Line Attribute**, such as a dotted line or a heavier weight.

Add the new handshakes. (Remember to click only when the message says **This point** so that you don't create a new point.)

Count the handshakes, and enter the results on the chart at the beginning of the exercise.

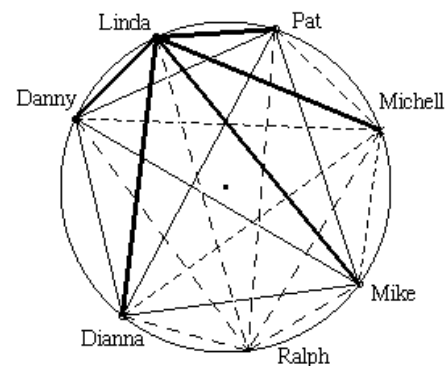


Add the sixth and seventh friends and handshakes

26. Add the additional friends and the associated handshakes. Change the line color and attribute for each.

Count the handshakes, and complete the chart.

Do you see a pattern? Can you predict how many handshakes there are for eight friends? For 20 friends? Generalize the equation.



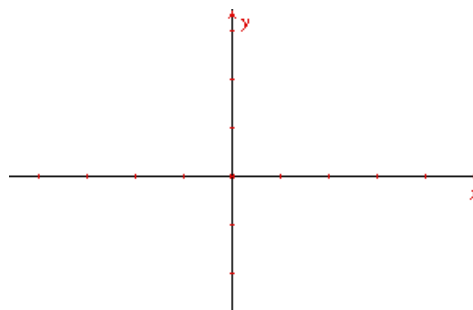
Solution: The total handshakes are 6, 10, 15, and 21, requiring 4, 5, and 6 new handshakes for the fifth, sixth, and seventh friends, respectively. In general, the number of new handshakes required is $n-1$, and the total number of handshakes is $n(n-1)/2$.

Exploring: Transformations in the Coordinate Plane

Problem: What happens to the Coordinate values of a triangle that is constructed in the upper right quadrant and then transformed in various ways? Explore using Cabri Geometry II to find out.

Get ready

1. Start the software (see page 1-3), if necessary, or select the **New** option from the **File** menu if the drawing window is already displayed. You will be prompted to save your current construction if one exists.

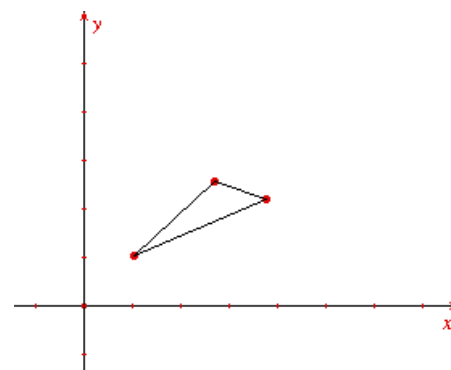


Display the rectangular coordinate axes

2. Select **Show Axes** from the **Draw** toolbox (last button). The axes appear, centered on the drawing screen.

Construct a triangle

3. Select the **Triangle** tool from the **Lines** toolbox (third button). To construct a triangle, move the \triangle and click once at each vertex. The lines are drawn automatically as you define the vertices. Make the triangle any shape you want, but put it in the upper right quadrant.

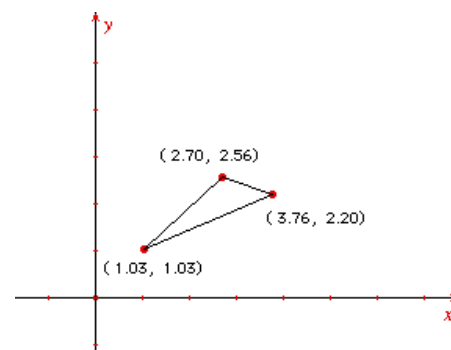


Display the coordinates for each vertex

4. Select the **Equation & Coordinates** tool from the **Measure** toolbox (ninth button).

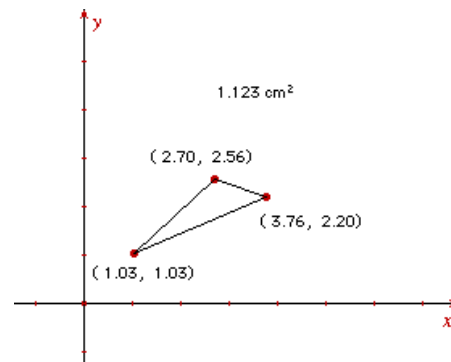
Move the \triangle toward any vertex until the \triangle and the message **Coordinates of this point** appear. Click once. The coordinates appear near the point. Repeat for the remaining two vertices. (Your coordinates may not match those shown here.)

5. Reposition the coordinates for better visibility. To do this, select the **Pointer** tool from the **Pointer** toolbox (first button). Move the $+$ toward one pair of coordinates until you see the message **This number**. Drag the coordinates away from the triangle. They momentarily “resist,” but then let you position them anywhere on the drawing screen. Repeat the process for the other coordinates.



Display the area of the triangle

6. Select **Area** from the **Measure** toolbox (ninth button). Move the \triangle toward the triangle until the message **This triangle** appears. Click once. The area is calculated and displayed.
7. Use the **Pointer** tool to reposition the area measurement so that you can see the measurement as you transform and explore the triangle.

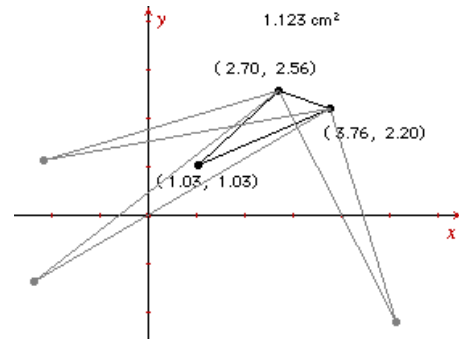


Transform and explore the triangle

8. Now use the **Pointer** tool to drag any one of the vertices. Drag it into each of the other quadrants.

What happens to the coordinate values? To the area?

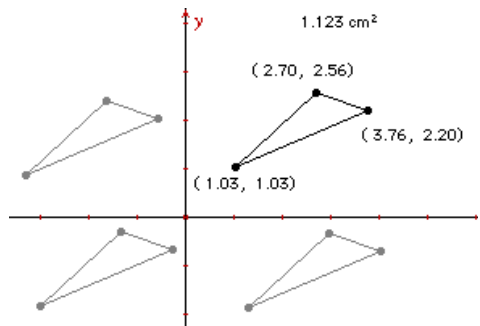
Return the vertex to the upper right quadrant.



9. Move the + toward a side of the triangle. Because the triangle was created as an object, the message **This triangle** appears. Drag the entire triangle into each of the quadrants.

What happens to the coordinate values? To the area?

Return the triangle to the upper right quadrant.

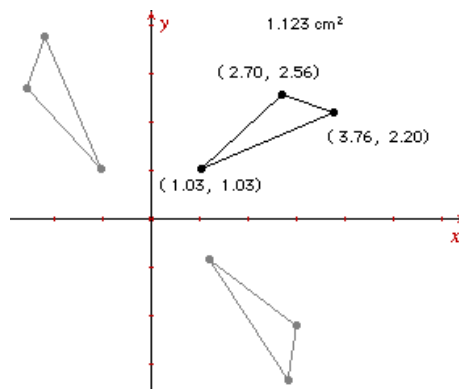
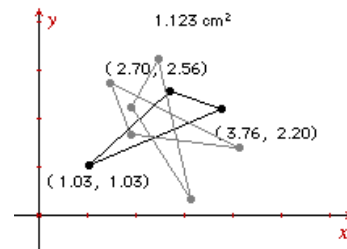


10. Select the **Rotate** tool from the **Pointer** toolbox (first button). Drag the triangle (not a vertex), moving the cursor in a circular motion. The entire triangle rotates around its geometric center.

What happens to the area?

11. You also can rotate the triangle around a specified point. With the **Rotate** tool selected, move the + to the origin until the **This point** appear. Click on the selected point. The selected point begins flashing. Move the cursor toward the triangle. When the message **This triangle** appears, drag the triangle in a circular motion around the origin.

What happens to the coordinate values? Does the area change? Why or why not?

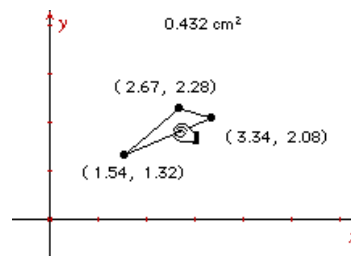


Exploring: Transformations in the Coordinate Plane (Continued)

Transform and explore the triangle (continued)

12. Select the **Dilate** tool from the **Pointer** toolbox (first button). Drag the triangle. If the origin is still selected, the triangle dilates toward and away from the origin. What does this do to the shape and size of the triangle?



Deselect the origin by clicking in a blank part of the drawing screen. Now dilate the triangle. What happens this time? (The triangle dilates around its geometric center.)

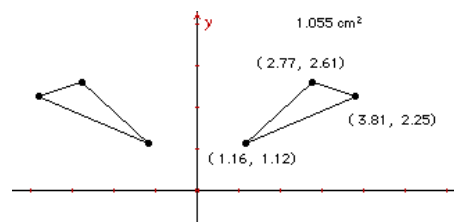


Explore reflections and symmetry

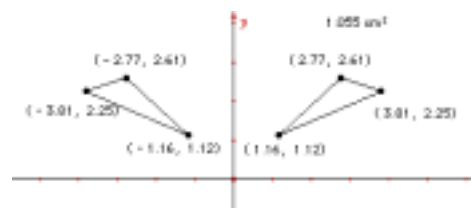
13. Drag the triangle back into the upper right quadrant, if necessary.

Select the **Reflection** tool from the **Transform** toolbox (sixth button).

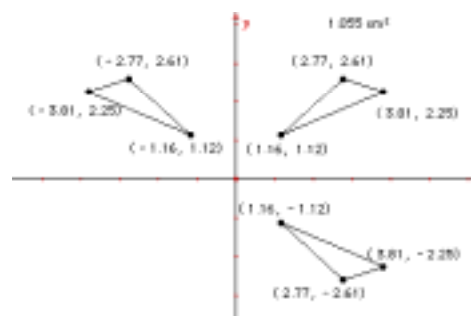
To reflect the triangle across the y axis, move the  until the message **Reflect this triangle** appears. Click once. Move the  to the y axis and click when the message **with respect to this axis** appears. The reflected triangle appears in the upper left quadrant.




14. Select the **Equation & Coordinates** tool from the **Measure** toolbox (ninth button), and add the coordinates to the reflected triangle.
15. Select the **Pointer** tool from the **Pointer** toolbox (first button) and try to drag the new triangle. What happens? Try to drag the original triangle. What happens? (The reflected triangle is dependent upon the original triangle and cannot be moved independently.)

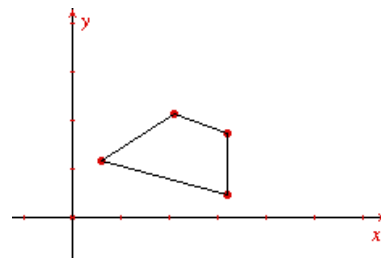


16. Select the **Symmetry** tool from the **Transform** toolbox (sixth button). Point to and click on the triangle in the upper left quadrant when the message **Reflect this triangle** appears. Then click on the point at the origin when the message **with respect to this object** appears. A triangle that is symmetric to the origin appears in the lower right quadrant.
17. Add the coordinates to the reflected triangle with the **Equation & Coordinates** tool from the **Measure** toolbox (ninth button).
18. Select the **Pointer** tool from the **Pointer** toolbox (first button), and drag the triangle in the upper right quadrant into each of the other quadrants.





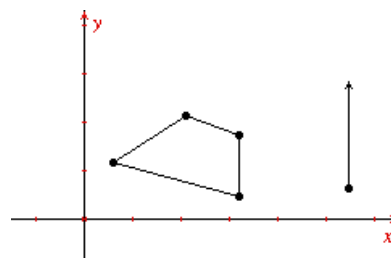
Construct a polygon

19. Open a new drawing by selecting **New** from the **File** menu.
20. Display the coordinate system by selecting the **Show Axes** tool from the **Draw** toolbox (last button).
21. Select the **Polygon** tool from the **Lines** toolbox (third button). Construct a four-sided polygon in the upper right quadrant by moving the  and clicking once at each vertex. Make it any shape you want. The last vertex must be the same as the first. Click when the message **This point** appears.

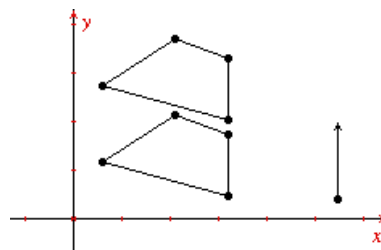



Translate the polygon

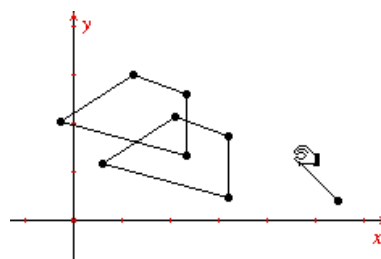
22. You can translate an object according to a selected vector.
Select **Vector** from the **Lines** toolbox (third button). Move the  and click once in the upper right quadrant to create the tail of the vector, and move the  and click again to create the head of the vector.



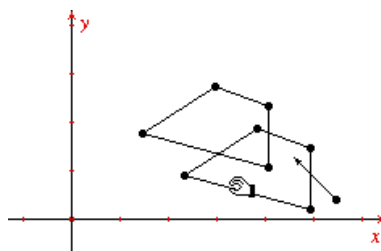
23. Select the **Translation** tool from the **Transform** toolbox (sixth button).
Click on the polygon when the message **Translate this polygon** appears, and then click on the vector when the message **by this vector** appears. The translated polygon appears, offset from the original polygon by the direction and length (magnitude) of the vector.



24. Drag the head of the vector when the cursor changes to  and the message **Translate this point** appears. The translated polygon follows the head of the vector.



25. Using the **Pointer** tool from the **Pointer** toolbox (first button), drag the original polygon. What happens to the translated polygon?



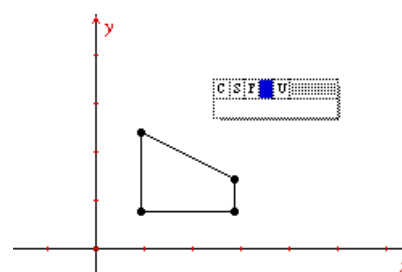
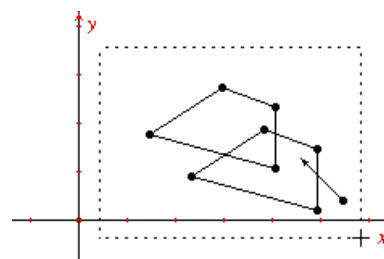
Rotate a polygon by a defined angular value.

26. You can rotate a polygon by an angular value that you define. This example begins with the value 30° .

First, remove the polygons created previously. To do this, select the **Pointer** tool from the **Pointer** toolbox (first button). Then press and hold the mouse button in a blank area outside the polygons and vector. Drag the mouse across the drawing until a marquee rectangle surrounds all of the objects. Release the mouse button. All of the objects in the rectangle are selected (except the axes, which cannot be removed in this manner).

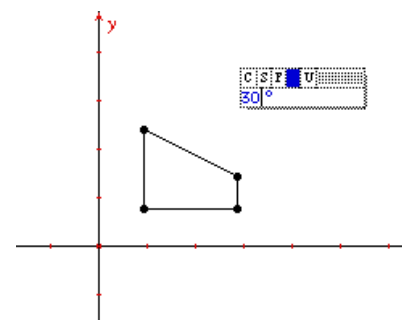
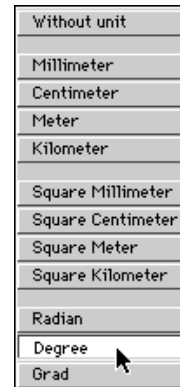
Press **DELETE** on your keyboard. The objects are removed.




27. Select the **Polygon** tool from the **Lines** toolbox (third button). Construct a four-sided polygon in the upper right quadrant. Make it any shape you want.
28. Select the **Numerical Edit** tool from the **Display** toolbox (tenth button). Click at the location where you would like to place the numerical value (you can place it anywhere in the quadrant). A numerical edit window appears.

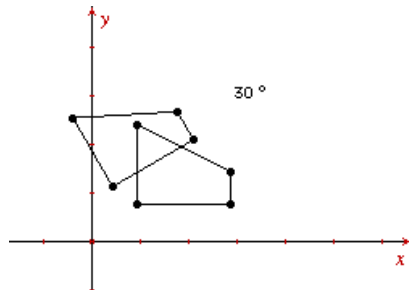


29. Type the value **30** in the numerical edit window. Then, press **U** (Macintosh) or **CTRL+U** (Windows, DOS). A list of units appears in a pop-up menu.


Select the unit **Degree**. The degree symbol ($^\circ$) is assigned to the value 30.

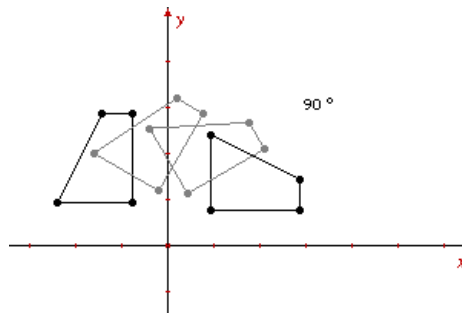


30. Select the **Rotation** tool from the **Transform** toolbox (sixth button). Move the  toward the polygon until the message **Rotate this polygon** appears. Click to select the polygon.
31. Move the  toward the origin point until the message **around this point** appears. Click to select this point. Now move the  toward the value 30 until the message **using this angle** appears. Click to select the value. An image of the polygon that is rotated 30 degrees around the origin point is created.



Dynamically change the rotation angle.

32. Select the **Numerical Edit** tool from the **Display** toolbox (tenth button). Move the  towards the value 30 degrees until the message **This number** appears. Click once to select the value. A flashing cursor appears in the window next to the number.
33. Press the \leftarrow (left arrow key) on your keyboard to position the flashing cursor to the right of the 3. Now press the \uparrow (up arrow key). Notice that the first digit increases by 1. (The **Numerical Edit** tool increases/decreases the digit to its left when the up and down arrow keys are used.) Press the \uparrow (up arrow key) until the value reads 90 degrees, noticing the changes in the rotated polygon. Now, press the \downarrow (down arrow key). The digit decreases by 1.



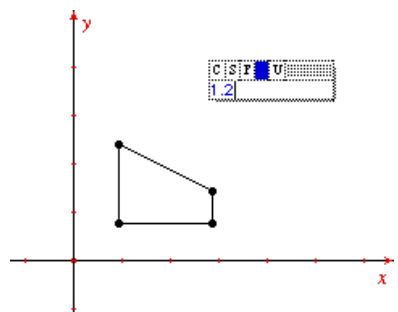
You can change the rotation angle dynamically to any value using this method. Alternatively, you can highlight the value using the mouse and type in a new value.

Dilate the polygon by a defined factor.

34. You also can dilate a polygon by a factor that you define. This example begins with the factor 1.2.

Select the **Numerical Edit** tool from the **Display** toolbox (tenth button), if necessary. Click at the location where you would like to place the numerical value (you can place it anywhere in the quadrant). A numerical edit window appears.

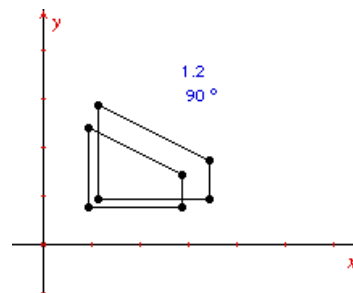
35. Type the value **1.2** in the numerical edit window. Then press **U** (Macintosh) or **CTRL+U** (Windows, DOS) to see the list of units.



Select the option **Without unit**. No unit is assigned to the value.

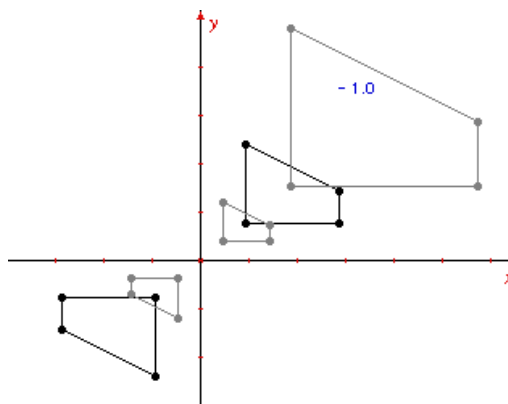
Dilate the polygon by a defined factor (continued)

36. Select the **Dilation** tool from the **Transform** toolbox (sixth button). Move the Ⓢ toward the original polygon until the message **Dilate this polygon** appears. Click to select the polygon.
37. Move the Ⓢ toward the origin point until the message **with respect to this point** appears. Click to select the point. Now move the Ⓢ toward the value 1.2 until the message **using this factor** appears. Click to select the value. An image of the polygon that is dilated by the factor 1.2 with respect to the origin point is created.



Dynamically change the dilation factor

38. Select the **Numerical Edit** tool from the **Display** toolbox (tenth button). Move the I (I-beam cursor) toward the value 1.2 until the message **This number** appears. Click once to select the value. A flashing cursor appears in the numerical edit window next to the number.
39. Use the left and right arrow keys on your keyboard as necessary to position the flashing cursor to the right of the 2. Press the \uparrow (up arrow key) until the value reads 2.0. Now press the \downarrow (down arrow key) until the value reads -1.0.



You can change the dilation factor dynamically to any value using this method. Alternatively, you can highlight the value using the mouse and type in a new value.

Continue to explore by changing the numerical values in various ways and comparing them with other transformational methods in Cabri Geometry II.

Exploring: Power (Steiner) of a Point Problem


Problem: A theorem which originally appeared in Euclid's Book III, Proposition 35 states the following: Given that a secant intersects a circle at A and B , and that a second secant intersects the circle at C and D , if the secants intersect at S , then $AS * BS = CS * DS$. This property was investigated by the Swiss geometer Jakob Steiner (1796–1863) who first used the term “power of the point” for this product.

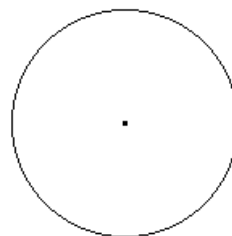
Get ready

1. Start the software, if necessary, or select the **New** option from the **File** menu if the drawing window is already displayed. You will be prompted to save your current construction if one exists.

Construct a circle


2. Select the **Circle** tool from the **Curves** toolbox (fourth button).

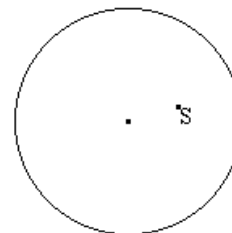
To construct a circle, move the  and then click once to create the center point. Move the mouse away. The outline of the circle is drawn. Click again to specify the radius of the circle.



Construct a point that lies within the circle



3. Select the **Point** tool from the **Points** toolbox (second button).

Move the  to a location inside the circle. Click once to create a point. Then, type the letter **S** from the keyboard.



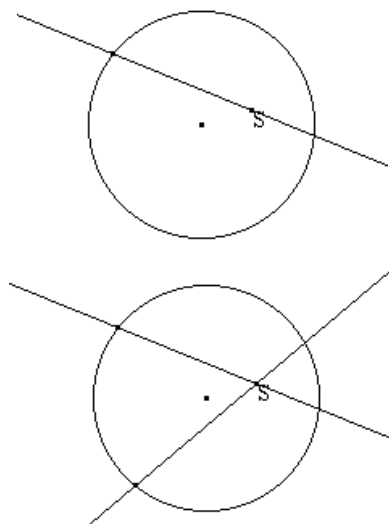
Construct two lines that intersect at S

4. Select the **Line** tool from the **Lines** toolbox (third button).

Move the  toward the circle until the  and the message **On this circle** appear. Click once. The initial point of the line appears. Move the cursor toward the point **S** until the message **By this point** appears. Click once to attach the line to the point and complete the definition of the line.

Repeat this procedure to construct another line attached to the circle that intersects the first line at **S**.

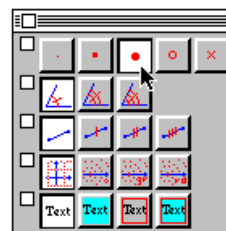
Note: The intersection point **S** is a *basic object*. That is, it can be moved freely about the construction. The two points that are attached to the circle are *independent points*. Independent points can be moved with respect to the object to which they are attached. These types of points are in contrast to *dependent points* which cannot be moved directly. For a complete discussion of basic, independent, and dependent points and objects, read Chapter 1: Basic Operations in the *Cabri Geometry II Guidebook*.




Modify the appearance of the construction

5. Select the **Modify Appearance** tool from the **Draw** toolbox (last button). A pop-up screen showing the various appearance attributes appears. Click on the large, solid point in the top row.

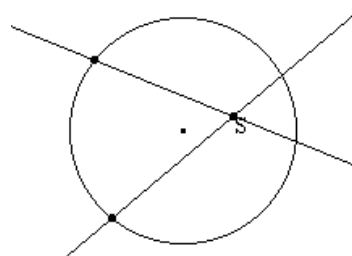
If necessary, point to the top line of the pop-up screen and hold down the mouse button to “drag” the pop-up screen away from your drawing.



6. Move the + toward point **S** until the + changes to a  and the message **This point** appears. Click once. The point changes to a large point.



Repeat this procedure for the two independent points.

7. Click on the close box in the top left corner of the pop-up screen to remove the screen from the drawing window.





Construct segments within the circle

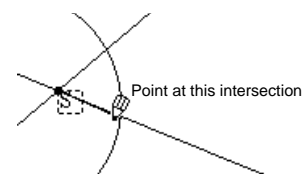
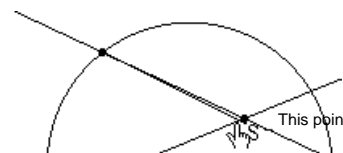
8. Select the **Segment** tool from the **Lines** toolbox (third button).

Move the  toward one of the independent points on the circle until the message **This point** appears. Click once. The initial end point of the segment appears. Move the  toward point **S** until the message **This point** appears. Click to complete the segment construction.

Repeat this procedure to construct a segment on the other line.

9. Move the  toward point **S** until the message **This point** appears. Click once to create the initial end point of the segment. Move the  toward one of the intersections of line and circle until the message **Point at this intersection** appears. Click to complete the segment construction.

Repeat this procedure to construct a segment on the other line.



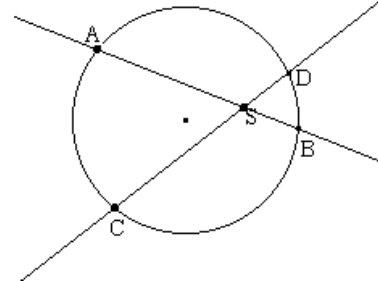
Label the points

10. Select the **Label** tool from the **Display** toolbox (tenth button).

Move the + toward one of large points on the circle until the + changes to I (I-beam) and the message **This point** appears. Click once. An edit window appears next to the point. Enter the label from the keyboard. Call this point **A**.

Move the I toward the small point which is on the same line. Click once to open the edit window. Call this point **B**.

11. Repeat step 10 for the two unlabelled points on the circle, labeling them **C** and **D**.



Hide the lines

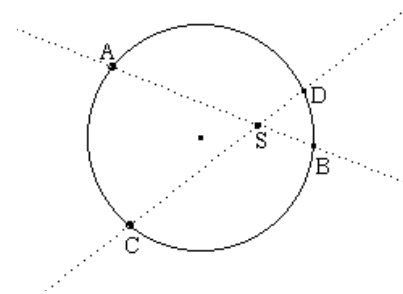
12. Hiding objects can often make a construction easier to read visually as well as add an element of intrigue. Hiding the lines will aid you in evaluating the intersecting chords.

Select the **Hide/Show** tool from the **Draw** toolbox (last button). Notice that the construction is redrawn quickly.

13. Move the + toward a line until the message **This line** appears. Click once. The line becomes dotted. Move to the other line and click. It also becomes dotted. These objects will be hidden from view when you change to another tool.


14. Select the **Pointer** tool (first button).

You now have a construction similar to the one investigated by Euclid over 2000 years ago!



Measure the lengths of the segments

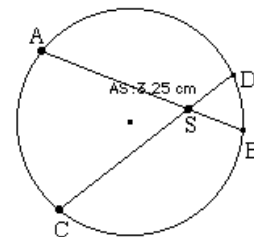
15. Select the **Distance & Length** tool from the **Measure** toolbox.

Move the  toward segment \overline{AS} until the message **Length of this segment** appears. Click once to display the length of the segment.

Immediately after the measurement is created, type **AS:** from the keyboard. The measurement is now labeled.

16. Repeat step 15 for segments \overline{BS} , \overline{CS} , and \overline{DS} . You may need to adjust the positions of the displayed measurements in order to read them more easily.

Note: Measurements also can be labeled using the **Comments** tool from the **Display** toolbox. Select **Comments**. Select the measurement. Enter a label in the edit window.



Measure the lengths of the segments (continued)

17. You may find it beneficial to group the measurements in one location in order to inspect the values easily.

Select the **Pointer** tool from the **Pointer** toolbox. Drag each measurement to an unoccupied area of the drawing window. The measurement will hesitate initially when being dragged, but will then follow the pointer.

AS: 3.25 cm

BS: 1.21 cm


CS: 3.38 cm

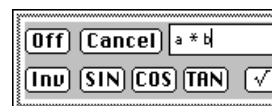
DS: 1.16 cm

Calculate the power of the point S

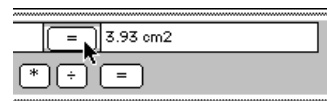
18. According to the theorem, $AS \cdot BS = CS \cdot DS$. Use the Cabri II built-in calculator to verify this result.


Select **Calculate** from the **Measure** toolbox (ninth button). A calculator appears at the bottom of the screen.

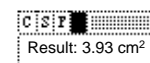
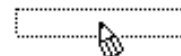
19. Move the  toward the measurement of \overline{AS} until the message **This number** appears. Click once to include the measurement in the calculation. A marquee box appears around the measurement along with an **a**.



20. The variable **a** also appears in the calculator edit window. Now click on the multiplication ($*$) button. Next, select the measurement of \overline{BS} . To complete the calculation, click on the equals ($=$) button. The result is displayed in the calculator result window.



21. Move the result into the drawing window by clicking once on the result window. An empty marquee box appears in the drawing window. Move the  (pencil) to move the box to a location near the measurements. Click to place the result. The calculation is tagged with the label **Result**.



22. Select the **Comments** tool from the **Display** toolbox. Move the \dagger cursor toward the label **Result**: until the **I** (I-beam) and the message **Edit this text** appear. Click once to open an edit window around the label and the measurement. Highlight the label by dragging the cursor across the text, and then enter a new label **AS * BS**.

23. Repeat steps 18–22 for \overline{CS} and \overline{DS} . Change the label on the result to **CS * DS**.

AS: 3.25 cm

BS: 1.21 cm

AS*BS: 3.93 cm²

CS: 3.38 cm

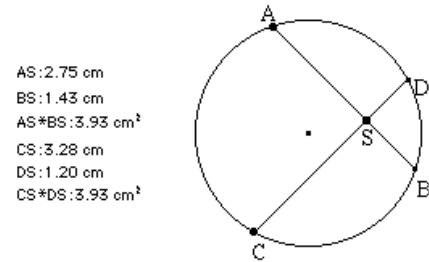
DS: 1.16 cm

CS*DS: 3.93 cm²

Manipulate the construction to explore the results

24. Select the **Pointer** tool from the **Pointer** toolbox. Evaluate the proposed theorem by manipulating the construction. As you drag point **A** or point **C** around the circle, does the property hold true? That is, do $AS \cdot BS$ and $CS \cdot DS$ remain constant?
25. Drag point **S** to a new location within the circle. What happens to the calculation results? Now drag point **A** and point **C** around as before. Does the property still hold true?
26. Drag point **S** to several locations within the circle while monitoring the power of the point calculations. Make a list of your observations.

A partial list of observations is shown at the end of this exercise.



Construct a table


27. Construct a table of values to support your generalizations.

Select the **Tabulate** tool from the **Measure** toolbox (ninth button).

To define the size and location of your table, move the pointer to an unoccupied location in the drawing window. Press and hold the mouse button down. Move the cursor to another location to draw a rectangle. Release the mouse button. A table appears within the rectangle. If the size is unsuitable, resize the table by dragging the lower right corner.

C	S	T
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

28. Select the values you want to tabulate (copy).

Move the  on top of the number you labeled as $AS \cdot BS$ until the message **Tabulate this value** appears. Click once to place it in the table for tabulation. The label and the current value appear in the table.

Repeat this procedure for the value labeled $CS \cdot DS$. If this value is not visible, you must change the size of the table. Only fully visible columns display results. Resize the table by dragging the lower right corner.

	AS*BS:	CS*DS:
1	3.93	3.93
2		
3		
4		
5		
6		
7		
8		
9		
10		

Collect data to support the hypothesis

29. You may wish to record additional values to support the hypothesis.

Select the **Pointer** tool from the **Pointer** toolbox. Drag the points **A**, **C**, and **S** to manipulate the construction as you wish. Press the TAB key to record additional values in the columns defined.

Note: At least one value must change in order for a new row of data to be recorded in the table. In this case, the value may be the length of a segment which is included in the calculation, although it is not visible in the table.

30. There are several ways in which to approach this problem. This step examines one possible observation. You may wish to explore other facets of the problem.

Drag point **S** on an imaginary line through the center point of the circle. Press the TAB key about every centimeter to collect a new power of **S** calculation.

	AS*BS:	CS*DS:
1	3.93	3.93
2	4.93	4.93
3	5.35	5.35
4	5.44	5.44
5	5.35	5.35
6	5.08	5.08
7	4.92	4.92
8	3.97	3.97
9		
10		

Analyze the data

31. Notice that the powers of **S** are smaller the further away from the center point you move point **S**. (This is true as long as you keep point **S** within the circle. The opposite occurs outside of the circle, although the property continues to hold true.) Did any of the values repeat when you moved point **S** across the circle?

If necessary, resize the table to view all of its contents. Drag the table up the drawing window to see the lower rows.

Modify the table and delete values from the table

32. Select **Tabulate** from the **Measure** toolbox.

Point to the table and click. An edit window encloses the table.

Point to the first column of a row and click. (The first column is the column which contains the numbers in sequential order. Each number represents a row.) The entire row appears in gray. Press the DELETE key to delete the values in that row. The remaining values move up one row.

	AS*BS:	CS*DS:
1	3.93	3.93
2	4.93	4.93
3	5.35	5.35
4	5.44	5.44
5	5.35	5.35
6	5.08	5.08
7	4.92	4.92
8	3.97	3.97
9		
10		

33. Point to the first row of a column and click. (The first row is the row which contains the title of the column.) The entire column appears in gray. Press the DELETE key to delete the values in the column. The remaining columns move left. Repeat to delete the values in the remaining columns.

	AS*BS:	CS*DS:
1	3.93	3.93
2	4.93	4.93
3	5.35	5.35
4	5.44	5.44
5	5.35	5.35
6	4.92	4.92
7	3.97	3.97
8		
9		
10		

Animate the construction

34. Animate the construction to record data in the table automatically.

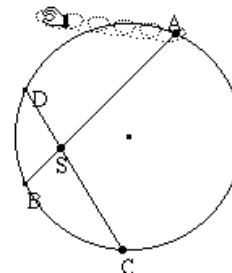
Select the **Animation** tool from the **Display** toolbox. Next, move the + until the message **This table** appears to select the table. The table is enclosed in a marquee rectangle to indicate it is selected.

	AS*BS:	CS*DS:
1	3.43	3.43
2		
3		
4		
5		
6		
7		
8		
9		
10		

35. Move the pointer to point **A** until the message **This point** appears. Press and hold the mouse button and move away from the point. The animation spring is connected to the point and the cursor. Release the mouse button to start the animation. (The animation spring indicates the direction and relative velocity of the animation.) Click again to stop the animation.

Values are recorded in the table automatically.

There are many facets to this problem. We encourage you to explore further.



Constructing a Macro: Pentagonal Curve of Pursuit

Problem: Line designs created with colored thread can produce attractive patterns. With Cabri II, line designs are easy and fun. Some designs can be developed by inscribing regular polygons within similar regular polygons. This can be described as a series of two-step transformations. In this example, we create a Pentagonal Curve of Pursuit by inscribing pentagons to illustrate some important features of macros.

Get ready

1. Start the software, if necessary, or select the **New** option from the **File** menu. You will be prompted to save your current construction if one exists.

Construct a segment



2. Select the **Segment** tool from the **Lines** toolbox (third button). To construct a segment, click once at each end point. Construct a segment that is about 5 cm long.

Tip: If you press the SHIFT key after creating the first end point, the slope of the segment is limited to 15-degree increments.







Divide the segment into eighths

3. Select the **Midpoint** tool from the **Construct** toolbox (fifth button).

Move the  toward the segment until the  and the message **Midpoint of this segment** appear. Click once. The midpoint of the segment appears. The segment is divided into halves.



4. To divide the segment into eighths, you need to divide the segment into two more halves. That is, $1/2 * 1/2 * 1/2 = 1/8$.

Use the **Midpoint** tool to perform the division. Move the  toward the midpoint until the  and the message **Midpoint between this point** appear. Click once. Move the  toward the end point on the right until the  and the message **and this point** appear. Click once. The midpoint between the two selected points appears. The segment has a one-quarter division.



Divide the right-most quarter again using the **Midpoint** tool. The segment now has a one-eighth division.



Define a macro to perform a segment division

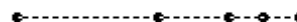
To build a pentagonal curve of pursuit you need to find a point on each side of a regular pentagon that is one-eighth the distance of that side. The segment division performed in the previous steps shows the procedure you need to accomplish the task.

Macros are used to perform repetitive tasks or to create unique objects. Since building a pentagonal curve of pursuit is a repetitive task, it would be beneficial to create a macro that would perform the task.

To create a macro, you first must select initial object(s) that are used to define the final object(s). The next step is to select the final object(s) and then, if necessary, to change the attributes of the object(s) as they will appear in the final construction. The final step is to define the macro for inclusion in the **Macro** toolbox. The macro is then available for use.

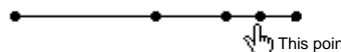
Select the segment as the initial object

5. Select **Initial Object** from the **Macro** toolbox (seventh button). Move the + toward the segment until the message **This segment** appears. Click to select the segment as the initial object. The segment appears to be moving or flashing (a marquee outline), indicating that it is selected.



Select the point that is one-eighth the length of the segment as the final object

6. Select **Final Object** from the **Macro** toolbox. Move the + toward the second point from the right on the segment until the message **This point** appears. Click to select this point as the final object. The point flashes.
7. You are now ready to define the macro. Select the **Define Macro** tool from the **Macro** toolbox. A dialogue box appears in which you can name your macro.
8. (Macintosh) Enter the name “Segment Division” from the keyboard in the field **Name of the construction:**. Notice that the letter in the icon font: field changes to **S**. This letter will appear as an icon in the **Macro** toolbox identifying the **Segment Division** macro.



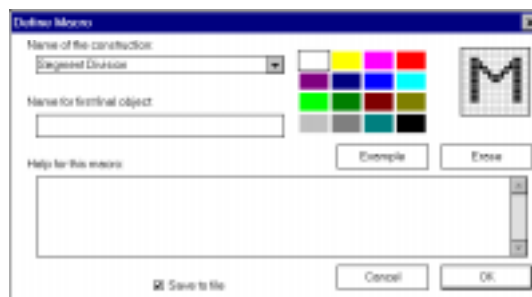
(Windows, DOS) Overwrite the default name “New construction” and enter the name “Segment Division” from your keyboard in the field labeled **Name of the construction:**.

It is not necessary to save the macro to a file in this case since it is an intermediate step in the construction of the pentagonal curve of pursuit. However, if you wish to save the macro to a unique file on disk, click on the **Save to file** box to mark it with an “x.” This is your only opportunity to save the macro to an independent file, although it will be saved automatically with the construction.

Macintosh



Windows, DOS

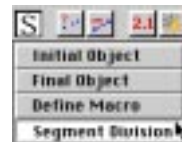


Note: Colors available in Windows version only.

Note: It is not necessary to save a macro to disk to use the macro. If you save the file, the macro also will be saved with the file, provided it was used in the construction.


9. Click on **OK** to save the macro.
10. The macro now appears in the **Macro** toolbox with the name **Segment Division**. This macro will generate a point that is located on a segment at one-eighth of its length.

Note: Macros created using a segment as the initial object can also be applied to the side of a triangle, polygon, or regular polygon.

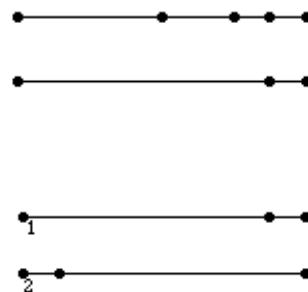


Test the Segment Division macro


11. Draw another segment using the **Segment** tool from the **Lines** toolbox (third button). Then, select the **Segment Division** macro from the **Macro** toolbox (seventh button).

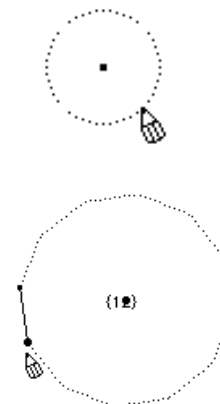
Move the  toward the segment until the message **This segment** appears. Click once. The point that appears on the segment is located one-eighth of the length of the segment from the second end point.


Note: Macros follow the order of the original construction. Construct another segment. If you constructed the segment from left to right last time, construct it from right to left this time. Then apply the **Segment Division** macro. Notice that the macro places the point closest to the second end point created. This is consistent with how the macro was defined.



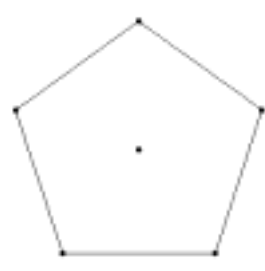
Construct a regular pentagon

12. Select the **Regular Polygon** tool from the **Lines** toolbox (third button). Move the  to an empty section of your drawing window. Click to create the center point of the regular polygon.
13. Move the cursor away from the center point, noticing that a polygon appears. Click to specify the radius of the regular polygon. Make your radius about 3 or 4 cm. The number of sides of the regular polygon is displayed at the center point.




-
14. Now move the  in a clockwise direction. The number of sides decreases. When the number of sides is five, click to complete the construction of the regular polygon. A regular pentagon is displayed.

If you move in a counterclockwise direction, the number of sides becomes a fraction and the polygon drawn is a regular star polygon.

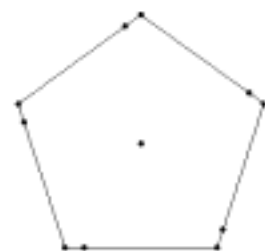


Apply the Segment Division macro

15. Select the **Segment Division** macro from the **Macro** toolbox (seventh button).

Move the  toward a side of the regular polygon until the message **This side of the polygon** appears. Click once to apply the macro. A point is created on the side of the pentagon.

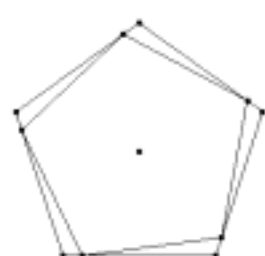
Repeat this step for each side of the pentagon.




Inscribe the regular pentagon

16. Select the **Polygon** tool from the **Lines** toolbox (third button). Use the **Polygon** tool to connect the points created by the **Segment Division** macro. Proceed in a clockwise direction. Do not connect the vertices of the regular pentagon.

Select each point. When all of the points have been selected, select the first point again. This terminates the polygon. An inscribed regular pentagon is created.



Define a macro to create an inscribed regular pentagon

17. Select **Initial Object** from the **Macro** toolbox. Select the outer regular pentagon as the initial object. Move the  toward the outer pentagon until the message **This regular polygon** appears. Click once. The pentagon is shown as a marquee outline.

Note: Objects created by macros can be used to generate other macros. For example, the points created by the **Segment Division** macro now are being used in the definition of the new macro.



Constructing a Macro: Pentagonal Curve of Pursuit (Continued)

18. Select **Final Object** from the **Macro** toolbox. Select the inner pentagon as the final object. The macro is now ready to be defined.

Note: A macro generates its final object with the object's existing attributes when **Define Macro** is chosen. These attributes can be changed at any time prior to the selection of **Define Macro**.



19. Select **Hide/Show** from the **Draw** toolbox (last button). Select each vertex of the final object (the inner regular pentagon).

These points will be hidden when the regular pentagon is generated from the macro.



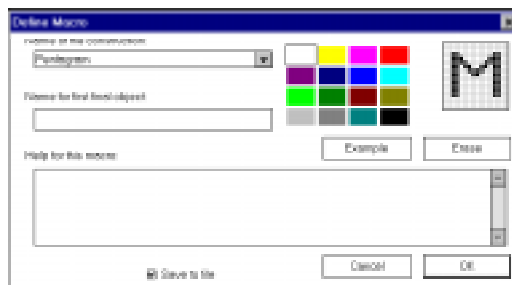
20. Select **Define Macro** from the **Macro** toolbox. A dialogue box appears in which you name your macro.
21. Enter the name "Pentagram" from your keyboard in the field labeled **Name of the construction:**.

Click on the **Save to file** box. This is the only opportunity to save the macro to an independent file, although it will automatically be saved with the construction.

Macintosh



Windows, DOS



Note: Colors available in Windows version only.

22. You can enter a help message and the name of the first final object for future reference. It is a good idea to document how your macro works in these fields. Enter appropriate messages.
23. Click on the **OK** button to save the macro. The macro now appears in the **Macro** toolbox with the name **Pentagram**. The macro will generate an inscribed regular polygon.

Test the Pentagonal Curve of Pursuit macro


24. Select the **Pentagram** macro from the **Macro** toolbox. Point to the inner regular pentagon until the message **This polygon** appears. Click to create a new inscribed pentagon within the selected pentagon.

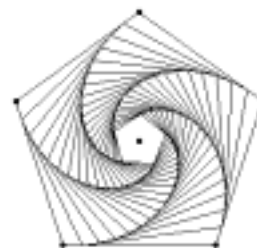
Does the macro meet your criteria? If not, repeat the definition of initial and final objects and selection of attributes. If problems still exist, you may need to review the original construction again.



Continue to apply the Pentagram macro

25. Apply the macro **Pentagram** to the construction again. Point to the new inner pentagon and click to create yet another pentagon. Repeat until you have a construction similar to the illustration.

Note: As your construction gets more and more crowded, you can rely on the ambiguity feature of Cabri II to select the pentagon created last. That is, the  pointer may appear along with the message **Which object?** Press and hold the mouse to see a list of the objects available. Point to the last object in the list, which is the last object created, and release the mouse to select it. Your computer's response will become slower as more objects are added to the construction.



Optional macros

It is also possible to combine more steps in a macro. For example, create four inscribed pentagons, select the original pentagon as the initial object, select the remaining pentagons as the final objects. The macro then will generate four inscribed pentagons.

Other line designs

Try using this technique to construct other line designs.

This example was inspired by Dale Seymour's book Introduction to Line Designs published by Dale Seymour Publications.

Menu Options

File

Ctrl+N	New	Open a new Cabri Geometry II drawing.
Ctrl+O	Open...	Open a saved Cabri Geometry II drawing.
Ctrl+S	Save	Save the current Cabri Geometry II drawing in the file from which it was loaded.
	Save as...	Save the current Cabri Geometry II drawing to a specified file.
	Revert...	Replace the current drawing with the most recently saved version.
Ctrl+P	Show Drawing...	Zoom out to the one-square meter drawing sheet; reposition the window.
	Page Setup... (Macintosh, Windows) Printer Setup... (DOS)	Select printer and page options.
	Print...	Print the current page (Macintosh, Windows, DOS) or the entire drawing area (Macintosh only).
Ctrl+Q	Quit	Close Cabri Geometry II.


Edit

Ctrl+Z	Undo	Undo the last action.
Ctrl+X	Cut	Remove the selected object(s) from the drawing to the clipboard.
Ctrl+C	Copy	Copy the selected object(s) from the drawing to the clipboard.
Ctrl+V	Paste	Paste the clipboard contents into the current drawing.
	Clear	Clear (erase, delete) all selected items.
Ctrl+A	Select all	Select all objects in the drawing.
	Replay Construction	Replays each step of a construction.
Ctrl+F	Refresh Drawing	Refresh the drawing screen; remove leftover Trace elements.

Options

	Hide/Show Attributes	Hide the toolbar or display the toolbar that controls how objects look.
	Preferences...	Set preferences for how drawings are set up.
	Tool Configuration...	Rearrange or hide tools.

Help





	 (Macintosh) Help (Windows, DOS)	Displays a description of the selected toolbar icon in the Help window at the bottom of the Cabri Geometry II screen.
	About...	Displays information about Cabri Geometry II that includes the authors' names, copyright notice, and the version number of the software.

Helpful Shortcuts




Press + or -	<ul style="list-style-type: none"> To increase or decrease the displayed precision in Numerical Edit. To increase or decrease the animation speed in Animation or Multiple Animation. To increase or decrease the number of objects in the selected locus.
Press Shift	<ul style="list-style-type: none"> To limit the slope of lines, rays, segments, vectors, triangles, polygons, or axes to increments of 15°. To limit the radius to multiples of 1 cm when creating circles. To select multiple objects.
Press Tab	<ul style="list-style-type: none"> To record new values in a table. To change the format of a selected equation.
Press Enter	To start a Multiple Animation.
Press and hold the mouse key	To display all directly moveable (basic and independent) objects as flashing. The cursor must be in an unoccupied space.
Press Ctrl and drag the mouse	To scroll the drawing window.
Double-click the mouse key	On a label, comment, numerical value, or table to invoke the appropriate editor.
Click the mouse key	Anywhere in the gray area of the Toolbar to access the Pointer tool.
Ctrl+U	Displays list of units in a pop-up menu when the Numerical Edit tool is selected.

Toolbar Commands








Pointer

	Pointer	Select, move, and manipulate objects.
	Rotate	Rotate an object around a selected point or the object's geometric center.
	Dilate	Expand or contract an object around a selected point or the object's geometric center.
	Rotate and Dilate	Simultaneously rotate and dilate an object around a selected point or the object's geometric center.




Points

	Point	Construct a point defined in free space, on an object, or at the intersection of two objects.
	Point on Object	Construct a point defined on an object.
	Intersection Point(s)	Construct a point at each intersection of two selected objects.












Lines

	Line	Construct an infinite line through a point at a slope (specified by clicking a second time in free space or at a point).
	Segment	Construct a segment, defined by two end points, which may be created or defined in free space or on a defined object.
	Ray	Construct a ray, defined by an end point and direction, extending infinitely.
	Vector	Construct a vector with magnitude and direction defined by two points.
	Triangle	Construct a triangle, defined by three points (vertices), which may be created or defined in free space or on a defined object.
	Polygon	Construct an n-sided polygon; the last point must coincide with the beginning point. Select or create a point for each vertex.
	Regular Polygon	Construct an n-sided regular polygon. Click for center and radius, move clockwise (convex) or counterclockwise (star) to set n (≤ 30).







Curves

	Circle	Construct a circle defined by a center point and a specified radius.
	Arc	Construct an arc defined by an initial end point, a radius point, and a final end point.
	Conic	Construct a conic (ellipse, parabola, or hyperbola) defined by five points.

Construct




	Perpendicular Line	Construct a line perpendicular to a selected line, segment, ray, vector, axis, or side of a polygon, passing through a created or selected point.
	Parallel Line	Construct a line parallel to a selected line, segment, ray, vector, axis, or side of a polygon, passing through a created or selected point.
	Midpoint	Construct a midpoint of two selected points, a segment, or side of a polygon.
	Perpendicular Bisector	Construct a perpendicular line bisecting two points, a segment, or side of a polygon.
	Angle Bisector	Construct a line that bisects an angle identified by three selected points; the second point is the vertex.
	Vector Sum	Construct the sum of two vectors by specifying the vectors and the end point of the new vector.
	Compass	Construct a circle from a center point with radius defined by a segment or the distance between two selected points.
	Measurement Transfer	Create points on specific objects based on proportional or equivalent selected numerical values.
	Locus	Construct the locus of a single selected point or object defined by movement along a path.
	Redefine Point (Macintosh, DOS)	Redefine a previously defined point to a new location. (Defining a point in free space as on an object, for example.)
	Redefine Object (Windows)	Redefines a previously defined point, object, or line.

Transform






	Reflection	Create the image of an object reflected across a line, segment, ray, vector, axis, or side of a polygon.
	Symmetry	Create the image of an object rotated 180° around a point .
	Translation	Create the image of an object translated by a specified vector.
	Rotation	Create the image of an object rotated around a point by a specified angular value.
	Dilation	Create the image of an object dilated from a point by a specified factor.
	Inverse	Create the image of a point by reflecting it inversely to the radius of a selected circle.

Toolbar Commands (Continued)








Macro

	Initial Object	Specify the initial object(s) needed to define the final object(s).
	Final Object	Specify the final object(s) that will result from the initial object(s).
	Define Macro	Open the dialogue box for naming and saving the macro defined by the initial and final object(s). The macro is added to the Macro toolbox.








Check Property

	Collinear	Report whether or not three selected points are on the same line.
	Parallel	Report whether or not two selected lines, segments, rays, vectors, axes, or sides of a polygon are parallel.
	Perpendicular	Report whether or not two selected lines, segments, rays, vectors, axes, or sides of a polygon are perpendicular.
	Equidistant	Report whether or not three selected points are equidistant.
	Member	Report whether or not a selected point lies on a selected object.










Measure

	Distance & Length	Display the distance between two selected points or the length of a segment, perimeter, circumference, or radius.
	Area	Display the area of a selected polygon, circle, or ellipse.
	Slope	Display the slope of a selected line, segment, ray, or vector.
	Angle	Display the measure of a marked angle or an angle defined by three selected points.
	Equation & Coordinates	Display the coordinates of a point or the equation of a line, circle, or conic.
	Calculate	Open the calculator to perform calculations using measurements, numerical values, calculation results, or numerical inputs from the keyboard.
	Tabulate	Collect selected measurements, calculations, numerical values, or coordinates of a point into a single data table.

Display

	Label	Attach a user-created label to a point, line, or circle. The label may contain text and numbers.
	Comments	Enter a comment in the drawing. The comment window is defined by location and size.
2.1	Numerical Edit	Edit any measurement, coordinate, or equation; the value, precision, units, font, size, and style may be modified.
	Mark Angle	Place an angle mark on an angle defined by three points, the second of which is the vertex.
	Fix/Free	Fix the location of a point. Free a fixed point.
	Trace On/Off	Trace a selected object along a specified path. Quit tracing.
	Animation	Automatically translate, rotate, or dilate an object in the direction specified by the animation spring. Click once to stop the animation.
	Multiple Animation	Animate multiple objects along multiple paths.

Draw

	Hide/Show	Select objects to hide (including labels and measurements). Show hidden objects.
	Color	Open a color palette for changing the color of a selected object.
	Fill	Fill a triangle, polygon, or circle with a selected color.
	Thick	Change the appearance of an object by selecting a thick line.
	Dotted	Change the appearance of an object by selecting a dotted line.
	Modify Appearance	Open an attribute palette for changing the appearance of objects.
	Show Axes Hide Axes	Show the default coordinate system for coordinate geometry. Hide the default coordinate system.
	New Axes	Create a coordinate system by defining a point for the origin, a point for the x-axis, and a point for the y-axis.
	Define Grid	Display a grid for the selected axes.

Toolbar Commands (Continued)

Color Palette



Angle Mark

	1 tick mark
	2 tick marks
	3 tick marks

Line Thickness

	Light lines
	Medium lines
	Thick lines

Segment Mark

	No tick mark
	1 tick mark
	2 tick marks
	3 tick marks

Line Appearance

	Solid lines
	Dotted lines
	Dashed lines

Cartesian & Polar Coordinates

	Cartesian coordinates
	Polar coordinates measured in degrees
	Polar coordinates measured in grads
	Polar coordinates measured in radians

Point Types

	Small point
	Medium point
	Large point
	Hollow point
	Crosspoint
	Cross

Text Appearance

	Plain
	Colored background
	In box
	In colored box