INTRODUCTION

In this week's tutorial, we're going to start by looking at the transformation that results from reflecting an object over two intersecting lines. First construct an angle using the segment tool. Then use the Polygon tool to construct a polygon inside of angle ABC. Now, double click segment AB to mark it as a mirror, select the polygon and choose transform reflect. Double click segment BC to mark it as the mirror and choose transform reflect again. Drag the vertices of the original angle and the original polygon and observe the behavior on both reflected polygons. Now we'll make this double reflection into a custom tool. Then, in the rest of this tutorial we'll explore using this custom tool to create a kaleidoscope.

DEFINE A DOUBLE REFLECTION TOOL

I'm going to select the desired givens—first the original interior, then segment AB, then segment BC, then the desired results, which are the two reflected interiors. Now I have five objects selected. The next thing I want to do is choose Create New Tool from the Custom Tools menu in the toolbox. Enter the name Double Reflection and click OK.

The new custom tool will now be listed at the bottom of the Custom Tools menu, as shown here.

USE THE CUSTOM TOOL

Click on the Custom Tool icon in the toolbox to choose this new tool. Click on the upper left polygon then the lower segment, then the upper segment. Two interiors appear. Notice that what was done to the original interior being reflected over the two segments has been done to the clicked on interior.

The custom tool is still active. Click this time on the last interior constructed by the tool, which, in this case, is the orange one here. Next, click on the two reflection segments. Now you should have seven polygons, as I do here.

Choose Undo from the edit menu twice. Notice that one entire double reflection is undone each time. Now choose Redo twice to return to the previous state.

EXPERIMENT WITH THE MIRROR ANGLE

We want to use our double reflection tool several times to create about 25-30 interiors. We're going to skip ahead to the place where I have 27 polygons. You want to drag point C around and notice that for certain angles, many of the interiors are coincidence. For example, if I try 30 degrees, I have one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve interiors. What happens if I change it to 36? Can you state a conjecture as to why certain angles have this special property? Can you predict how many interiors there will be for any one of these given angles, say 60 degrees? Click anywhere on the screen when you're ready to continue.

The reason that the interiors will line up at 30 degrees and 36 degrees is that they are both factors of 360. In fact the number of interiors shown is the quotient of 360 and the angle. Therefore, if you make the angle 60 degrees you will only see 6 interiors.

Using the keyboard shortcut for Undo, which is Ctrl-Z or Apple-Z, undo back to the point at which there were just seven interiors. We're going to use the Dilation command to make smaller and smaller copies of the original polygon.

Double click point B to mark it as a center for subsequent transformations. Select three interiors with the same color and choose dilate from the transform menu. I'm going to enter a scale factor of -1/2, and then I'm going to click dilate. You'll see three dilated images appear, each of which are half the size of their preimages. Also, because of the negative scale factor, each image is on the side of the centerpoint opposite its preimage. Now, with these new three interiors selected, redilate these new interiors. Now let's color these new interiors, mmm, brown.

Select the other three of the original six interiors. Dilate these just as we did with the others.

DILATE EACH OF THE POLYGONS

Now comes the best part. We're going to animate and merge our kaleidoscope. First, drag one or more of the vertices of the original interior to see how everything else in the sketch changes accordingly.

What would happen if select a polygon interior and choose animate? Click anywhere on the screen when you're ready to continue.

The points that define the interior, the five vertices of the original polygon, are independent. That means that they can animate randomly around this plane, as you can see. You can gain more control over these animating points by first merging them to existing in newly created paths. So let's click on the stop button in the motion controller or choose "Stop Animation" from the display menu. I'm going to now choose undo to move the points back to where they were before we started this animation. Select one of the vertex points and one of the segments and choose "Merge Point to Segment" from the edit menu. Notice the point attaches itself to the segment. Try dragging it, and you'll see that it can now only move along its new segment path. Use the same technique to merge a second vertex point to the other segment.

Then use the compass tool to create circles of any size anywhere in your sketch. Make sure to click only in blank space. Don't attach the circles to any existing objects.

MERGE INDEPENDENT POINTS TO PATHS

Now, we merge, one by one, the remaining three vertex points to the circles. Each vertex point should now be attached to a different segment or circular path. Select any interior and choose animate. Each vertex starts animating along its path. Use the

motion controller to fine-tune your kaleidoscope. You can target individual points by pressing on the target pane near the top of the motion controller. Try changing the speeds and directions of several of the points. You can also drag points to change the size and location of the path objects in the sketch.

When you're pleased with your kaleidoscope, hide everything but the interiors. Here's a quick way to do that: First, deselect all objects. Then choose the point tool. Then choose select all points from the edit menu. Then choose hide points from the display menu.

Repeat these last two steps with the compass tool, and then the segment tool.

CREATE AN ANIMATION BUTTON

You can create an action button that will turn the animation on and off. Select the object that you wish to animate, in this case the pentagon, and then go to the action button in edit menu and choose animation. Now you can start or stop the kaleidoscope by clicking on this button. You can change the name of the animation button just as you change a hide/show button. Use the right edge to select the button and choose Label Action Button from the Display menu.

This concludes the walkthrough of the kaleidoscope tour. Use the index to repeat any part of this video.