APPENDIX A

A Brief Introduction to *The Geometer's Sketchpad®*.

The Geometer's Sketchpad® is computer application for sketching and manipulating geometrical figures that is distributed by the Key Curriculum Press. When it is opened, a window appears which is called a *sketch*. The sketch has toolbox with several icons, which are the tools for the basic constructions of geometry.

Arrow tool: In order to select a figure click first on the arrow tool and then on the figure. To select several objects hold down the shift key while selecting them.

Point tool: To draw a point, click the arrow tool and then the location where the point is to fall.

Circle tool: To draw a circle, click the circle tool, place the cursor at the location where the center is to fall, and then drag to create the desired radius.

Line tool: Holding the mouse down on this tool reveals a pop-up menu with three options: segment, ray, and (infinite) line. The appropriate tool is selected by dragging to it. Dragging the mouse in the window then creates the desired line.

Text tool: This is the tool for manipulating labels. When this tool is chosen, selecting any unlabeled object will create a label, and selecting a labeled object will hide the label.

Hiding: To erase an object select it and then drag down to the appropriate **Hide** command in the **Display** menu

Measurement: To measure any aspect of a figure, select that figure and then drag down to the appropriate function in the **Measure** menu (an angle is measured by selecting three points on its sides; to measure the area of a polygon first fill it with **Polygon Interior from the** Construct menu). The value of the function will appear in the upper left hand corner of the window.

In order to algebraically manipulate such measurements, display the calculator in the **Measure** and select the desired measurement.

More constructions:

1. A variety of standard constructions can be performed by the **Construct** menu. Select the objects to which the construction is to be applied and then drag down in the menu to the appropriate command.

2. The users can encode and keep their own constructions as **scripts**. To create a script use the **File** menu to open both a new sketch and a new script. Draw and select some points in the sketch that are to serve as the *input* for the construction, and click the **REC** button in the script window. Apply the construction to these points in the sketch (note that *sketchpad* automatically records the steps of the construction in the script). Signify the completion of the construction by clicking the **STOP** button in the script. Save the script. In order to apply this construction script to any set

of points, select these points, open the script, and click the **PLAY** button in the script.

If the script concludes with the selection of a set of points similar to those in the input, then these are termed the *output*. If the number of points in the output equals that of the input, the script can be reapplied to the output. Such scripts are said to be **reapplicable.**

The following is the script that takes two (selected) points at its input and constructs an equilateral triangle on them.

Given:

1. Point A
2. Point B

Steps:

1. Let [j] = Segment between Point B and Point A.
2. Let [c1] = Circle with center at Point B passing through point A (hidden).
3. Let [c2] = Circle with center at Point A passing through point B (hidden).
4. Let [C] = Intersection of Circle [c2] and Circle [c1].
5. Let [k] = Segment between Point [C] and Point B.
6. Let [l] = Segment between Point [C] and Point A.

EXERCISES

Use sketchpad to verify the following propositions.

1. The three perpendicular bisectors of the sides of a triangle are concurrent.
2. The three bisectors of the interior angles of a triangle are concurrent.

3. The three medians of a triangle are concurrent.

4. The three altitudes of a triangle are concurrent.

5. The line joining the midpoints of two sides of a triangle is parallel to the third side and has half its length.

6. The triangle formed by joining the midpoints of the sides of a given triangle has area one fourth that of the original triangle.

7. The quadrilateral formed by joining the midpoints of the successive sides of an arbitrary quadrilateral is a parallelogram.

EXPLORATION EXERCISES

Use sketchpad to locate and/or investigate the special properties of the points or figures specified below.

1. That point the sum of whose distances from the vertices of a triangle is minimum.

2. That point the sum of whose distances from the sides of a triangle is minimum.

3. A triangle of minimum perimeter with its vertices on the sides of a given triangle.

4. A triangle of minimum area with its vertices on the sides of a given triangle.

5. Triangle $A'B'C'$ where ABC is an arbitrary triangle and $\Delta A'BC, \Delta AB'C, \Delta ABC'$ are clockwise equilateral triangles.

6. Triangle $A''B''C''$ where A'', B'', C'' are the respective centers of the equilateral triangles of Exercise 5.

7. The centers of the squares constructed on the sides of (and outside of) a convex quadrilateral.

8. Replace the equilateral triangles of Exercise 6 with similar triangles.

9. Replace the squares of Exercise 7 with similar rectangles.

10. The quadrilateral formed by the perpendicular bisectors of a given quadrilateral.

11. The quadrilateral formed by the angle bisectors of a given quadrilateral.

12. That point on a given line the sum of whose distances from two points not on the line is minimum.