How to Draw a Tessellation

PART ONE

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Introduction

A tessellation is when a specific shape can be repeated within a plane (or flat surface) and interlock together without having any overlapping edges or leaving any empty spaces. We see tessellations just about every day of our lives. The simplest example would be a checkerboard which is, of course, made up of squares. Every time you look at a brick wall, you're looking at a tessellation made of rectangles. There are more familiar shapes that will tessellate such as diamonds and triangles. Have you ever seen a honeycomb design? That's a tessellation made by bees. And if bees can do it, so can you.

There are endless numbers of tessellating designs yet to be found. This lesson will get you started on your quest to search for them. All you need to get started is a pencil & an eraser, graph paper, and an imagination. In fact, the very last page of this lesson contains a printable sheet of graph paper, so all you really need is the pencil and the imagination.

Finding new tessellations is like figuring out a puzzle or playing a game. And with any game, you need a gameboard to play on. For this lesson, we're going to be using a checkerboard. Why a checkerboard? Because new tessellations are created by changing a simple tessellation that already exists. We're going to use a square because it's simplest of the tessellating shapes. And as you know, squares form a checkerboard. Of course, don't run off just yet to borrow the board from your set of checkers. We're going to make our own checkerboard.

We're going to start with a square and change it using a set of specific rules. (These rules are sometimes referred to as mathematics.) There are a lot of rules to this game; some of them are simple, and some are complex and complicated. But the great thing about this game is that you don't need to know all of the rules in order to play. As long as you know a few of the basics, it's easy to get started.

As you change the shape of a square into a new tessellating shape, many times these new shapes are only just that... shapes. But here's where the imagination comes in. Have you ever stared at some clouds in the sky and looked for different objects or animals in the cloud formations? That's what you need to do as you look at the new tessellating shapes you come up with. Sometimes the new shapes don't look like anything other than cool designs, but sometimes they might look like a bird, or a fish, or some other recognizable object. When you discover a tessellating shape that looks like something, it needs to be reworked and refined to make it look more like the animal and less like a shape (still following the rules, of course).

And even if you don't find any animals, don't get discouraged. It's just as fun to come up with new shapes that don't look like anything other than a cool design. Remember, tessellations are made up of repeated shapes, not necessarily shapes that look like something... just shapes
Let's get started

We're going to begin by creating our checkerboard. As a tessellation, a checkerboard could repeat forever into infinity (if you had a board that big). But we won't need one quite that large. We only need to create a small section of a checkerboard. Do this by adding dots onto the graph paper to create the corners of what will become your squares, as I've done below.

We now have a layout for nine squares. Don't fill it in just yet, because that would require a lot more time spent with an eraser. For now, just visualize that the four corners and the center square will be the black ones, and the other four will be white.

like this...

The reason we're using nine squares (or shapes) is because this gives us one shape in the center completely surrounded by eight neighboring shapes. It's easier to focus on the center shape when we later rework it into a recognizable object.
Now for the Rules

There is one basic rule to this game: **If you change one, you must change them all.**

What this means is that when you make a change or an alteration to one of the squares, you must make the exact same change to all of the others.

Think about it; if you were going to continue to make a normal checkerboard, you would do so by adding the exact same lines to create the sides of the squares, as I've done below.

![Diagram of a checkerboard with vertical lines](image)

All of the lines are exactly the same... they're all short vertical lines.

Now pick out one of these vertical lines and ask yourself, "Is it the right side of a square, or the left side?" You're probably smart enough to know that the answer is "both". Therefore, when you change the right side of the squares, you'll be changing all the left sides at the same time. This is something you need to keep in mind as you play the game.

There are more rules that can be applied to this game, and you'll learn some more of them as you continue with this lesson. But for now, you've just learned enough to be able to get started creating new tessellations.

So let's start playing.
Playing the Tessellation Game

Just as I drew the sides of the squares in the last image, do the same thing on your graph paper, but instead of using a straight line, use one that's bent, crooked or squiggly. And remember, each time you draw the line, it has to be the same, identical line. How do you do that? Well, this is why we're using graph paper. By using the grid inside of your checkerboard squares as a guide, you can create "directions". As long as you follow the same directions for each line, they'll all be the same.

Here is an example using a very simple altered line. We'll call this "Line A"

To create Line A, I started at the dot on top and came down two spaces, then went to the left two spaces, down one space, back to the right two spaces, and finally down two spaces to get back to the dot on the bottom. By repeating these specific steps (or directions), you can easily draw this same line over and over.

In the drawing below, I began adding Line A to our checkerboard layout.
And here is the result when we use Line A for all nine squares instead of the straight vertical lines.

![Design A](image)

After the black shapes are filled in... We have a new tessellation. We'll call this **Design A**, since we used Line A to make it.

Here's a line that's a bit more interesting. We'll call this **Line B**.

![Line B](image)

Again, I used the smaller inner squares as a guide to create directions for this line. I came down one space from the top, and then moved to the right one space. Then I went down diagonally to the right across two of the little squares, moved three spaces to the left, and finished by moving back diagonally down to the right across two squares to wind up at the dot on the bottom.
This is what our nine-squared checkerboard layout looks like using Line B:

After the black shapes are filled in, we have another new tessellation. We'll call this Design B

Until now, we've only played with the sides of our shapes, but we can do the same thing with the tops and the bottoms. My first example of this is Line C.

I again used the little squares to draw this line, but you'll notice that this time I used the centers and halfway points. The reason I did this is to show you that you don't need to restrict yourself.
Using Line C as the tops and bottoms of our shapes, we get this result:

![Image of design C]

After the black shapes are filled in... We have our third tessellation, **Design C**.

![Image of design C filled in]

I'll show you one more example. Below is **Line D**.

![Image of line D]

This is a fairly simple line with only two points sticking up.
Here’s what Line D looks like when it’s used to make a new shape.

![Diagram of Line D](image)

And here it is with the black shapes colored in, giving us our fourth tessellation, **Design D**.

![Design D](image)

So far, I’ve shown you a few simple examples, but you can draw any kind of line you want. You can use semi-circles, loopy indentations, zigzags; anything at all your imagination can come up with. Here are a few more examples to try on your own.
So far we’ve altered the sides of our checkerboard squares and we’ve altered their tops & bottoms, but we did each of these things separately. Now it’s time to do both at the same time.

If we combine Line A and Line C, this is what we get. We’ll call this "Design AC".

When we combine Line A and Line D...

...we get another entirely new tessellation. We’ll call this "Design AD".
Here's what Line B looks like along with Line C. Now we have "Design BC"

And when we combine Line B with Line D...

...we get yet another new tessellation, "Design BD"
When you combine different lines in this manner, one thing to watch out for is that the lines you use for the tops and the sides should not overlap each other. Here is an example of what I'm talking about.

Below are two more altered lines.

![Line E](image1.png) ![Line F](image2.png)

Line E will be used for the tops & bottoms, and Line F will be used for the sides.

Individually, these two lines work out quite nicely as you can see below.

![Design E](image3.png) ![Design F](image4.png)

But when they're combined into the same design, they overlap each other.
In order to fix this, we need to change one of these two lines until there is no overlap. One way of doing that, in this instance, is to reverse one of them.

In the figure below, I reversed Line F to go in the opposite direction.

From this to this

Now when they're combined together...

...we no longer have an overlapping problem.

Instead, we get a nice solid shape, and yet another new tessellation.

Design EF
Before I continue, I want you to know that the images I'm using were darkened and enhanced for the purpose of this lesson. When you're creating your own new designs, they don't have to be perfectly finished drawings, and they don't even have to be colored/darkened. Think of this as more of a planning stage, and these are preliminary drawings.

Below is an actual page from my sketchbook.
Finding the Hidden Figures

You've just learned enough about creating tessellations to discover an endless number of new designs on your own. And all it takes is a few crooked, squiggly lines.

But as I stating in the beginning of this lesson, the game doesn't end here. It's time for the imagination to play a stronger role in this. Let's take a look at a couple of the new tessellations I just created. Let's study a few of them to see if we can find anything, just as we would look for animals in cloud formations.

Let's take a look at Design BC

This shape doesn't look very much like anything, so let's try rotating it.

After turning it to the left (counter-clockwise), do you see anything now?

I see a man with a hat, sitting down, reading a book.
When I turn it the other way, to the right (clock-wise), what do you see?

To me, this looks a bit like turkeys facing the left.

Let's try another one. This time we'll look at Design AD

It doesn't look really look like anything this way, so let's try rotating it.
When I rotate it to the right...

...it doesn't look like much to me. Do you see anything?

When I rotate it to the other way...

I see some seals facing the left. Do you see them?

Note: For the purpose of this lesson, I limited myself to rotating my designs once in either direction. As you create your own tessellations, you'll be able to turn your paper in any direction to search for the hidden figures.
Refining the Design

I decided to use the last design that looks like seals. This means we’re ready to start changing the lines again, but with a specific purpose this time. The idea is to change them to make our shape look more like a seal, and less like a shape. And keep in mind that although the shape looks like a seal, it’s still a shape with only two different lines being used. Therefore, when a change is made to the top of the seal, the bottom will change at the same time. When the left side of the seal is changed, the right side will change. Refining a tessellation sketch is a trial and error process that you have to play with until you get it the way you want. Be sure to keep an eraser handy.

Since we rotated Design AD counter-clockwise to find the hidden seals, the original lines A and D have to be rotated as well.

![Diagram](image1.png)

**Line A**, after it's rotated, no longer serves as the side(s). It becomes the top & bottom of our shape.

![Diagram](image2.png)

**Line D**, after it's rotated, now becomes the side(s) of our shape.

It doesn't take very much to transform your shape into an image.

![Diagram](image3.png)

Just by making a small change to **Line A**, as shown above...
...the design is already looking more like seals.

And after I played around with the lines for a while, this is my result.

At this point, it's not only the shape that helps to create a recognizable figure, but it's the additional details that are included, such as in this instance, the eyes, the belly, the flippers, etc.

As I mentioned in the beginning of this lesson, I focused mostly on finishing the seal in the middle of the nine "squares" (the squares are still visible due to the dots).

Please note that the final sketch (above) was done on different graph paper. This paper has a larger grid than the paper I used earlier. This is an easy way to enlarge your design. The larger the grid you use, the larger your image turns out.
Once I'm satisfied with the final design of my "seal shape", I simply repeat it over and over onto the graph paper.

And after playing this game for only a short time, I discovered a brand new tessellation.

Transferring your Design

If you don't want grid lines on your drawing, you can transfer your image onto a clean sheet of paper so you can color or paint it to create a nice piece of artwork.

Here's a little trick you can use to transfer your image. Place a piece of tracing paper over your final design and tape it down. Then trace the entire image onto the tracing paper. Once you've completed that, turn the tracing paper over and, using the side edge of a pencil, scribble on the back of it. Completely cover the back of the tracing paper with pencil. When you're done, turn the tracing paper back over and tape it onto a clean sheet of paper or art board. Make sure the scribbled side is facing down. Now redraw over the lines of the traced image and it'll transfer the image onto the clean paper.
Finishing your Tessellation

After you've transferred your image, remove the tracing paper and go over the light pencil lines using a marker or a pen to redraw the outline of your tessellation.

When you've completed the outline, you're ready to add color. You can use paint, markers, crayons, colored pencils, etc. You can even scan your outline and color it on the computer, as I've done with mine (below). With this type of tessellation, it's best to limit yourself to two colors. It doesn't necessarily need to be black & white, but it should be a light color and a dark color.

I hope you enjoyed this lesson, and I wish you hours of fun playing this awesome game!

The completed Seal Tessellation

On the following page, you'll find a printable sheet of graph paper, suitable for creating tessellations. This tutorial and its contents are the property of David B Sullivan. © 2009 www.dbsullivan.com.