This is a spreadsheet and instructions to make wooden spiral staircases.

A single central column 4 to 7 inches in diameter (round, square, or irregular) has two faces milled per step to provide a front and back riser. This document shows how to make the dial used to set and mill the faces, how to mill the column, and how to assemble the stairs. Read the whole document before you start!

| Value	Meaning
=========	===
100 =	total rise from bottom of first step to top of last step
42 =	radius of stairway
4 =	minimum width of glue face = 4 inches
2.18 =	height of saw above center of cylinder to give a 4 inch glue face
2.5 =	minimum radius of cylinder to assure 4 inch wide glue face
13 =	number of steps
180 =	spiral, in degrees (e.g: 180 for half circle)

Results==>

7.69 =	rise per step (total rise/# of steps)
13.85 =	angle between steps (degrees spiral/# of steps)
12.05 =	width of tread at extreme radius (radius*cos[degrees spiral/# of steps])
174.99 =	correction so back riser is under front riser of the next step up =180+(-1*(C16-C16*((C17-2*B11)/C
44.18 =	total length of step to fit across all of the upright cylinder cut face (=B9+B11)
84 =	total width of stairs =B9*(MIN(180;MAX(B14;90))/90)

Tables and Plots

| Number of Steps	Angle	
1	13.85	188.84
2	27.69	202.68
3	41.54	216.53
4	55.38	230.38
5	69.23	244.22
6	83.08	258.07
7	96.92	271.91
8	110.77	285.76
9	124.62	299.61
10	138.46	313.45
11	152.31	327.3
12	166.15	341.14
13	180	354.99
14	193.85	368.84
15	207.69	382.68
16	221.54	396.53
17	235.38	410.38
18	249.23	424.22
19	263.08	438.07
20	276.92	451.91
21	290.77	465.76
22	304.62	479.61
23	318.46	493.45
24	332.31	507.3
25	346.15	521.14
26	360	534.99

Plotting Instructions

To use QCAD to make the dial for cutting the flats with a radial arm saw, follow the instructions below.
Open QCAD and create a new blank document.
From the Lines menu, select 'horizontal lines', and 100 for the length.
Click once on the origin- you should have a new line.
Now click on the line you just created.
Click on the Main Menu "Modify " option and choose Rotate.
Note a new thick black arrow appears at the base of the left hand menu- click once on the arrow.
Click once on the origin. A dialog window will next prompt you for the "Rotation Options"
Click on Multiple copies, enter the number of steps in the Number of Copies field.
For a right handed spiral ("handedness" examples below) enter the angle between steps as a positive value.
For a left handed spiral, enter the angle as a negative number. Click on the origin and the
Click on Select All. Then choose the Main Menu's Modify Attributes command, and again click on the thick
black arrow that appears at the bottom of the left hand menu: a dialog appears, change the color to blue.
This completes the first half of the dial, it should look like the below.
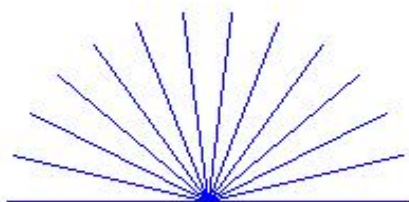
Next comes the flip cuts for the back risers
Start by Selecting All, then Modify/Rotate click once on the origin to get the dialog box.

Click on Keep Original, and enter the degrees shown above in the "Correction so back riser is under front riser" field
Fix the colors for the lines just created. From the
Main Menu choose Select/Window, and select all the new lines
You'll have to include some of the old lines, but they get deselected next
Next, choose Modify Attributes, then click the thick arrow at the bottom of the lefthand menu
Change the color to red and click OK
Now click on both horizontal red lines – they should have stayed blue & need to be set back to that color.
Click on the Main Menu Modify Attributes, and click once on the thick arrow that
appears at the bottom of the left hand menu. Set the color attribute to blue. The dial should look like the below.
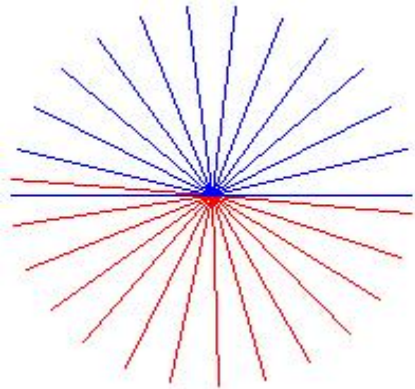
NB: If you make a dial with the wrong "handedness", simply mirror the dial about the y axis in
QCAD before you print it, and number the rays appropriately.
Print the dial using the following steps
Click on the Print Preview button, then once each on the Center to Page button and the Fit to Page button
Next Click on the Print button, choose Print in Color, and the printer to use.
Print on heavy card stock.
Once the print is complete, hand number the blue rays starting with the horizontal
right line (1) and proceed CCW (if you are making a right hand spiral, CW if a left)
Next hand number the red rays in the same order as above.

Use a reasonably straight column of wood for the pole. Some bow is OK, as the technique used here
cuts a perfect cylinder by rotating the pole around pins set in the two ends. You may want a long pole
to provide a post above the top stair. Find the center of the pole end as the intersection of two diagonals, and drill a
hole the size of your support pins (say 1/2"), and insert the pins in the holes.

Cut the dial out of the card stock and drill a 1/2" hole (the size of the support pins) at the origin
Once you have prepared the central column for milling on the radial arm saw,
glue, staple, or otherwise attach the dial to the top end of the column. Orient the
dial so that the first (top) cut is square with the post, if you are using a sawed (square) post
so that it will bolt flush against the upstairs joist/rafter, otherwise you'll need to cut a wedge
or extend the face cut of the first back riser above the stair and place a flat shim,
as the column will meet the upstairs face at an angle.

Proceed to cut each flat onto the column, first the blue, then flip to the corresponding red.
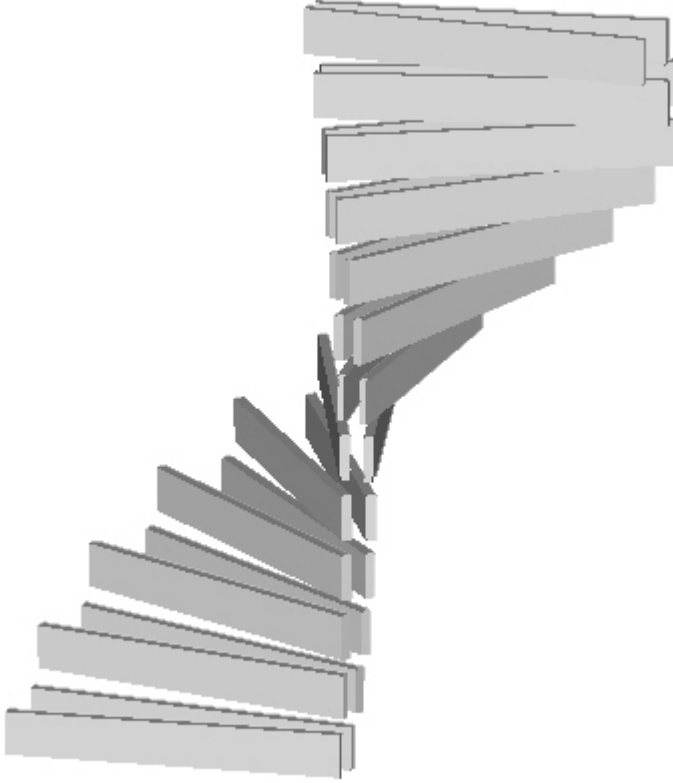If the riser is not as deep as the rise per step (stair riser's depth is not equal to the rise per step),
make the top cut, then mark the work to show the rest of the face to cut.
Move the pole up the height given above as the 'Rise Per Step', and rotate to the second blue ray to cut the next flat.
Repeat for each step.

Right Hand Spiral
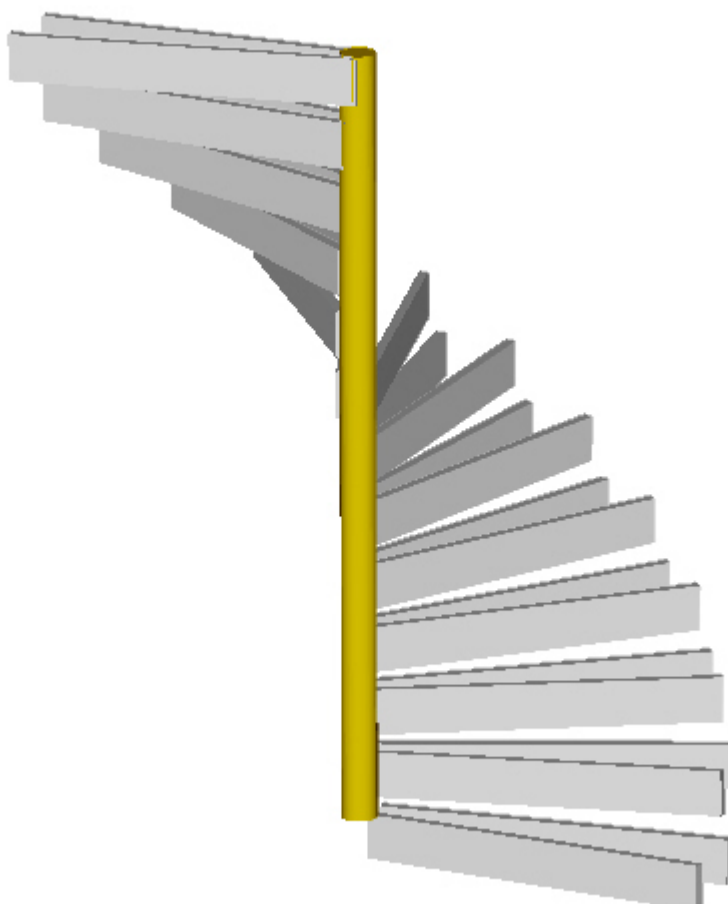
Left Hand Spiral

Note the yellow paper dial in the photo below-that's the product of the work above.
It is used to set the angles for the stairs as they rise up the column in spiral
Note also the trolleys made from roller skates that support the pins set in the pole ends.
The pole rotates on the pins, and travels from cut to cut on the skates.

Photos
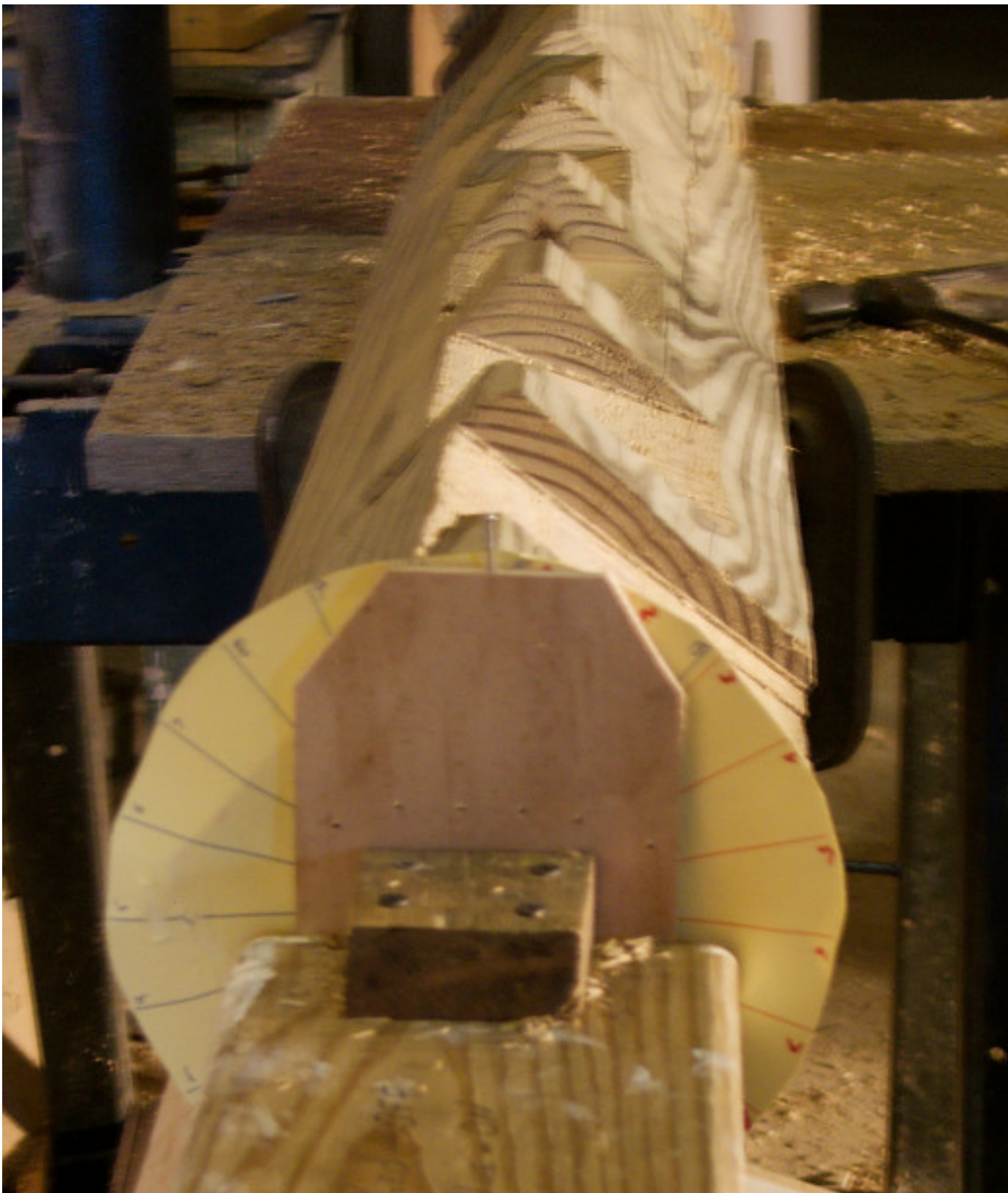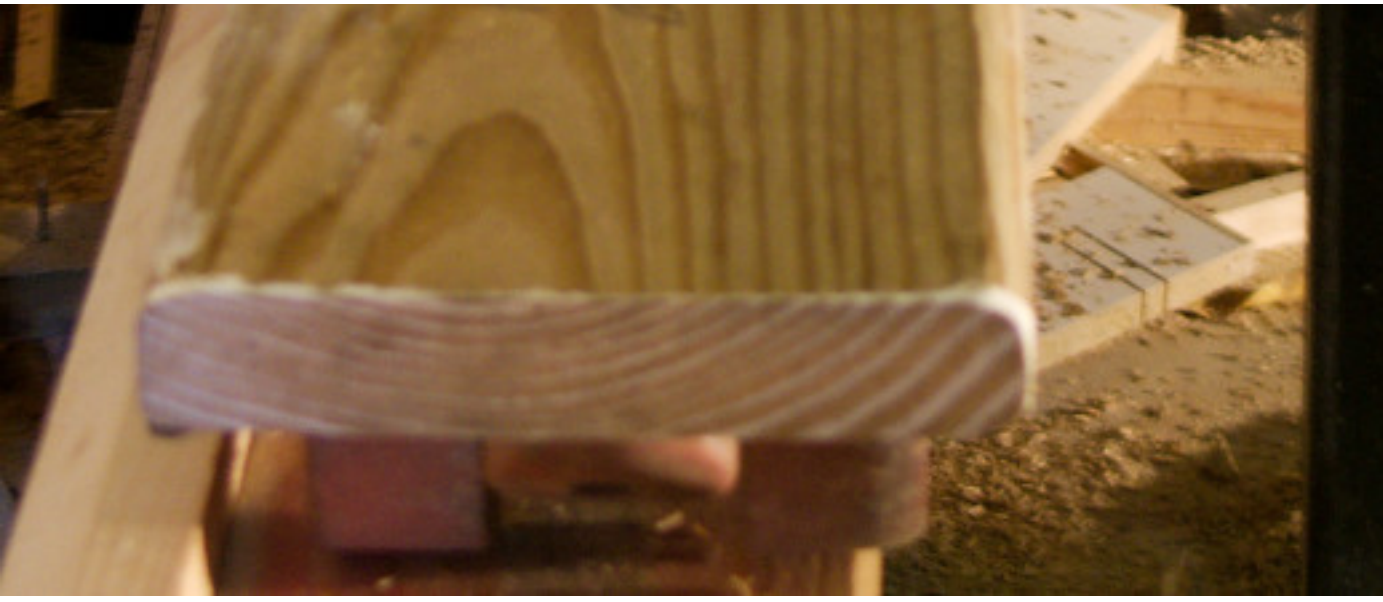
If you look closely at the picture below, you will see the wooden wrenches used to hold the pole in position during a cut. They are the handled objects under the saw table (directly below the C-clamp).

A narrower central core to the column makes for more available step surface towards the center- it's a tradeoff between the strength of the material and the step surface-this design puts a large torsion/wringing force on the wood face at the column where the riser is glued. Each step above the first can rest it's front riser on the back riser of the step below.

Milling:

Suspend the column from the end pins by setting the pins into the roller skate trolly- see the example above.
Either mark the column at each rise to locate the position to cut the faces, or just start at one end, and
then mark each cut relative to the one above as you go along.
Cut the first face according to the first blue line on the dial, then rotate the pole to align with the
first red line, and cut that face. Use wooden wrenches like those shown above to hold the pole while cutting.
Use dado blade to expedite the cutting- the bigger the better, as small diameter
blades limit the depth of cuts.
After both faces for a step have been cut, move the pole along to the next face to cut
and repeat until done. The pole rolls easily on the skate trolleys. You may to sand the faces to make a better glue joint.

Fabrication:

To attach the risers, suspend the pole on ropes from the two pins on the ends higher above the ground than the stair radius.
Run a taut string between the suspending ropes over the long axis of the pole. Make the string height above the pins
about the same as the radius of the stairway. Next, make the string as level as you can and
re-adjust the suspension ropes so that the pins are at equal distance from the string-that makes the pole level.
You may have to iterate. The string will be used to align the steps to a common radius.

Cut the riser planks out of 1x6 or better, and make them at least 6" longer than the radius- they should
fly off the back of the pole slightly, more or less depending on the form of the pole (square, round, irregular, etc).
If the wood is not fresh-cut and finished, sand the plank and pole glue faces.
It's an easy mistake to make to make the risers short relative to the radius, but they won't have a full glue face if you do.
Rotate the pole through it's spiral, stop each time a face is plumb. Use the height string and a marking stave/ruler
mark the face on the pole where the riser ends by measuring down from the string to mark the end of the riser on the pole.
Marking the cut faces on the pole to the radius set from the string and stave/ruler makes it is easy to place each step for gluing.
You only have to do one side (inside/outside)
Use an excellent quality of wood glue (e.g.: resorcinol) and attach the risers to the center pole- Nails will hold until the glue sets,
Start with the top and stay to one side (inside/outside) for the first round. Rotate the pole so that the glue face is plumb and
attach the riser plank. Set a single nail to start, and orient the plank down and use a level to set it plumb (making it square to the pole).
then add more nails to hold the riser plank in place while the glue sets. You can add screws later if you choose.

Once the first side is done, do the second side, and align the riser length with the riser glued to the first side.

Installation:

Once the glue has set. Install the stairs.   Cut enough of a hole to the second floor that the full top step can fit.
Make the hole the stair radius wide. The pole will thru-bolt to the rafter/joist. It should be flush (is a square pole)
Winching from above is the easiest means of erecting the pole- but two or three people can certainly lift it into position.

The pole is stepped onto the floor, on a pedestal or stone with a 1/2" hole (to accommodate the lower pin).
The pedestal/stone needs to be immobile, as there is a lot of torque and side thrust from using the stairs.

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