Wild Gears

How to calculate number of points in a design:

Prime Factor Method:

- Write the ratio of the stationary gear over the moving gear; (for example 180/60 for a 60 tooth gear in a 180 ring).
- Replace the numbers with their prime factors; (2*2*3*3*5)/(2*2*3*5)
- Cancel the common factors, numbers that are present on both sides of the fraction. (~~2~~*~~2~~*3*~~3~~*~~5~~)/(~~2~~*~~2~~*~~3~~*~~5~~)= 3/1
- The top number is the number of petals that the design will have; this is also the number of times the moving piece will rotate.
- The bottom number is the number of times the moving piece will move around the stationary piece.

More math approach:

Two objects, gear-ring or gear-gear work. Take the lowest common factor (LCM) of the tooth count of the two objects. This gives the travel distance, in teeth. Then dividing that number by the tooth count of the moving object; this gives the number of full rotations, and therefor petals, that the design will have.
I specify moving object rather than smaller number because when using one gear around another gear it can be the bigger one that is moving.

Parallel lines:

Use a medium or large pen hole to make a design. Then, using the same pen hole, place a plastic doughnut into the pen hole and repeat the design. This will make a different kind of design than if you used two side by side pen holes.

The doughnut pieces come in 4 colours that have different size pen holes in the middle. From smallest to largest they go:

- clear (smallest)
- opaque white
- fluorescent green
- fluorescent orange (largest)

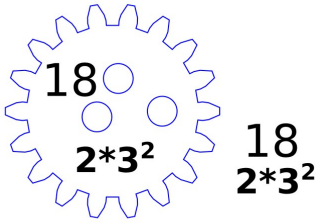
For the large doughnut pieces this colour pattern is repeated twice to get from small to large. (smallest) clear, white, green, orange, clear, white, green, orange (largest).

Wild Gears

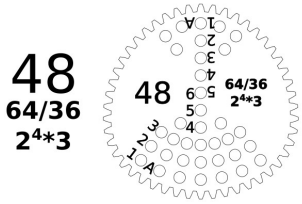
What the numbers mean:

Gear sets have many numbers on them to help you use the gear sets. Then numbers have many different uses, they are:

- **Tooth Count** and the **Prime Factors**. These two are listed for every gear on the gear and on the frame by the ring. Tooth count tells you how many gear teeth are in the circumference of the gear (18). The numbers below the tooth count are the prime factors of the tooth count (2*3*3). These can be helpful in determing how complicated a design is going to be.

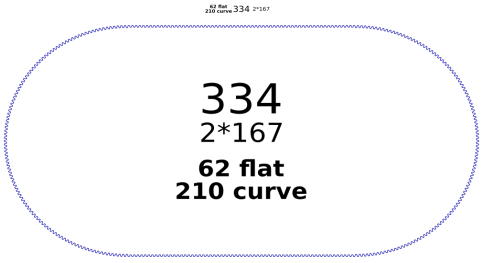


- **Side and Corner numbers**. Most non-circular gears are made of arc-segments of two (or more) sizes of circles. This means that the sides have one circumference and the corners have a smaller circumference. These two numbers are shown as a fraction that is listed near the Tooth Count and Prime Factors.



    - In the example to the right it is a 48 tooth gear with prime factors of 2*2*2*2*3. It is a triangular gear with sides of circumference 64 and corners of 36. This means that if you use the gear it won't work in anything smaller than a 64 ring. If you use the ring of this triangular shape then only gears smaller than 36 will work in it. Anything bigger than 36 will get stuck in the corners because they are too small.

- **Oblong Gears** have a straight portion. They have three numbers: 1) the total tooth count (biggest), 2) The size of the circle that makes the rounded ends (labelled curve), and 3) The length of the straight section on each side (labelled flat)



Glossary of terms:

Gear: The usually circular shapes cut out of the acrylic. They have lots of pen holes and are the moving part of the gear set.

Ring: The hole left by removing a gear from the sheet of acrylic

Frame: The square of acrylic for a gear set that has many rings in it.

Design: A shape made from using a specific pen hole on a gear.

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Advice about pens:

In terms of pen recommendations I will make the following general suggestions. Experiment with whatever pens you have on hand. Avoid gel pens, they are globby and smudgy, until you want to play with that messy effect on purpose. Felt tipped pens have stronger, more consistent, line quality but will bleed into the paper if held stationary whereas ballpoint pens bleed less (or not at all) but can have inconsistent line quality if they are used fast as sometimes they cannot supply ink to the ball fast enough to maintain high line quality.

I enjoy the Hi-Techpoint lining pens and the Staedtler Stabilo as well as Bic Rollerball pens. Sharpies are good too. That being said I think that experimentation is good to do. I regularly buy inexpensive pen sets just to see how they will work and explore the range of styles different pens offer. I've formed more opinions about blue and black ink properties than I thought it was possible to hold.

Advice about paper:

I'd suggest getting some printer paper. I like using heavy stock printer paper; it has more solidity for when designs cross in the same place a bunch of times. Heavy stock refers to the lb weight listed on the package. The heavier the better; but regular printer paper is great to use too. This relatively cheap paper allows me to experiment lots without feeling like I am wasting expensive paper. Nicer art papers are also great to use and I have a selection of sizes and colours to deploy as needed. Paper can also be bought by the roll if you want to just cover your table and go to town. This is also a good way to work on larger designs without having to dedicate a page of a large form art book to experimentation.

On bound sketech books. If you are considering a book with a spiral binding, or any other sort that doesn't open completely flat keep the gear frame in mind. The designs might fit on the paper but the frame or hoop that the designs are going to be contained in could easily overlap the edges of the paper. Ones I make often overlap all the sides by several inches at least. This means that if the book you are using has a raised metal binding the frame cannot sit flat on the paper which means that the gears won't work properly or at all. Pads of paper with a glue binding on one side could prove to be flexable enough to lay flat but if the glue binding strip is reinforced with fabric or other fibers that might still get in the way. There is a huge variety of paper out there; have fun experimenting.

Pens for the tiny holes:

Pens with a cylindrical metal barrel fit into the smallest (~1mm) holes. Art lining pens will often be constructed this way. Some pens from office supply stores (or random stationary sections) will have this feature too.

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Tricky Techniques:

Making your designs look more solid:

Completing a design once will give one look and if you keep going and repeat the design a second time it will make the line look just a bit more solid and crisp and bold. This partially depends on the pen and how much ink it lays down in one go. I really like this effect.

Popping parts of a design:

To make a symmetrical design you should hold the pen straight up and down. Holding it at an angle will give some very slight asymmetries to the loops and curves. This isn't really noticeable if done on a single pass design. However, it you do the design once with the pen straight up and down then experiment with holding the pen at a specific sharp angle for the second pass you'll see that some parts of the design will be bolder than other. By experimenting with angle and direction you can add a lot of depth and nuance to design line weight.

Keeping parts stationary:

Holding a frame or gear still while making a design can be hard work. For big pieces like a gear set frame or large hoop I like to weigh it down with something heavy like large cans, heavy books, or weights. If the size is right a clipboard can hold the frame and paper securely in place, or large binder clips on a bigger surface. Magnets on a metal sheet are also very effective; they need to be fairly strong to hold the 3 mm acrylic securely so please be careful.

In addition to using weight, clips, or magnets sometime tape or other sticky products can be a good solution to keeping things still. This is especially useful when dealing with smaller parts; like when rolling one gear around a central stationary gear. Making a loop of tape to keep the stationary gear stuck to the paper is one option. Things to consider are if the tape will leave sticky goo on the gear or paper as well as if the tape will tear the paper when you try and take it off. Blue tack, white tack, or other sticky putties can also be used to great effect. Do test them on the paper first though as sometimes they pull the paper apart when removed, or leave a discoloured spot.

Stopping gears from slowly lifting up:

Sometimes gears will slowly ride up and eventually hop out of the ring that they are in. This can be very frustrating but there are a few tricks to try if this is happening to you:

- Flip the gear or frame over. The laser cuts that make the gears are ever so slightly sloped. This means that one side up will have a slope that helps lift up the gear and the other side up has a slope that is a slight overhand and will help push the gear down.
    - This technique can be applied to using the doughnut pieces in the medium and large pen holes too.
- Relax and don't push as hard. If you use less force it could help the gear stay on the paper and not lift up. Sometimes concentrating and pushing hard can help hold the gear up on the wall of

the ring.

- Put a small weight on the gear. This can be a bit of a challenge because sometimes the gears are small and sometimes their quick movement throws the weight off. But it doesn't take much, just a quarter or two will do it in most cases. A small loop of tape can help the weight stay in place.