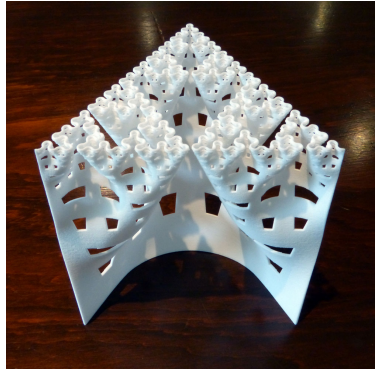




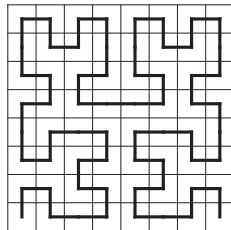
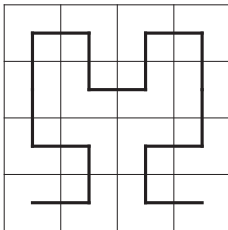
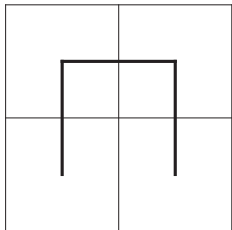
Henry Segerman
Oklahoma State University



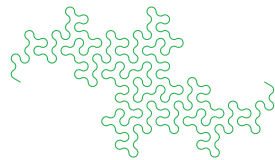
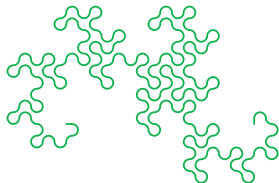
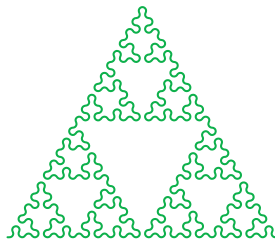
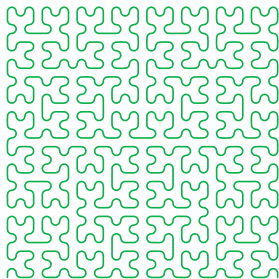
Geoffrey Irving
Otherlab

Developing fractal curves

Fractal curves



Fractal curves



Hilbert curve (Hilbert, 1891), Sierpiński arrowhead curve (Mandelbrot, 1983),
Dragon curve (Heighway, 1967), Terdragon curve (Davis-Knuth, 1970)

L-systems (Aristid Lindenmayer, 1968)

An *L-system grammar* consists of an *alphabet*, an *axiom* and a set of *replacement rules*. For example:

$$G_{\text{terdragon}} = (\{F, -, +\}, F, \{F \mapsto F - F + F\})$$

Start with the axiom, and repeated apply the rule:

$$F$$

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$$F \qquad - \qquad F \qquad + \qquad F$$

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Start with the axiom, and repeated apply the rule:

$$\begin{array}{cccccccccccccccc} & & & & & & & & F & & & & & & & & \\ & & & & & & & & F & & + & & & & & & \\ F & - & F & + & F & - & F & - & F & + & F & + & F & - & F & + & F \end{array}$$

Now interpret the strings as “turtle graphics” instructions:

F		move forward one unit
$-$		turn right 120°
$+$		turn left 120°

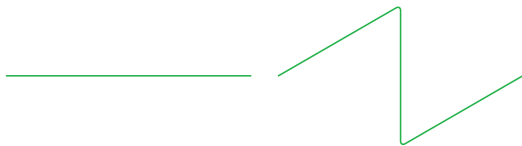
F



Now interpret the strings as “turtle graphics” instructions:

F		move forward one unit
$-$		turn right 120°
$+$		turn left 120°

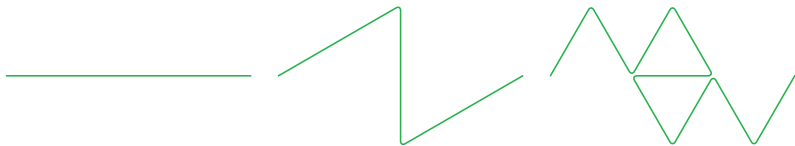
F $-$ F $+$ F



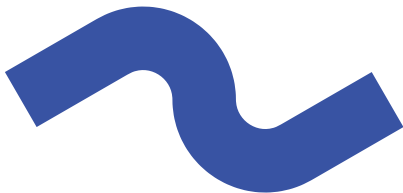
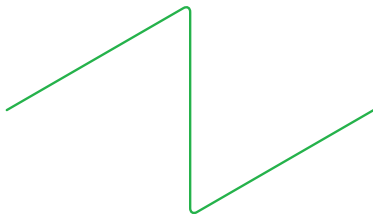
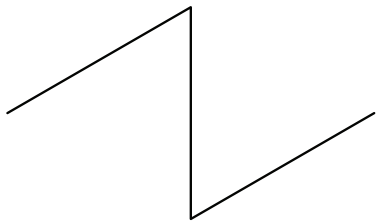
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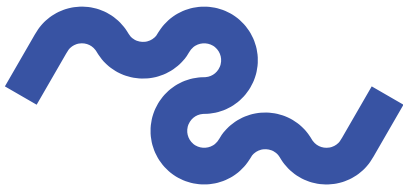
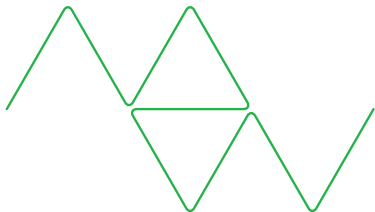
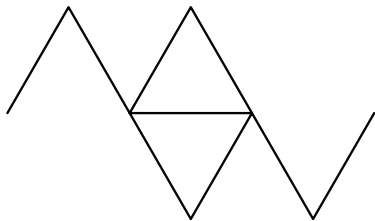
F		move forward one unit
$-$		turn right 120°
$+$		turn left 120°

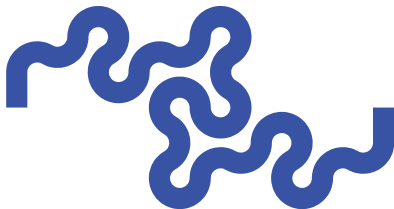
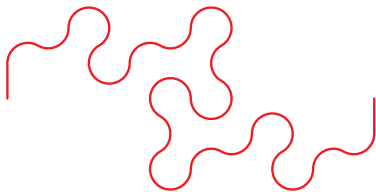
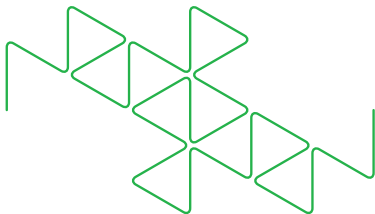
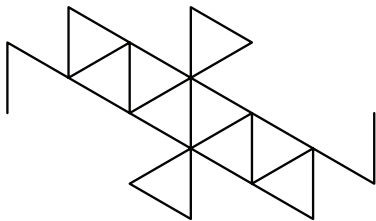
$F \quad - \quad F \quad + \quad F \quad - \quad F \quad - \quad F \quad + \quad F \quad + \quad F \quad - \quad F \quad + \quad F$

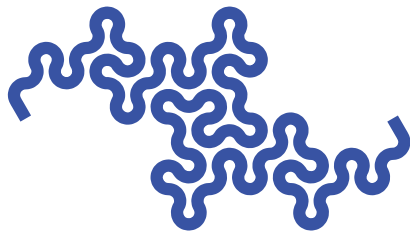
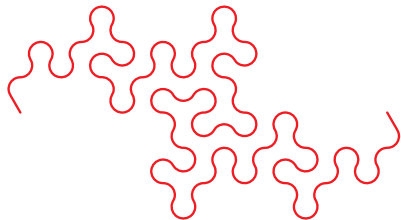
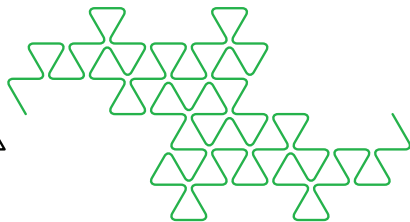
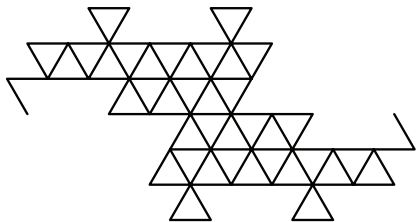


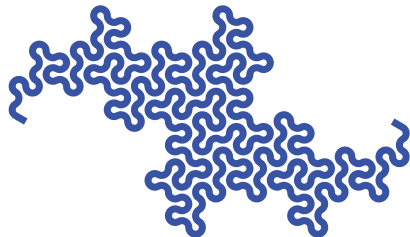
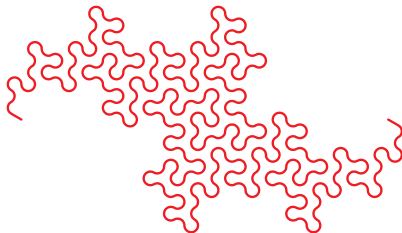
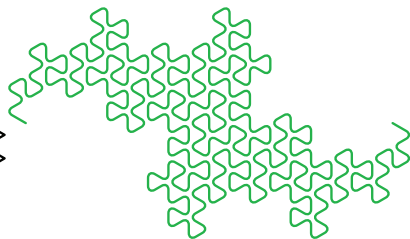
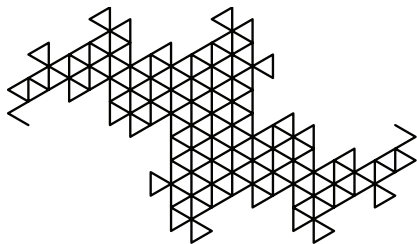




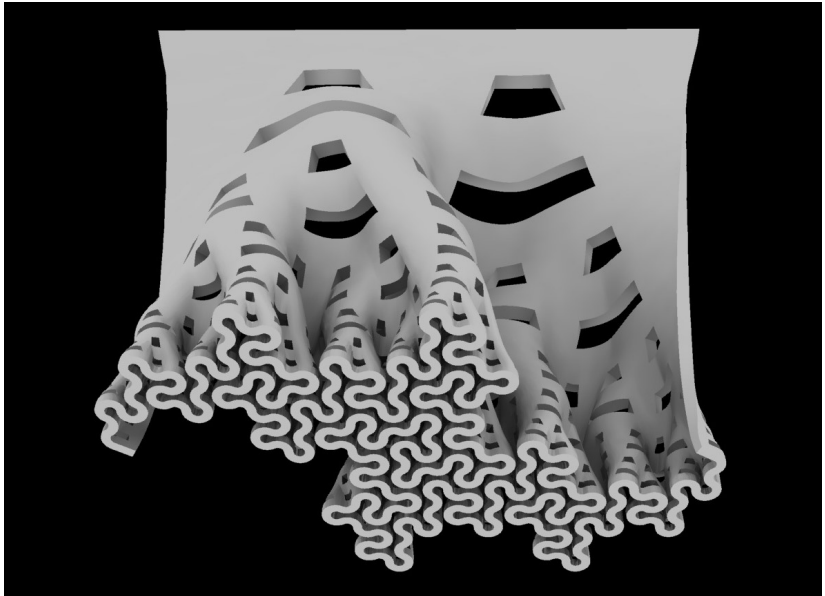




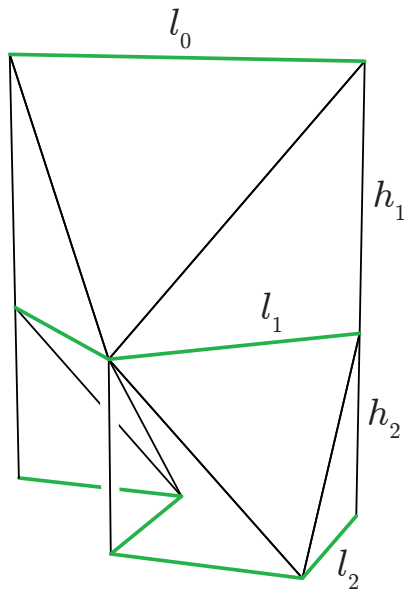
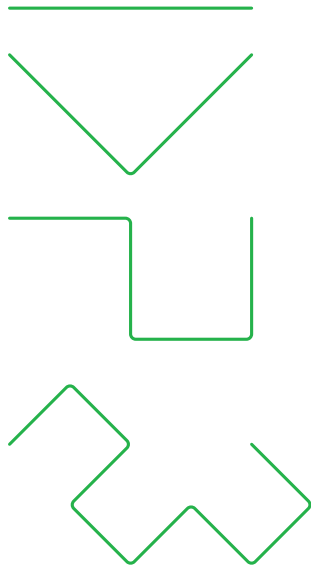


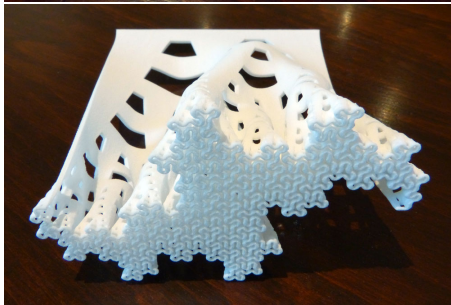
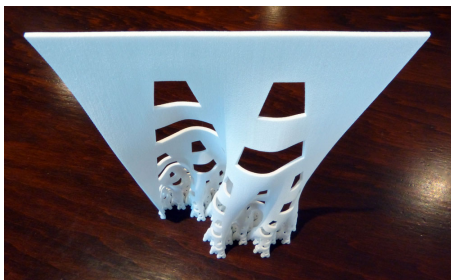
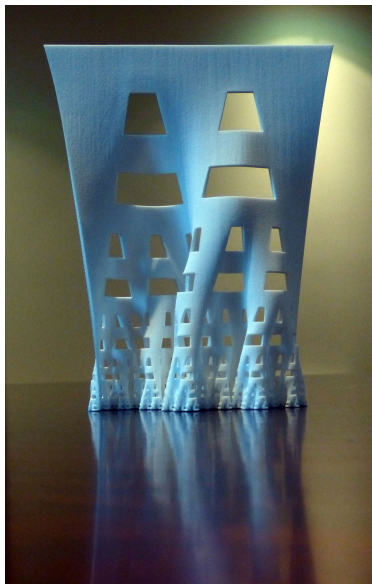


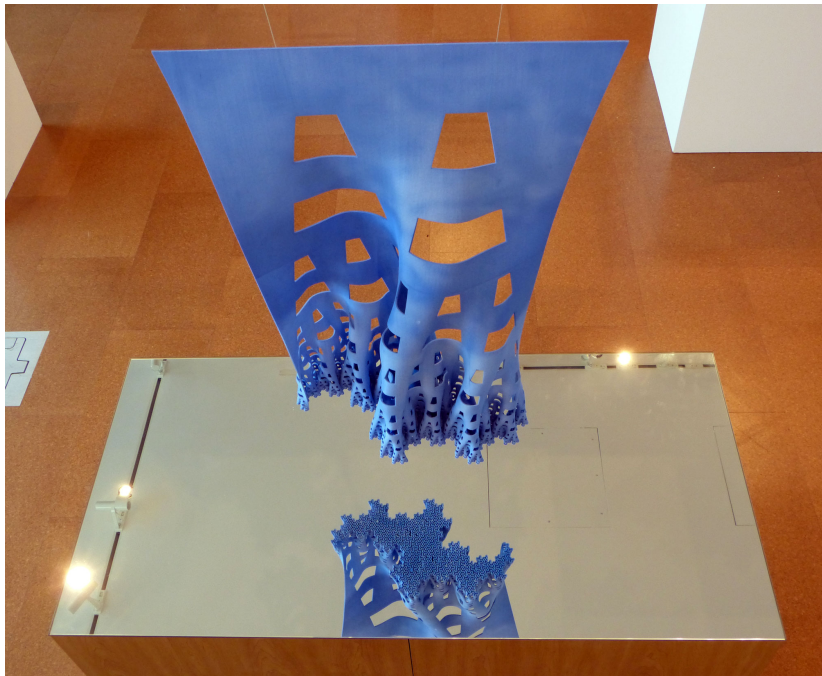
Now arrange these in space rather than time!

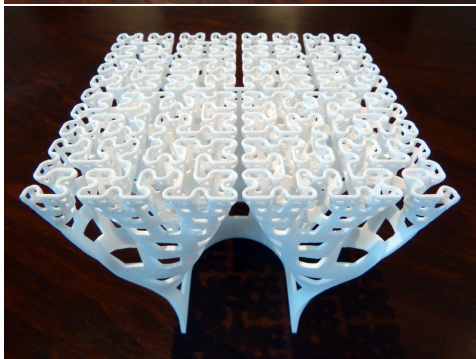
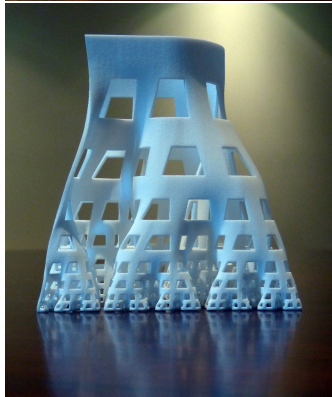


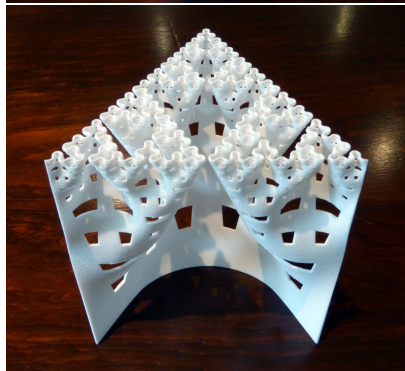
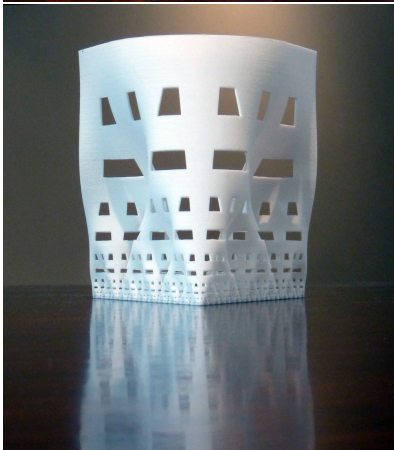
Self similarity

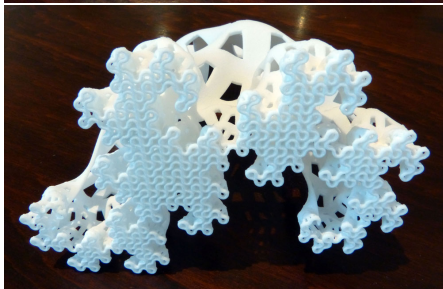
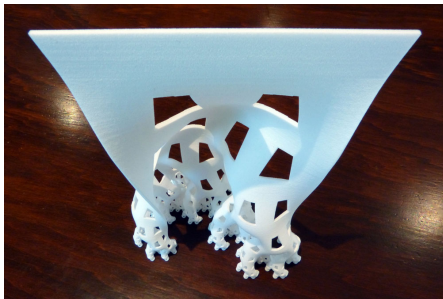


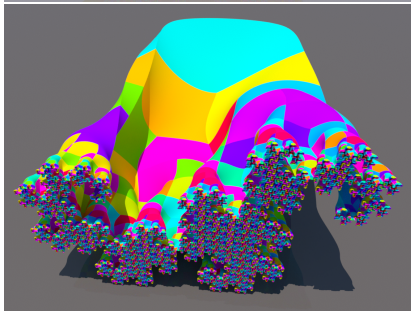
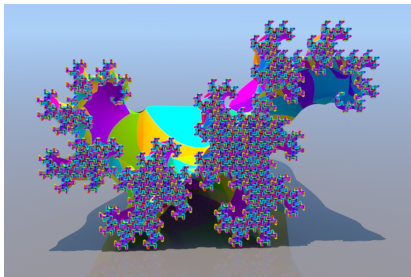
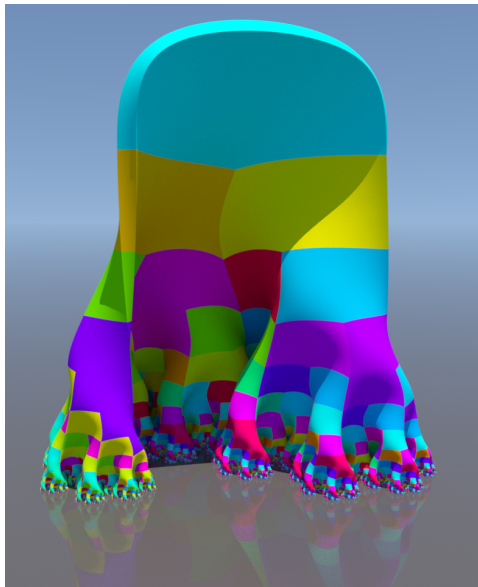




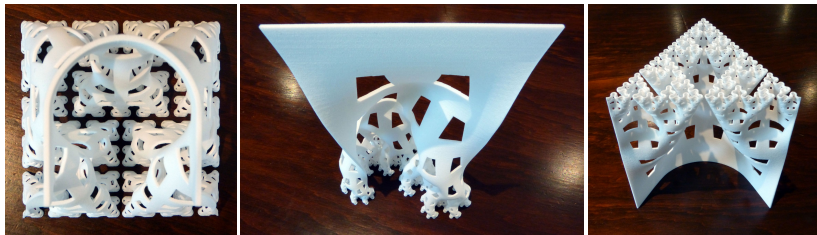








Thanks!



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