

Curves from Lines and Points

The curves in string art images are typically created from portions of the line segments that make up the image. Using the [image archetypes sheet](#), the curved parts of curved-tip stars, porcupine polygons and stars, and spinning needle stars are all created from small parts of line segments. (If you want to read about these small parts from a mathematical point of view, the curve is the *envelope* of a family of lines.) A second way to “see” a curve is to smooth out the small line segments that are arrayed in a curved pattern such as this [chrysanthemum](#). A final way to view curves is to watch the pattern of kinked subdivision endpoints used to create a figure such as the [odd and even dancing partners](#) in spinning needle stars.

This [two footballs image](#) (248, 164, 248, 83) image has 8 curves from lines and two footballs from subdivision endpoints.

About the footballs. If you view this image on *Pause* using *Single Lines Overlaid Drawing* (SLOD) mode and *Drawn Lines* = 2 you will see that when the *Drawing progress* number is **even**, the two even endpoints (the start and stop of the highlighted two lines) are on the vertical football and the odd one in the middle is on the horizontal football. However, when *Drawing progress* is **odd**, the reverse is true. This means the vertical football contains only even endpoints, and the horizontal football contains only odd ones.

Second, notice that you can clearly see the footballs even though they really are not part of a *connected* set of lines. Put another way, here are *sets of points that create curved images*.

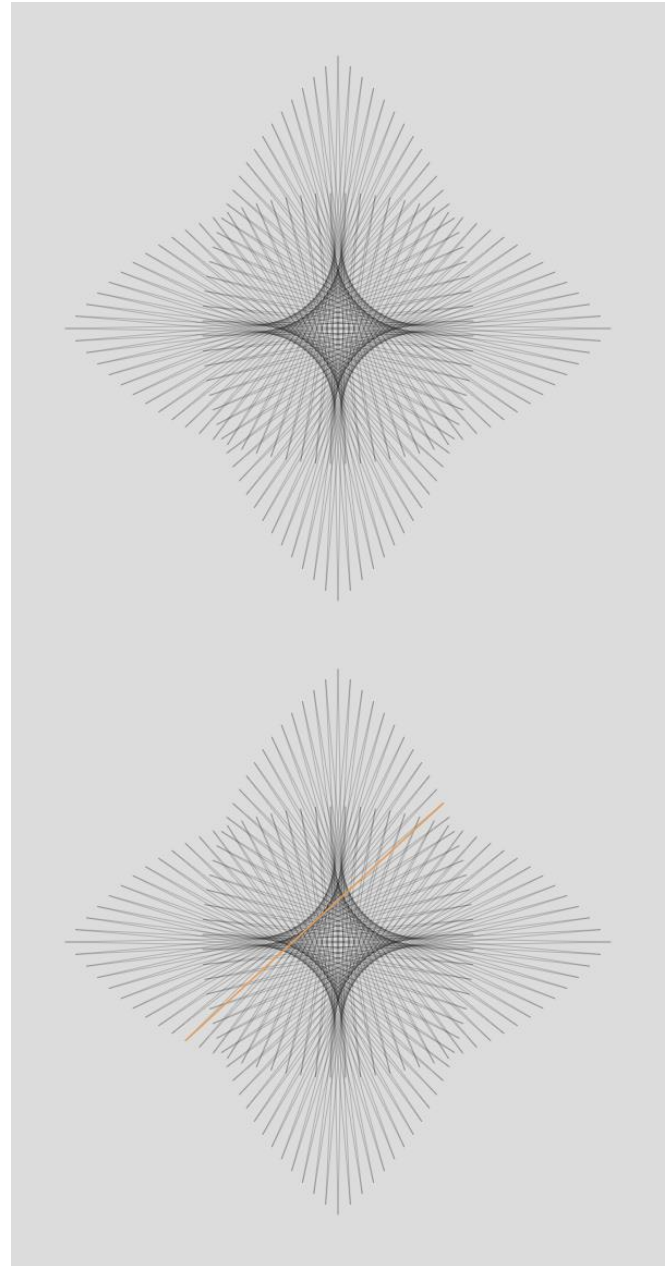
About the curves from lines. The image has 8 distinct curves in two sets of 4 curves connected when they become horizontal or vertical. This 4-point star is sometimes called an *astroid* (not an asteroid). Using SLOD with *Drawn Lines* = 1 you can quickly uncover how these curves were created.

The second image shows a line at *Drawing progress* = 21 meaning that the line in question goes from 21 (on the horizontal football) to 22 (on the vertical football). The tangency shows that this is one of the lines that helps create the *Inner curve on the Top Left, TLI* in the table below.

If you *Step Forward 1* so *Drawing progress* = 22 you will note that the point on the vertical football has not changed but the point on the horizontal football has moved one point over (up and to the left). The resulting line (from 22 to 23) is helping to create the outer curve on the top left, *TLO*.

The table below summarizes how each of the curves is formed. In this instance, the two 4-point stars are formed in four [cycles](#) in a counterclockwise fashion. One star is made using even starting point lines the other uses odd starting point lines.

Click *Play* in SLOD mode and watch the line bounce back and forth between inner and outer curve to create both curves. Note also that inner and outer curves alternate in each star and that all 164 lines were used to create the two stars (21 for outer curves 20 for inner). A final way to verify that the line-drawn curves employ only lines is to *Toggle Subdivisions* on and off.



		Curve using even starting point lines.			Curve using odd starting point lines.			
Cycle	Curve	First	Last	# lines	Curve	First	Last	# lines
First	TLO	0	40	21	TLI	1	39	20
Second	BLI	42	80	20	BLO	41	81	21
Third	BRO	82	122	21	BRI	83	121	20
Fourth	TRI	124	162	20	TRO	123	163	21

Curve labels: **T/B** for Top/Bottom, **L/R** for Left/Right, **I/O** Inner/Outer.