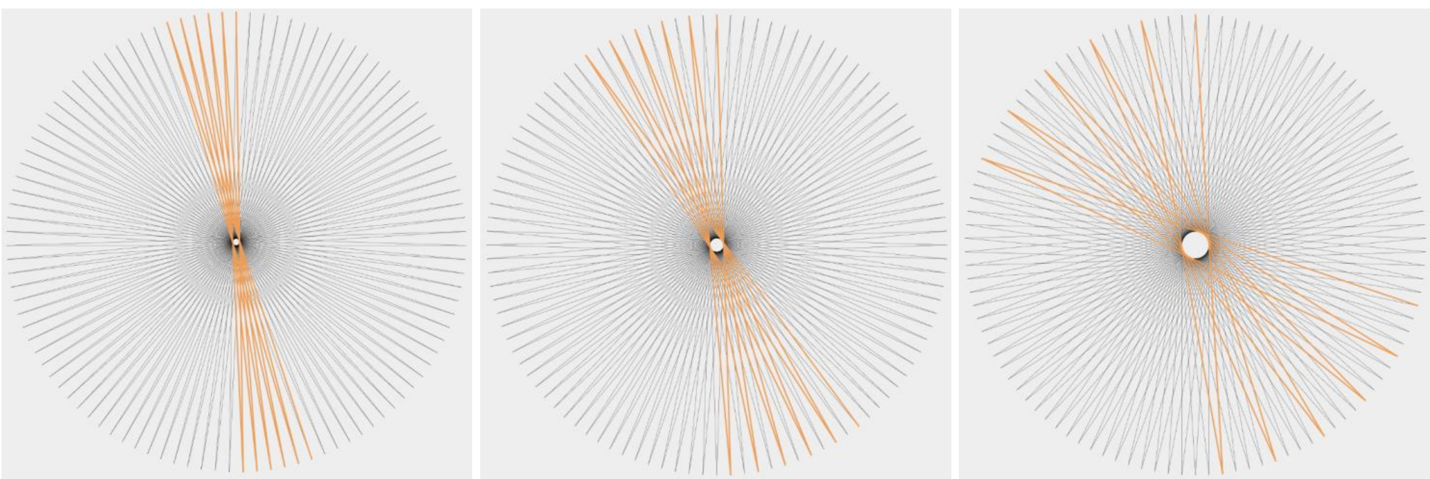
MA. Generalized Sharpest Central Needles

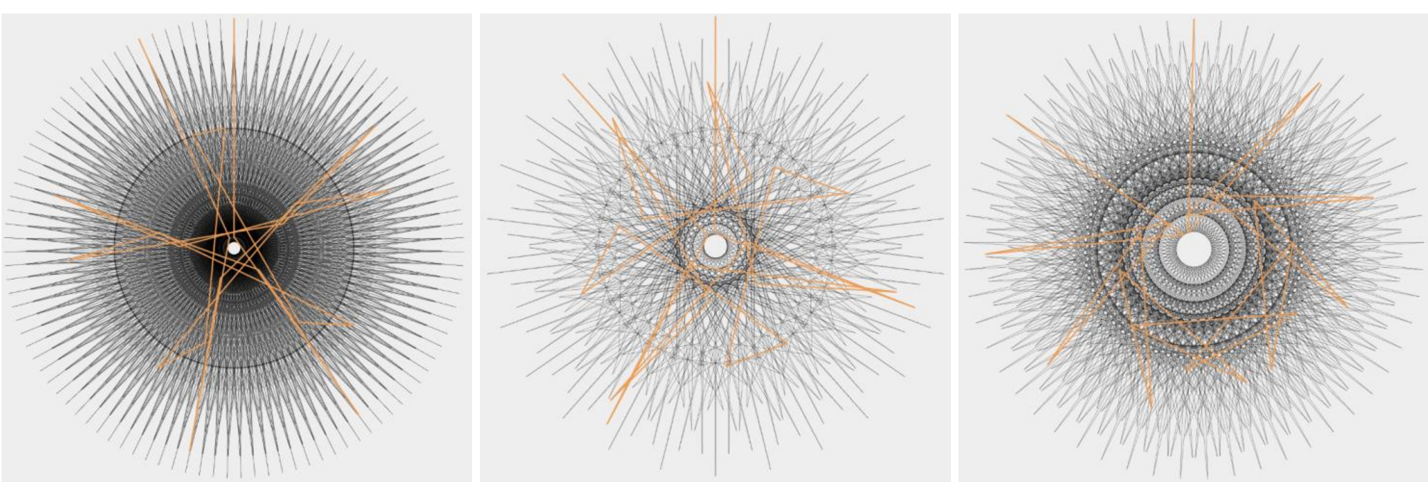
The analysis begun for sharpest odd needles and expanded to sharpest open and closed donut hole central needles can be expanded beyond having ***P*** on VF lines 2 or 3. The same methodology applies as long as the VF line under consideration have endpoints in quadrants II and IV. That way, as ***n*** increases, the curvature of the vertices declines, and the resulting first ***P*** value approaches the vertical diameter. Rather than talk through the alternatives one by one, the table shows the required ***S*** and ***P*** for the first 10 versions (meaning ***P*** is on the 2nd through 11th line). The equations creating these values are provided in the table and the VF for odd and even ***n*** using ***J*** = 51 to create the sharpest star are provided beneath the table. Notice that in each instance all of the highlighted VF lines are downward sloping.

P is on VF line	Fully used VF lines, **T**	***S*** = 2T+1	***P*** = T+***S*** *T	***P/S*** is **T** plus fraction ***P/S***	First line ends Bottom / Top	First line ends in Quadrant	Quadrant of VF line containing ***P*** Start	Quadrant of VF line containing ***P*** End	***n*** = 2***k***+1 Start	Example 103, 51 End	***n*** = 4***k*** Start	Example 104, 51 End	***n*** = 4***k***+2 Start	Example 106, 51 End
									# of Vertices from Vertical Diameter of VF line containing ***P***					
2	1	3	4	1.333	B	IV	IV	II	0.5	1	1	2	2	4
3	2	5	12	2.400	T	II	II	IV	**1**	1.5	**2**	3	**4**	6
4	3	7	24	3.429	B	IV	IV	II	1.5	2	3	4	6	8
5	4	9	40	4.444	T	II	II	IV	2	2.5	4	5	8	10
6	5	11	60	5.455	B	IV	IV	II	2.5	3	5	6	10	12
7	6	13	84	6.462	T	II	II	IV	3	3.5	6	7	12	14
8	7	15	112	7.467	B	IV	IV	II	3.5	4	7	8	14	16
9	8	17	144	8.471	T	II	II	IV	4	4.5	8	9	16	18
10	9	19	180	9.474	B	IV	IV	II	4.5	5	9	10	18	20
11	10	21	220	10.476	T	II	II	IV	5	5.5	10	11	20	22

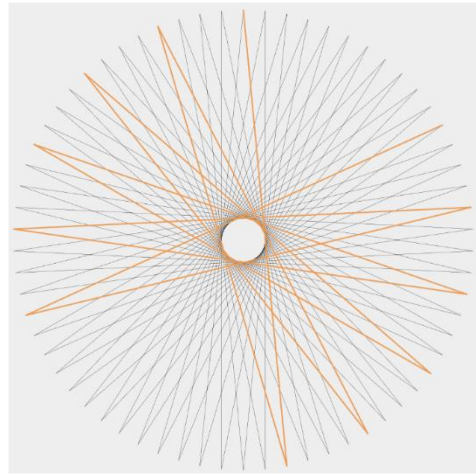
n = 103, 104, 106 with ***J*** = 51 VF images with first 11 lines of the VF in orange. The VF skip pattern is highlighted from left to right.



S and ***P*** for 30 images are provided in the table, the three images below are from the last row, ***S*** = 21, ***P*** = 220.

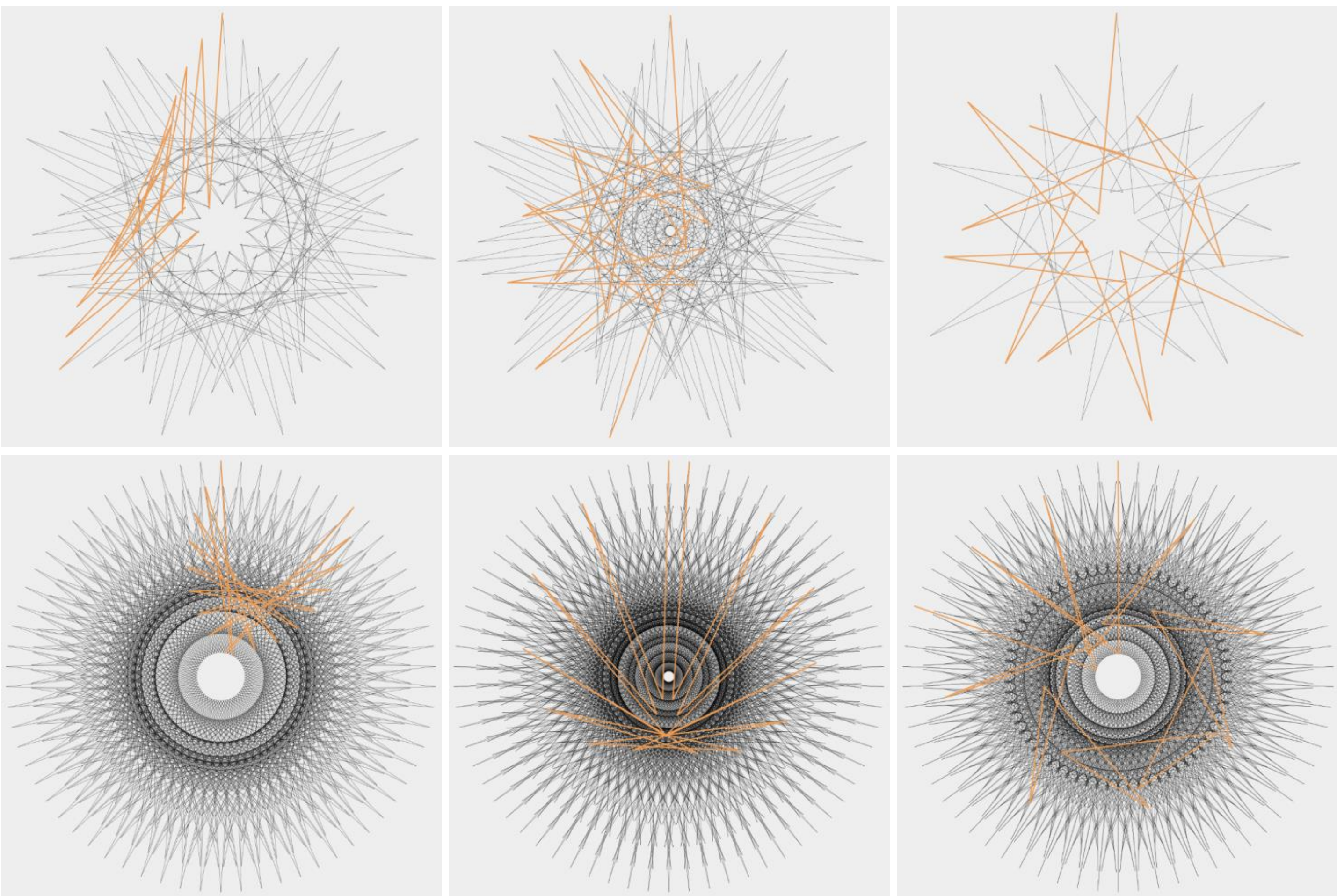


The ***S*** and ***P*** values only work when the VF line is downward sloping with endpoints in quadrants II and IV. This requires that ***n*** be sufficiently large, which is why 103, 104, and 106 were shown. These three values have the same sharpest VF star jump of ***J*** = 51. The sharpest VF star for ***n*** = 105 is 52, not 51, a pattern which is discussed in E2.4.4.



The same qualitative results occur if all 11 VF lines are downward sloping. Quite clearly, the type of ***n*** that violates this requirement for smallest ***n*** is if ***n*** is of the form ***n*** = 4***k***+2. Given the bottom right number in the table, 22, we need to have ***n***/4 > 22 or ***n*** > 88 for the end of the 11th line to be in quadrant IV. Next, we examine what happens when this is violated.

What happens if VF lines slope upward? The VF to the right highlights the first 11 lines of ***n*** = 66, ***J*** = 31. The last three lines are upward sloping. The top row below shows following the rules laid out in the table. The next row adds 1 to each ***P*** so that the first line is on the other side of the vertical diameter. Each highlights the first cycle. The second row middle and right ***P*** = 145 and ***P*** = 221 are both SCF = 1 versus SCF = 6 and SCF = 22 in their upper row counterparts.



Compare the first line of the image by column relative to the vertical diameter. The upper row first lines are left, right, left. The lower row first lines are the opposite: right, left, right (although the third is so close to vertical that it is hard to tell). It is worth noting that the *Palm Frond* bottom middle image is a clockwise one-time-around image since the first cycle ends at vertex 1. A link to that image is provided, set DL = 19. By contrast, the bottom left is clockwise 7-times around, set DL = 17, and the bottom right is counterclockwise 12-times around, set DL = 21.

The images in the lower row have sharper needles than those in the upper row but they are NOT the theoretically derived ***S*** and ***P*** values that one would obtain by counting the vertex deviations on either side of vertical diameter provided by these upward sloping lines. This is left as an exercise.