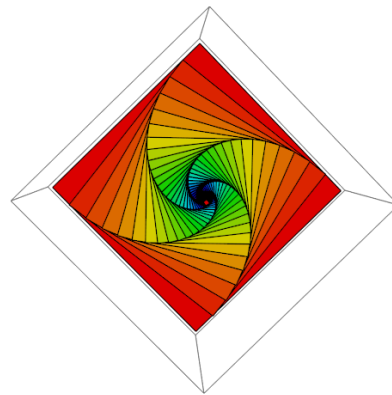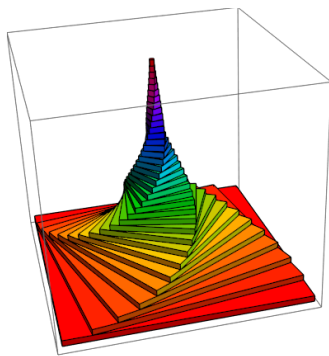Redwanul Haque

4/1/2023

Spiral Tower

Printing Material - PA12 (MJF)

    Spiral Tower design blends Egyptian pyramid & F&F Tower. Vector coordinates, sequences & transformations add math elegance. Showcasing Mathematica creativity when applying math to design.

When deciding on the Spiral Tower as my project, I brainstormed several ideas, including the Dyson sphere, tower structures, and car models. However, I ultimately discarded the Dyson sphere idea because I wasn't sure how to approach it in terms of coding and modeling. Similarly, the car model seemed like a challenging task because of the necessary cutting and remodeling. After careful consideration, I decided to go with a tower structure and started sketching rough ideas in my notebook. I experimented with different designs such as the Egyptian pyramids and the F&F Tower and finally came up with the idea for the Spiral Tower. I found that the Spiral Tower looked very impressive in 3D, but not as much in 2D. One of my primary goals in creating the Spiral Tower was to display my creativity to the observer. To achieve this, I spent a lot of time creating detailed drawings and refining the final design. I wanted the structure to be visually stunning and aesthetically pleasing. Throughout the modeling process, I continually refined the design, experimenting with different ideas and techniques. As a result, the final structure was a culmination of numerous drawings and iterations. I carefully considered each detail, from the size of the cuboids to the spacing of the stairs. The final product was a visually stunning, mathematically sound structure that I am incredibly proud of.

When I started building my project, I followed a linear process to ensure that each step was completed before moving on to the next. The first step was to experiment with different base shapes to find the most suitable one. I wanted a shape that would be easy to implement when defining the coordinate vectors, and after careful consideration, I chose a cuboid as the base shape. After selecting the base shape, I moved on to the next step, which was to create a stack of cuboids. To do this, I used a Table command and inserted the cuboid coordinates into the table. Once I had the cuboid stacking complete, I proceeded to create stairs for my model. To achieve the desired staircase feature, I had to implement a positive and negative vector coordinates to each side. This way, all four sides had a stair-like feature. After combining the positive and negative vectors, I added depth to each level to ensure there were no empty spaces between each layer. Finally, to achieve the model that I envisioned, I added the Rotate command, which rotates my tower around the Z axis, and Hue command, which adds color to my Spiral Tower. One thing that helped me during the construction process was getting feedback from my professor. He advised me to avoid making the model too thin and pointy at the top because it would be difficult to print using a 3D printer. This advice led me to adjust the height of my model to a more reasonable height when printing my prototype and the final model. After printing my prototype, I was satisfied with the outcome and did not make any further changes. Overall, the linear process, careful consideration of printing constraints, and feedback from my professor were instrumental in creating a successful final product.

Creating a 3D model can be a thrilling and challenging experience. My journey wasn't any different. I encountered several challenges along the way, each requiring a unique approach to overcome.

The first obstacle was defining the coordinates of the positive and negative vectors accurately. The slightest mistake in defining the coordinates could significantly alter the size of the model. I realized that precision was the key to success, and I focused on defining the correct coordinates through many experiments. The second challenge was the formation of the stairs. I wanted my model to have a depth between each level of the stairs, but when I combined the positive and negative vectors, I ended up with a flat 2D-like structure that separated each stair level with an empty height. However, I refused to give up and tried a new approach. I added (X+1) to either the positive or negative side to give the stairs more depth, and my model was finally taking the shape I had envisioned. But the obstacles didn't stop there. When I uploaded my model to Shape Ways, I expected everything to go smoothly. But as the height of my model increased, it got thinner and thinner, resulting in a portion that the 3D printer couldn't print. To fix this issue, I adjusted the height of my model to cut off the thinner portion making it possible to 3d print. In the end, I learned that challenges are a part of the journey, and each obstacle helped me grow and improve my skills in 3D modeling.

When I first printed my prototype of the Spiral Tower, I was thrilled with the result as it matched the model I had envisioned. However, with more expertise in Mathematica, I could have enhanced it further. For instance, I would have added more angles to create a more stair-like effect, such as a pentagon or hexagon base shape. Initially, I avoided using this approach because defining each vector on every side seemed too complex. Additionally, I would have incorporated a cube or sphere at the top of the tower to enhance its aesthetics and make it more appealing.

Observing my model of the Spiral Tower provides a profound understanding of a few mathematical and geometrical principles. Firstly, the geometric transformation is the most prominent feature, demonstrated by the rotation of the model around the Z-axis, which represents the fundamental concept of 3D transformations in geometry. Another notable aspect of the model is the sequence and iteration of patterns, which is visible as each cuboid is stacked upon the previous one, forming a pyramid-like structure. Apart from these fundamental principles, the model incorporates additional mathematical concepts, which may not be immediately apparent to the observer. For example, the use of vector coordinates ensures that each side of the spiral tower has a stair-like feature, adding another layer of detail to the structure. This feature is essential to ensure the accurate measurement and scaling of the model. Moreover, scaling is another vital mathematical concept utilized in the model. Each cuboid is smaller than the previous one, as it ascends to its designated height, which maintains the overall structure of the model.

Building my structure was a challenging but rewarding experience that required extensive knowledge of mathematics and programming. One critical concept that I utilized when building my Spiral Tower was the use of the Table command. This command allowed me to stack the cuboids precisely and create the final structure of the tower. Nesting commands into one another was also crucial in achieving

the desired result. Apart from my knowledge of Mathematica, my programming skills were also instrumental in the success of my project. The correct syntax is essential in programming because it dictates how the code is compiled. My understanding of the appropriate use of curly braces was particularly useful in the building process. Furthermore, the order of the code is an essential aspect of programming, and it played a vital role in building my project. I had to ensure that each section of the code was executed before proceeding to the next to avoid errors. Organizing the code was another vital aspect of programming that helped me build the Spiral Tower. I used parameters to specify their function, which made the code more readable and organized. Building the Spiral Tower was not an easy task, but my knowledge of mathematics and programming allowed me to execute the project successfully. The combination of mathematical principles and programming skills was crucial in achieving the final structure of the tower.