

Tessellation and where to find it

By Bruno Javier Limón Ávila
Matricola 646137



A tessellation is basically a pattern over a plane with one or more figures such that the figures fill the plane with no overlaps and no gaps. Everyday life is filled with this tiling patterns such as the tiles of your kitchen floor, a brick wall, a chess board or the cool pattern of your favorite t-shirt.

Tessellations can be made of basically any shape, as we can see from the image on top, they can take on complex or simple forms, as long as they respect the basic requirements of repetition, no overlaps and no gaps.

The etymology comes from the word 'tessera' in latin which means a small stone cube. These small stone cubes were used to make up 'tessellata', the mosaic pictures forming floors and tilings in Roman buildings. Nowadays, tessellations are still used for decorative and artistic purposes, as a supporting medium to artists, examples such as these can look like this:



Following the artistic path, this same technique can also be applied to architecture and civil engineering, where tessellation not only adds a creative and nice to look at design, but can even improve structural integrity, inspired for example in shapes as those seen in the honeycombs of bees, which have helped engineers come up with designs that can help reduce costs while rendering safer and better building materials. Some patterns, combined with innovative materials can also help with sustainability, profiting for example from patterns that optimize the placement of solar panels so as to maximize the amount of energy gathered, reducing expenses and strain on the energy infrastructure.



Finally, another great example of how human ingenuity has taken advantage of the tessellation patterns abundantly found in nature can be seen in computer generated graphics, especially those aimed at videogames, where tessellation has been a hot topic and talking point of game engine creators and hardware companies alike. What they did is essentially applying the concepts of tessellation to the textures that cover pretty much every object and character inside a virtual world.

As explained by Allan Willard, who works on the development team for the Unreal Engine of Epic Games; “Tessellation is a way of doubling the triangles on the graphics hardware – so what was two triangles becomes four, what was eight becomes sixteen, and so on. When we do that, that allows us to do things like displacement or smoothing and increase the apparent detail. This not only makes the surface look higher resolution, but also adds bumps and hills and valleys that weren't there before. You get a much higher fidelity surface.”

This technique takes advantage of the increasing computing power of hardware to take us one step closer to more realistic and immersive environments generated digitally. As shown in the picture below, a simple rock can have varying levels of details and realism all thanks to what we have learned about tessellation.



Image courtesy of www.chromesphere.com

In conclusion, as is the case of many if not most of the greatest discoveries along human development, the observation of the natural world has time and time again proved to be of essential importance, this time, by looking at the recurring patterns in animal's shells and furs, or the patterns of flowers and natural formations, we have acquired their beauty, functionality and overall design. Be it applied in art, construction or even the creation of digital worlds, tessellation has proved to be an essential asset in these endeavours.

References

- http://www.csun.edu/~lmp99402/Math_Art/Tesselations/tesselations.html
- <https://www.mathsisfun.com/geometry/tessellation.html>
- <https://www.livescience.com/50027-tessellation-tiling.html>
- <https://flexbooks.ck12.org/cbook/ck-12-basic-geometry-concepts/section/12.7/primary/lesson/tessellations-bsc-geom/>
- <https://study.com/learn/lesson/tessellation-patterns-examples-types.html>
- <https://www.gamersnexus.net/guides/1936-what-is-tessellation-game-graphics>