# An Introduction to *n* = *P* Images

Overview and Rationale. The class of images where *n* = *P* deserves special attention. These images tend to have a lot fewer lines than those that "surround" these images. Increase or decrease *n* or *P* by 1 and the number of lines expands dramatically. For example, the image to the right (which provided the rationale for creating this section in the first place) has 44 lines but change *P* by 1 to 45 and the image explodes to 2024 lines. Click here and watch the 44 lines per cycle 46 cycle twisted-quivering-triangle image emerge (set *Drawn Lines* = 3, *Drawing Speed* to 3 initially then to 25 or more once you see the pattern using the *Fixed Count Line Drawing* mode).
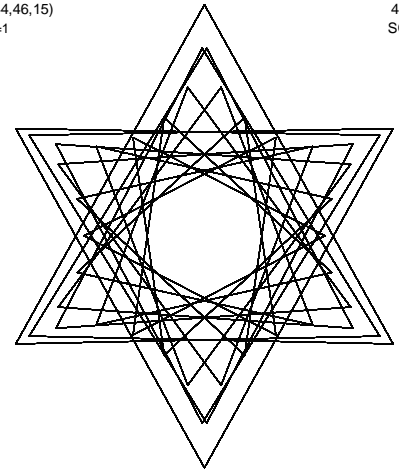
n = *P* images also tend to have a lot fewer cycles. For example, the *P* = 45 image discussed above had 46 cycles, the *P* = 46 version shown at the right has 2 cycles.

Although we will explore some of the attributes of these images with *Excel*, they are most appropriately examined using the web version of the file. These images employ much larger *n* values than the *Excel* file is set up to handle.

Lines in the image. The number of lines in an image is *nS*/VCF/SCF as noted in 2.2a. If *n* = *P* and VCF = 1, this simplifies to *S* lines in the image because SCF = GCD(*nS*/VCF,*P*) = GCD(*nS*,*n*) = *n*. When VCF > 1, the number of points used will be *S* or a factor of *S* because *SP* = *Sn* if *n* = *P* so that the *S*th subdivision endpoint MUST be a point at the top of the polygon, even if it is not the first time that the circuit has been completed. (For example, *n* = *P* = 20, *J* = 8 has VCF = 4. Consider three scenarios, *S* = 14, 15 and 16 shown below. The image has 7 lines if *S* = 14, 15 lines if *S* = 15, and 4 lines if *S* = 16. The first image has half as many lines as *S*, the second has *S* lines and the third has one fourth as many lines as *S*.)
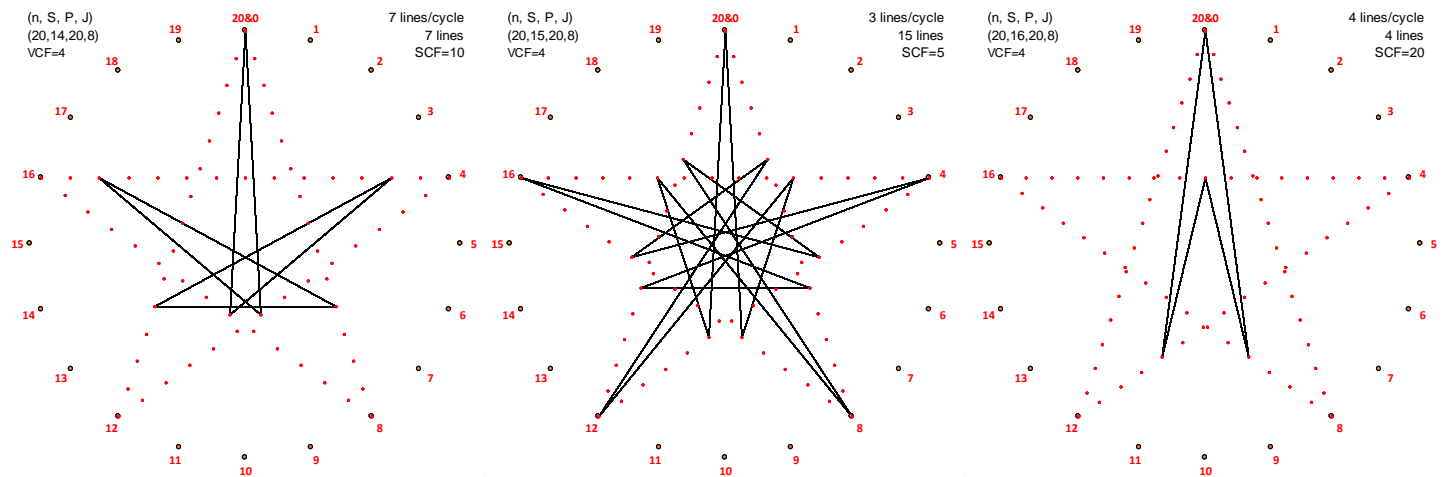
Cycles in the image. As always, the lines that comprise the image are made up of cycles. As noted in 2.3a, the number of lines in a cycle is *S*/GCD(*S*,*P*). The *S* = 14 image has 1 cycle since there are 7 lines per cycle, the *S* = 15 image has 5 cycles since there are 3 lines per cycle, the *S* = 16 image has 1 cycle since there are 4 lines per cycle.

Changing direction. As noted in 2.4b, you always get the same image drawn in the reverse direction by changing *J* to *n-J*.

When scrolling through *S* or *J* for fixed *n* = *P*, don't simplify values. This stands in opposition to the suggestion that the smallest values of *n*, *S*, *P*, and *J* be considered when analyzing an individual image proposed in 2.4a. The image analyzed in that explainer is the *S* = 16 version to the right, but it would not be seen in the context of varying *S* values had the image been simplified. Such situations inevitably arise due to common divisors between the parameters of the model.

Avoid divisibility issues by using primes for *n*. Note that lines in the VF depends on GCD of *n* and *J* and lines in the image as well as number of cycles depend on the GCD of *S* and *P* = *n*. Both GCDs equal 1 if *n* is prime so that the number of lines in the image is always *S*. Rusty on your prime numbers? The mathematical appendix provides a quick refresher.