Bonus Chapter 2

Constructing Geometric Figures

In This Chapter

- Constructing geometric figures
- Finding midpoints, points of intersection, and angle bisectors
- Moving and reshaping figures
- Hiding and deleting objects

The Cabri Jr. **Create** and **Construction** menus contain a plethora of tools that enable you do mundane things such as construct lines, segments, triangles, quadrilaterals, and circles. The **Create** and **Construction** menus also contains tools that enable you to do really neat things such as bisecting angles, constructing perpendicular and parallel lines, locating midpoints, and finding the points of intersection of geometric objects. This chapter tells you how to use the tools in these two menus.

Constructing Points

This section explains how to construct a freestanding point, that is, a point that is not part of another object such as a line or a circle. Constructing a point that is on an existing object or a point of intersection of two objects is explained later in this chapter.

To construct a freestanding point, press WINDOW 1 to select the **Point** tool from the **F2** menu. A pictorial representation of the tool you selected appears in the upper-left corner of the screen. Use the arrow keys to move the cursor to the location on the screen where you wish to construct the point and press ENTER. The point is constructed at the location of the cursor and the **Point** tool remains active so that you can construct more points. When you're finished constructing points, press CLEAR to deactivate the **Point** tool or select another menu item.

You can create points on objects, too. When using the **Point** tool, if you move the cursor near another object and that object begins to blink, just press ENTER to create the point on the blinking object.

Constructing Lines and Segments

Because two points determine either a line or a segment, the directions for creating lines and segments are pretty much the same. To construct such objects, follow these steps:

1. **Select the appropriate tool from the F2 menu.**

   To do this, press WINDOW, repeatedly press ▼▲ to highlight the tool you wish to use, and press ENTER to select that tool. A pictorial representation of the tool you selected appears in the upper-left corner of the screen.

2. **Use the arrow keys to move the cursor to the location on the screen of the first point that determines your line or segment. Press ENTER to anchor this point.**

   After you press ENTER, a flickering point appears on the screen. The point flickers to remind you that you have not yet completed constructing the line or segment.

3. **Use the arrow keys to move the cursor to the location of the second point that determines the line or segment and press ENTER to anchor that point, thus completing the construction of the line or segment.**

   As you move the cursor, a dotted line or segment appears on the screen. When you press ENTER, the line or segment appears as a solid line or segment. This indicates that the line or segment has been constructed.

After constructing a line or segment, the tool you were using remains active (as indicated by the picture in the upper-left corner of the screen) until you deactivate it. So if you want to construct more objects of the same kind, just repeat Steps 2 and 3. When you are finished using the tool, you deactivate it by pressing CLEAR or by selecting another menu item.

Constructing Circles

A circle is determined by entering its center and its radius. To construct a circle, follow these steps:

1. **Select the Circle tool from the F2 menu.**

   To do this, press WINDOW 4. A picture of a circle appears in the upper left of the screen indicating that the circle tool is active, as illustrated in the first picture in Figure B2-1.

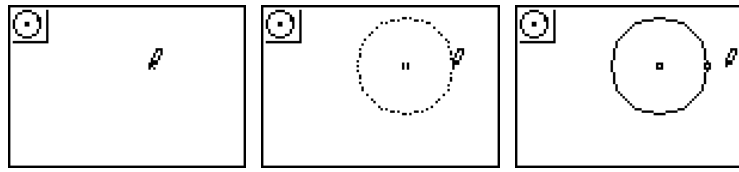


Figure B2-1: Constructing a circle.

2. **Use the arrow keys to move the cursor to the location on the screen where you wish to place the center of the circle. Press ENTER to anchor this point.**

   The center of the circle appears as a flickering point, indicating that the circle is not yet constructed. This is illustrated in the first picture in Figure B2-1, although the picture, of course, cannot display a flickering point.

3. **Use the arrow keys to expand the circle to the desired size.**

   As you use the arrow keys to move the cursor, the radius of the circle expands and the circle is displayed as a dotted circle, indicating that the construction is not yet complete. This is illustrated in the second picture in Figure B2-1. After using the arrow keys to expand the radius of the circle, you can, using the arrow keys, move the cursor in the opposite direction to contract the size of the radius.

4. **When the circle is as you want it, press ENTER to complete the constructing of the circle.**

   The circle appears as solid lines, indicating that the construction is complete. Also, a point appears on the circumference of the circle at the location of the cursor. This is illustrated in the third picture in Figure B2-1, where the cursor has been moved away from the circle.

After a circle has been constructed, you can move its location on the screen by moving the circumference of the circle, and you can change the size of its radius by moving the point on the circumference of the circle. Moving objects is explained later in this chapter.

Did you make a mistake?

Rejoice! The **F1** menu contains an **Undo** command that will undo the most recent operation, even if that operation was to clear the screen. To use its powers, press Y= 2 and watch your most recent construction vanish.

Do you now regret that you eradicated that construction? No problem! Even through Cabri Jr. has no Redo command, you can press Y= 2 again to undo what you just undid. To put it in mathematical terms, two undos equals one redo.

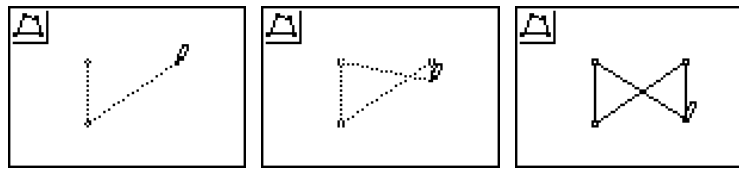
After constructing your first circle, the **Circle** tool remains active until you deactivate it. So if you want to construct more circles, just repeat Steps 2 through 4. When you are finished using this tool, you deactivate it by pressing CLEAR or by selecting another menu item.

Constructing Triangles and Quadrilaterals

Three points determine a triangle and four points determine a quadrilateral. So the construction of each is quite similar. To construct a triangle or quadrilateral, follow these steps:

1. **Select the appropriate tool from the F2 menu.**

   To do this, press WINDOW. Use ▼▲ to highlight the tool you wish to use and press ENTER to select that tool. You see a picture of that tool in the upper-left corner of the screen. The first picture in Figure B2-2 illustrates that the **Quad** tool is active and ready for you to construct a quadrilateral.



Anchor three points Locate fourth point Press ENTER

Figure B2-2: Constructing a quadrilateral.

2. **Use the arrow keys to move the cursor to the location on the screen where you wish to construct the first point of the triangle or quadrilateral. Press ENTER to anchor this point.**

3. **Use the arrow keys to move the cursor to the location on the screen where you wish to construct the second point defining the triangle or quadrilateral. Press ENTER to anchor this point. If you are constructing a quadrilateral, move the cursor to the location of the third point defining the quadrilateral and press ENTER to anchor that point.**

   As you move the cursor, the sides of the triangle or quadrilateral appear as dotted lines indicating that the construction is not yet complete. This is illustrated in the first picture of Figure B2-2 for the construction of a quadrilateral.

4. **Use the arrow keys to move the cursor to the location on the screen where you wish to construct the last point defining the triangle or quadrilateral.**

   As you move the cursor, the triangle or quadrilateral appears on the screen as dotted lines indicating that the construction is not yet complete. The second picture in Figure B2-2 illustrates this step when constructing a quadrilateral.

5. **Press ENTER to complete the construction of the triangle or quadrilateral.**

   The figure appears as solid lines indicating that the construction is complete. This is illustrated in the third picture in Figure B2-2.

After constructing a triangle or quadrilateral, the tool you were using remains active until you deactivate it. So if you want to construct more objects of the same kind, just repeat Steps 2 through 5. When you are finished using that tool, you deactivate it by pressing CLEAR or by selecting another menu item.

Constructing Polygons

The previous section explains how to construct triangles and quadrilaterals, but unfortunately, Cabri Jr. has no tool for constructing polygons having more than four sides. However, you can still construct a polygon having as many sides as you wish by stringing together line segments. Such a construction is shown in Figure B2-3.

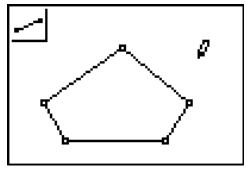


Figure B2-3: Using the Segment tool to construct a pentagon.

Constructing line segments is explained in detail earlier in this chapter, but here are the basic steps for constructing a polygon by stringing together line segments:

1. **Press WINDOW 3 to select the Segment tool.**
2. **Move the cursor to the location of the first vertex of the polygon and press ENTER.**
3. **Move the cursor to the location of the second vertex of the polygon and press ENTER *twice;* once to create the first side of the polygon, and a second time to start the second side.**
4. **Repeat Step 3 until all vertices, but not the last side, of the polygon had been constructed.**
5. **Move the cursor to the first vertex you created in Step 1. When that vertex starts blinking, press ENTER to complete the construction.**

No regular polygon tool?

Although Cabri Jr.'s lack of a tool for constructing polygons is only a minor inconvenience, its lack of a tool for constructing regular polygons is a real bummer! Now if Cabri Jr. allowed you to construct an angle having a given measure and a segment having a given length, then I could give you an easy solution to this situation. But it doesn't. It can, however, measure already constructed angles and segments and show you how these measures change as you resize the angle or segment, but this method is not accurate enough to, for example, construct a 40 degree angle. (Measuring angles and segments is explained in Chapter 7. Moving and resizing objects is explained later in this chapter.)

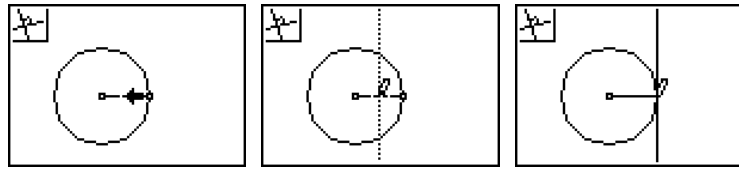
Disclaimer: The comments about Cabri Jr.'s lack of a tool for constructing regular polygons applies only to version 1.02 of this application. This is the version in existence at the time this book was written. Later versions could possibly contain this tool.

Constructing Perpendicular and Parallel Lines

The next section tells you how to construct a perpendicular bisector. This section tells you how to construct perpendicular or parallel lines. To construct such lines, you have to start with an already constructed line, segment, or side of a triangle/polygon. (Constructing these objects is explained earlier in this chapter.) To construct a line that is perpendicular or parallel to an already constructed line, segment, or side of a triangle/polygon, follow these steps:

1. **Select the appropriate tool from the F3 menu.**

   To do this, press ZOOM. Use ▼▲ to move the cursor to the tool you wish to use and press ENTER. A picture of the tool you selected appears in the upper-left corner of the screen. The first picture in Figure B2-4 illustrates that the **Perp** tool is active and waiting for you to construct a perpendicular line.



Select **Perp** tool Anchor all but last point Anchor last point

Figure B2-4: Constructing a perpendicular line.

2. **Use the arrow keys to move the cursor to the already constructed line, segment, or side of a triangle/polygon.**

   The line or segment appears as a moving dashed line and the cursor changes to a solid arrow, as illustrated in the first picture in Figure B2-4. In this picture, I'm about to construct a tangent to the circle at the endpoint of the radius.

3. **Press ENTER.**

   A perpendicular line appears at the location of the cursor, as illustrated in the second picture in Figure B2-4. It appears as a dotted line, indicating that it has not yet been placed where you want it.

4. **If necessary, use the arrow keys to move the line to the location on the screen where you wish to construct the perpendicular or parallel line. Press [ENTER] to anchor this location.**

   If you are moving the line to an already constructed point, you know you have reached that point when the point begins to blink. Press [ENTER] when the line is at the desired location. The third picture in Figure B2-4 illustrates this step when constructing a perpendicular line.

After constructing a parallel or perpendicular line, the tool you were using remains active until you deactivate it. So if you want to construct more objects of the same kind, just repeat Steps 2 through 4. When you are finished using that tool, you deactivate it by pressing [CLEAR] or by selecting another menu item.

Constructing Perpendicular Bisectors

In Cabri Jr., a perpendicular bisector can be constructed to an already existing line, segment, or side of a triangle/polygon. Constructing these objects is explained earlier in this chapter. To construct a perpendicular bisector, follow these steps:

1. **Press [ZOOM] [3] to select the Perp. Bis. tool from the F3 menu.**

   A picture of the **Perp. Bis.** tool appears in the upper-left corner of the screen.

2. **Use the arrow keys to move the cursor to any point of the already constructed line.**

   The line or segment appears as a moving dashed line and the cursor changes to a solid arrow, as illustrated in the first picture in Figure B2-4.

3. **Press [ENTER] to construct the perpendicular bisector.**

After constructing a perpendicular bisector, the **Perp. Bis.** tool remains active until you deactivate it. So if you want to construct more perpendicular bisectors, just repeat Steps 2 and 3. When you are finished using the tool, you deactivate it by pressing [CLEAR] or by selecting another menu item.

Constructing Angle Bisectors

For Cabri Jr. to recognize the existence of an angle, that angle must contain three defining points: the vertex and a point on each side of the angle. Also, Cabri Jr. recognizes a point only if it appears on the screen as a small square, such as the four points defining the quadrilateral in Figure B2-2. If the angle you wish to bisect does not contain the small squares representing these three defining points, then Cabri Jr. cannot bisect it. For example, in Figure B2-2, there is no small square at the intersection of the diagonal lines. So Cabri Jr. cannot bisect the angles formed by these lines intersecting lines.

But all is not lost. The next section tells you how to establish the point of intersection of two lines, and the section after that tells you how to place a point on an already constructed object. After you have constructed the three points defining your angle, Cabri Jr. can bisect it.

To construct the bisector of an already constructed angle containing three defining points, follow these steps:

1. **Press ZOOM 4 to select the Angle Bis. tool form the F3 menu.**

   A picture of the **Angle Bis.** tool appears in the upper-left corner of the screen.

2. **Use the arrow keys to move the cursor to an existing point on one side of the angle and press ENTER to anchor that point.**

   You know that the cursor has reached that when the point starts blinking.

3. **Use the arrow keys to move the cursor to the vertex of the angle and press ENTER to anchor the vertex.**

   The vertex must always be the second point that defines the angle.

4. **Use the arrow keys to move the cursor to an existing point on the other side of the angle and press ENTER to anchor that point.**

   The angle bisector appears as a solid line, indicating that your construction is complete.

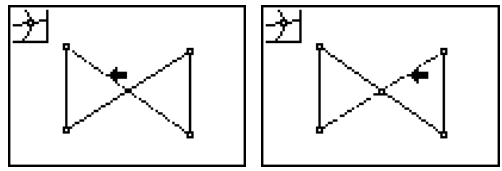
After constructing an angle bisector, the **Angle Bis.** tool remains active until you deactivate it. So if you want to construct more angle bisectors, just repeat Steps 2 through 4. When you are finished using the tool, you deactivate it by pressing CLEAR or by selecting another menu item.

Constructing Points of Intersection

Cabri Jr. can construct the points of intersection of any pair of the following types of objects: lines, segments, circles, and sides of triangles/polygons. To construct points of intersection, follow these steps:

1. **Select the Intersection tool from the Point submenu.**

   To do this, press WINDOW. Repeatedly press ▼▲ to highlight the **Point** tool. Press ▶ to display the point submenu. Use the ▼▲ keys to highlight the **Intersection** tool, and press ENTER to select that tool. A picture of the tool appears in the upper-left corner of the screen and the cursor becomes a solid arrow, as illustrated in the first picture of Figure B2-5.



Select first object Select second object

Figure B2-5: Constructing a point of intersection.

2. **Use the arrow keys to move the cursor to one of the objects in the intersecting pair of objects and press ENTER.**

   When the object you are approaching starts blinking, press ENTER to select it. This is illustrated in the first picture of Figure B2-5, where one of the diagonal sides of the polygon is selected.

3. **Use the arrow keys to move the cursor to the other object in the intersecting pair and press ENTER.**

   The point or points of intersection appear on the screen and the **Intersection** tool remains active.

Selecting objects

When you press ENTER to select an object, Cabri Jr. always selects the object that is blinking. For example, in the third picture in Figure B2-4, the cursor is near the circumference of the circle, the point on the circle, and the line. If you want to select the line but the point is blinking, move the cursor a tad until the line blinks. Then press ENTER to select the line.

You can construct more points of intersections by repeating Steps 2 and 3. When you are finished using this tool, you deactivate it by pressing CLEAR or by selecting another menu item.

Constructing a Point on an Object

The first section in this chapter explains how to construct a free-standing point; this section explains how to construct a point so that it becomes part of an existing object. To construct a point on an object, first press WINDOW and use ▼▲ to highlight the **Point** tool. Press ▶ to display the **Point** submenu and use ▼▲ to highlight the **Point on** tool.

1. **Press WINDOW and use ▼▲ to highlight the Point tool.**
2. **Press ▶ to display the Point submenu and use ▼▲ to highlight the Point on tool. Press ENTER to select that tool.**
3. **Use the arrow keys to move the cursor to the location on the object where the point is to be located.**

   The object blinks when the cursor is on the object.
4. **Press ENTER to place the point on the object.**

   The point is placed on the object at the location of the cursor. If you move this point at a later time, the point will move, but it will not move off the object. Moving points and objects is explained later in this chapter.

After constructing one point on an object, the **Point on** tool remains active until you deactivate it. So if you want to construct more points on the same or different object, just repeat Steps 3 and 4. When you are finished using that tool, deactivate it by pressing CLEAR or by selecting another menu item.

Constructing a Midpoint

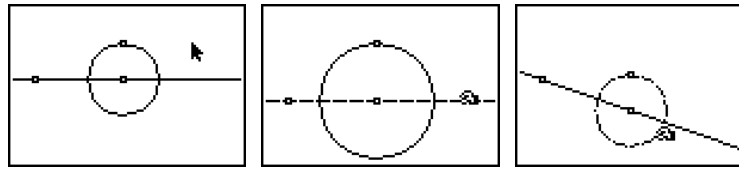
Cabri Jr. can construct the midpoint of an already constructed segment or the midpoint between two existing points. The segment can be the side of a triangle, quadrilateral, or polygon. Cabri Jr. recognizes only those points that appear on the screen as small squares. Constructing points is explained earlier in this chapter.

To construct a midpoint, press [ZOOM] [5] to select the **Midpoint** tool from the **F3** menu. If you are constructing the midpoint of a segment, use the arrow keys to place the cursor on the segment and when the segment starts blinking, press [ENTER] to construct the midpoint. If you are constructing the midpoint between two points, move the cursor to the first point and press [ENTER] when that point starts to blink. Then move the cursor to the second point and press [ENTER] to have Cabri Jr. construct the midpoint.

After constructing the first midpoint, the **Midpoint** tool remains active so you can construct more midpoints. When you are finished constructing midpoints, press [ENTER] to deactivate the **Midpoint** tool or select another menu item.

Moving and Reshaping Figures

When you move an object, all other objects associated with that object will also undergo a change. Figures B2-6 provides a surprising example. The circle and line in the first picture of this figure are associated objects because the center of the circle is also one of the points defining the line. So if you move *only* the line, as illustrated in the second picture of Figure B2-6, the center of the circle moves with it because it is on the line. But the point on the circumference of the circle remains fixed because it is not on the line. Because the center and point on the circumference determine the radius of the circle, the size of the circle changes when only the line is moved.



Associated objects Line moved Circle moved

Figure B2-6: Moving associated objects.

Labeling objects

I personally prefer to avoid labeling objects. Labels take time to create, crowd the screen, and are rarely placed where you want them. Additionally, after you have gone to the trouble of moving labels to a desirable location, if you move the object, its label(s) will not move with it. But let's face it — sometimes you just have to label those points and objects so you can refer to them by name.

To label a point or object, first press GRAPH 2 to select the **Alpha-num** tool from the **F5** menu. Then move the cursor to location on the screen where you want to place the label and press ENTER. The calculator is automatically set in Alpha mode so that you can enter letters. *Without moving the cursor,* enter the label for the object and press ENTER when you are finished. After creating one label, you can move the cursor to another object, press ENTER, give that object a label, and press ENTER to anchor the label. When you are finished creating labels, deactivate the **Label** tool by pressing CLEAR or by selecting another menu item.

And if you move *only* the circle, as illustrated in the third picture in Figure B2-6, the slope of the line changes because one of the points defining the line (the point that is also the center of the circle) moves with the circle but the other point that defines the line stays fixed.

You can reshape figures by moving the points that define the figure. An obvious example is increasing or decreasing the length of a segment by moving one of its endpoints. You can change the size of a circle by moving the point on its circumference that defines the radius — this is the point the calculator left on the circumference when you constructed the circle. Constructing circles is explained earlier in this chapter. And you can reshape a triangle, quadrilateral, or polygon by moving one of its vertices.

To move an object, follow these steps:

1. **Press CLEAR to deactivate all Cabri Jr. tools.**

   When no tools are active, no picture appears in the upper-left corner, as illustrated in the first picture in Figure B2-6.

2. **Use the arrow keys to move the cursor to the object you want to move and press ALPHA when that object begins to blink.**

   The cursor changes to a hand, as illustrated in the second picture in Figure B2-6.

3. **Use the arrow keys to move the selected object and press ENTER to anchor the new location.**

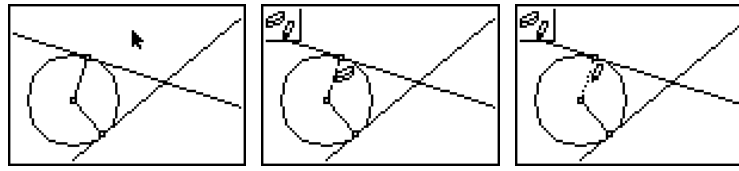
   The cursor changes to a hollow arrow and the object remains anchored in its new location.

Hiding and Deleting Objects

There is a big difference between hiding and deleting an object. If you *hide* an object, you can, if you so choose, bring it back into view at a later time. But if you *delete* an object, it is gone for good.

Hiding an object

The first picture in Figure B2-7 provides an example of when you may want to hide an object. Because Cabri Jr. has no tool that instantly creates a tangent to a circle, the tangents in this picture were created by first constructing radii, and then by constructing lines perpendicular to these radii. (Constructing such objects is explained earlier in this chapter.) If all you really want to see is the circle and tangents, you can hide the radii. If you were to delete the radii, the tangents would also be deleted because they were constructed perpendicular to the radii and are thus dependent on the existence of the radii.



Given figure | Select objects to hide | Press ENTER

Figure B2-7: Hiding objects.

To hide an object, follow these steps:

1. **Press GRAPH 1 to select the Hide/Show tool from the F5 menu.**

   A picture of the **Hide/Show** tool appears in the upper-left corner of the screen, as illustrated in the second picture in Figure B2-7.

2. **Use the arrow keys to move the cursor to the object you want to hide.**

   The object blinks and the cursor changes to an eraser, as illustrated in the second picture in Figure B2-7, where the radius is to be hidden.

3. **Press ENTER to hide the object.**

   The object appears as a dotted object and the cursor changes to a pen, as illustrated in the third picture in Figure B2-7.

4. **Move the cursor away from the object.**

   The object vanishes and the cursor changes to a solid arrow.

After hiding one object, the **Hide/Show** tool remains active (as indicated by the picture in the upper left of the screen) until you deactivate it. So if you want to hide more objects, just repeat Steps 2 through 4. When you are finished using the tool, you deactivate it by pressing CLEAR or by selecting another menu item.

Redisplaying hidden objects

To redisplay hidden objects, press GRAPH 1 to select the **Hide/Show** tool from the **F5** menu. Use the arrow keys to move the cursor to the location of the hidden object. When the cursor reaches the object, that object is displayed as a dotted object and the cursor changes to a pen, as illustrated in the third picture in Figure B2-7. Press ENTER to show the object. The object blinks and the cursor changes to an eraser, as illustrated in the second picture in Figure B2-7. Move the cursor away from the object. The object is redisplayed and the cursor changes to a solid arrow.

Because the **Hide/Show** tool remains active until you deactivate it, you can continue to hide and show other objects. When you are finished using this tool, deactivate it by pressing CLEAR or by selecting another menu item.

Deleting objects

If you delete an object, then all other objects whose construction is dependent on the deleted object will also be deleted. For example, the tangents in the first picture in Figure B2-7 were constructed perpendicular to the radii of the circle. If you were to delete the

radii, the tangents would also vanish because their existence is dependent on the existence of the radii.

To delete an object, press [CLEAR] to ensure that no tools are active. Use the arrow keys to move the cursor to the object. When the object starts blinking, press [DEL] to delete the object. If you regret deleting that object, press [Y=][2] to undo what you just did.