

This describes a project to use the Sherline mill to cut pieces of circuit board that could be used to construct a Koch analog antenna suitable for use in the television band. The goal of the exercise was to verify some facets of g-code (subroutines, recursion) and potentially get improved television reception as a by-product. The antenna produced here performs on a par with the \$12.00 set of radio shack rabbit ears so the project failed from a utility point of view. The original program for cutting a flake was located on the net and modified to produce the results described here, it was only 45 lines long so you can see we got an awful lot of cutting done with very few lines of g-code. I have tried to remove some of the inscrutibility in the code by adding comments to it, the code is included herein if you care to read it, its also located on the sherline control computer with filename joeyflake1.ngc and can be run there in the emc2 program.

Heres the code:

%

(Program to mill a flake for an antenna piece)

(K. Lerman's flowsnake pgm modified)

(declare subroutines before they are called, only one subroutine used here)

o1000 sub

#<level> = #1 (parameter named level is assigned to the first passed param)

#<startX> = #2 (in g code, up to 30 params can be passed with call)

#<startY> = #3 (these params define the co-ordinates of a straight line)

#<endX> = #4

#<endY> = #5

o1001 if [#<level> EQ 0] (conditional if statement)

o1004 if [#<endX> LT 7.35] (don't do any cutting beyond 7.35")

g1 f10 x#<endX> y#<endY> (all cutting is done here, set feed rate to 10%)

o1004 endif

o1001 else

(the co-ord of a point 1/3 of the way between start & end)

#<p1X> = [[#<startX> * 2 + #<endX>]/3]

#<p1Y> = [[#<startY> * 2 + #<endY>]/3]

(the co-ord of a point 1/2 of the way between + 1/3 of a the length)

(of the line connecting them offset by 60 degrees)

#<p2X> = [[#<startX> + #<endX>]/2 + [#<endY> - #<startY>]/[SQRT[12.0]]]

#<p2Y> = [[#<startY> + #<endY>]/2 - [#<endX> - #<startX>]/[SQRT[12.0]]]

(the co-ord of a point 2/3 of the way between)

#<p3X> = [[#<startX> + 2 * #<endX>]/3]

#<p3Y> = [[#<startY> + 2 * #<endY>]/3]

(call the subroutine to "draw" the line between start & end)

(using the parameter level to control how many times we shrink the length)

(of the individual crinkles in the line. Four straight strokes are needed)

(to finish each subfigure, so we need four calls to print each subflake)

(each subflake has four pieces, like this $_/_$)

```
o1000 call [#<level>-1] [#<startX>] [#<startY>] [#<p1X>] [#<p1Y>]
```

```
o1000 call [#<level>-1] [#<p1X>] [#<p1Y>] [#<p2X>] [#<p2Y>]
```

```
o1000 call [#<level>-1] [#<p2X>] [#<p2Y>] [#<p3X>] [#<p3Y>]
```

```
o1000 call [#<level>-1] [#<p3X>] [#<p3Y>] [#<endX>] [#<endY>]
```

```
o1001 endif
```

```
o1000 endsub
```

(S1M3)

(generic protocol leadin to initialize the machine and flush out)

(any settings that could be left over from previous jobs)

```
g17 g20 g40 g49 g54 g80 g90.1 g94
```

```
g10 l2 p1 x0 y0 z0 (make axis set 1 be absolute)
```

```
t1 m6 (tellit we're using a tool, )
```

```
f 100 (set feed to 100% for non-cutting movement)
```

```
G0 x0 y0 z0 (go to the place where the machine has been zeroed)
```

#<level> = 3 (each level divides the distance into smaller pieces)

(beyond level 3 exceeds the cutter compensation ability to cut)

(reasonably shaped figures. even at three, we get rounding on the edges)

(with tool size .33" and actual cutter = .07")

(alternately we could cut one line without compensation)

(and cut the other one with all of the "width" so with this modified)

(program we could round over either the inside or outside of the flake)

#<depth> = 0.0

o2004 while [#<depth> GT -0.092]

#<depth> = [#<depth> -0.022]

G40 (cancel cutter compensation)

G41.1 D0.33 (turnon cutter compensation left, with a .33 cutter diameter)

g0 x0.25 y1.00 z0.25 (cutter compensation lead-in)

g1 f10 z[#<depth>] (depress the cutter into the part)

o1000 call [#<level>] [.25] [1.0] [13.00] [1.0] (use subroutine to feed)

G1 z 0.25 (retract)

G40 (cancel cutter comp)

G42.1 D0.33 (turnon cutter comp right, after this call, the material left)

(.33 - 5/64 will be the thicknes of the finished flake)

g0 x0.00 y0.65 z0.25 (cutter comp leadin)

g1 f10 z[#<depth>]

(we're going to call sub once here with a length of 13", sub)

(won't cut anything beyond 7.35. This gives us reasonably sized)

(crinkle in our flakes. each should be about 1 inch long, this program)

(only makes them 3/4" long)

```
o1000 call [#<level>] [.25] [1.0] [13.00] [1.0]
```

```
G1 z 0.25
```

```
G40
```

```
o2004 endwhile (repeat calling the sub with deeper cut each time)
```

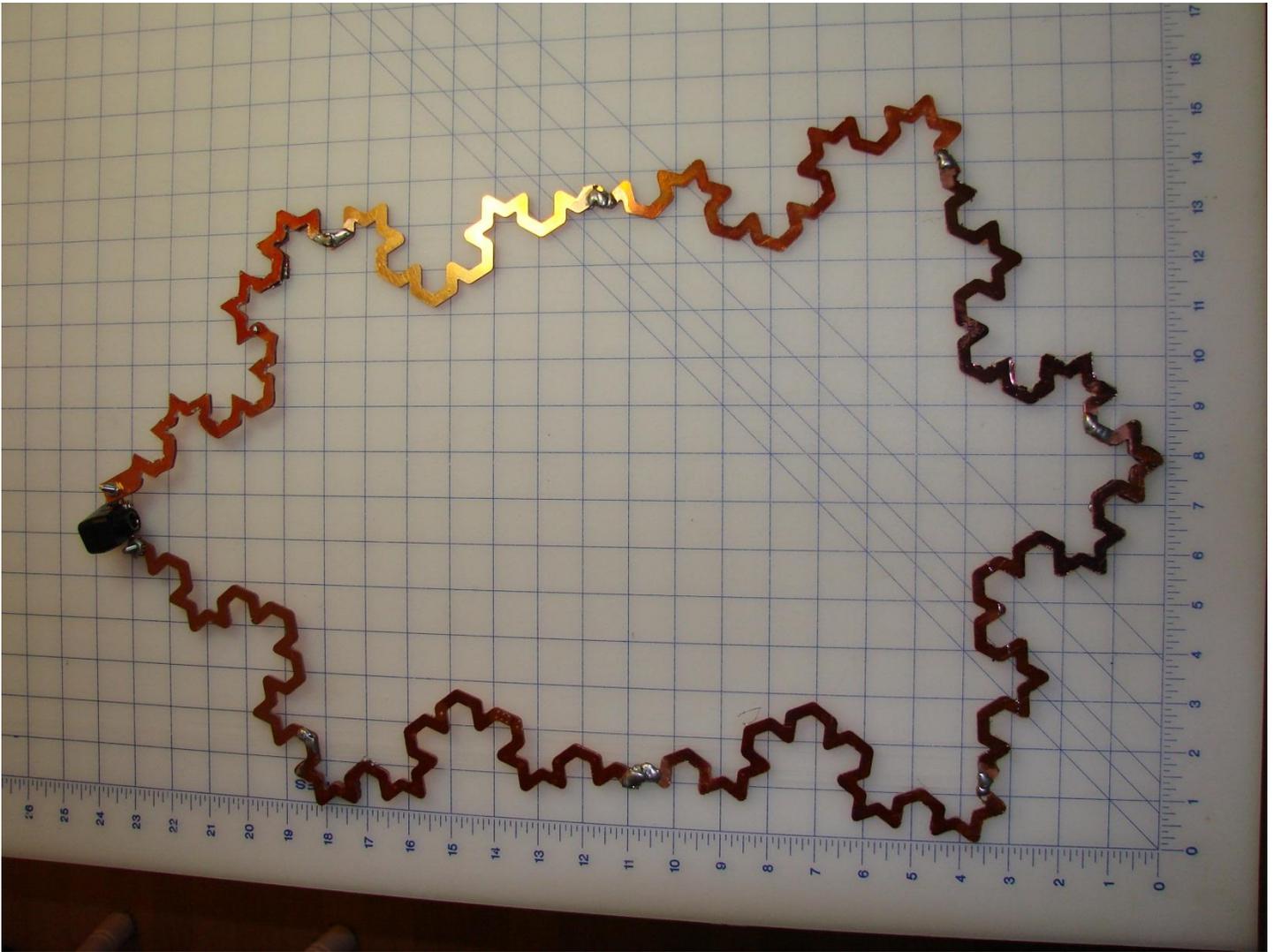
```
m2 (end the program)
```

```
%
```

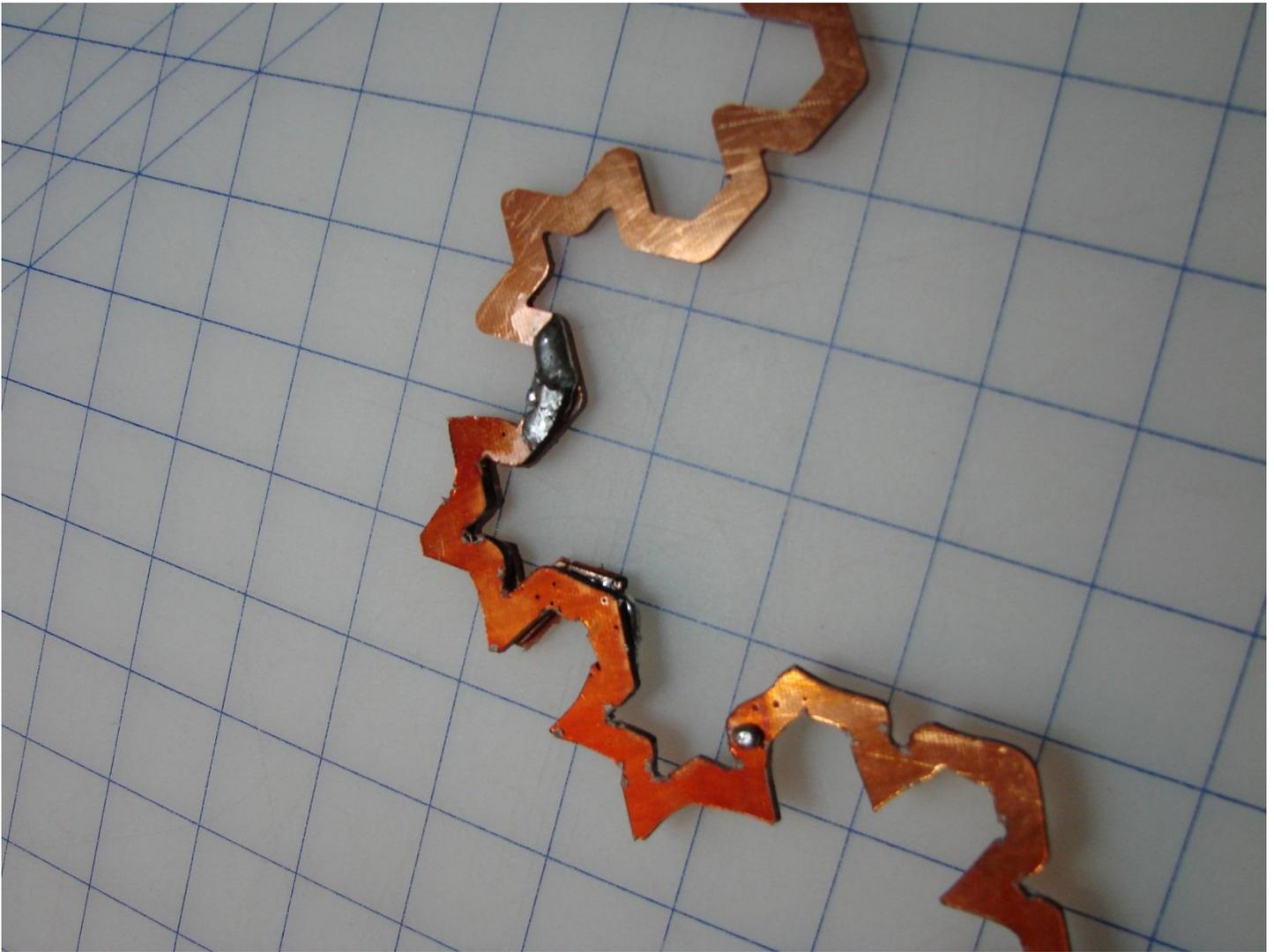
I went to Nashua circuit and got some scrap copper clad circuit board and milled the flakes on the Sherline using a 5/64 2 flute endmill. I had originally planned on drawing one figure then cutting several at a time in a scroll saw but my scroll saw was too underpowered to do more than one sheet at a time. I cut partial pieces and blob soldered the things together to get the "finished article" as shown below.



Heres a few of the cut flakes, I used 8 in the whole gizmo



I drilled holes in the two top pieces and attached a 100-50ohm cctv cable adaptor and cabled the thing into the digital converter box in front of my old analog TV for use. The antenna is somewhat directional both in the horizontal and vertical positions. The downfeed cable bisects the shape and appears to help it work better.



Pretty sloppy soldering: The edges of each flake aren't plated and I thought it made sense to make a connection between both sides of the PC board. This joint is between the flake I cut out on the scroll saw and one that came out of the mill. (notice round edges versus pointier ones)