The string art project

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String art projects provide a rich opportunity for students to explore various geometric concepts. Tasks such as this are intended to help the students understand, and get more familiar with, the power of visualisation as a problem-solving tool in mathematics and they are easily adapted to suit a wide range of students.

Introduction

In this article we describe a line design project: an exercise in visualisation in which Geometry students—usually 9th or 10th graders in the US education system—explore basic geometric principles, symmetry, and the interplay between points, lines, angles, shapes, and curves, and create curved patterns using only straight lines. These curved patterns are arranged in a visually appealing, artistic fashion and create an example of string art. As students' skills progress, string art can encompass parabolic curves and radial patterns, and can start to approximate ever more complex shapes. Visualisation is critical in mathematics and in mathematics education (Tiwari et al., 2021) because it fosters a deeper understanding of abstract ideas through mental images or physical models, making complex topics, especially in geometry and calculus (Rosken & Rolka, 2006), more approachable. In addition, it supports the development of more effective problem-solving strategies as it helps students recognise patterns, relationships, and potential solutions and improves math performance (Youcubed, 2017). It also develops visual reasoning and spatial awareness, crucial skills in mathematics, particularly in geometry and calculus. Finally, visualisation fosters the ability to consider a problem from multiple perspectives, which leads to a more comprehensive and deeper understanding, and usually makes math class more appealing, increasing engagement and motivation.

Project setting

At the intersection of mathematics and art, string art is created by weaving wool, wire ribbons, or colored threads between fixed points, such as nails, to make different shapes. Although each line is straight, together they can form what appear to be curved patterns that can form various appealing shapes. Initially, string art was developed as an educational method by mathematics teacher Mary Everest Boole (2004), who published a book about 'curve stitching' entitled *Philosophy and Fun of Algebra*. Curve stitching was a powerful teaching tool intended to make mathematical ideas, especially in geometry, more understandable even to young children and it laid the foundation for a decorative craft enjoyed by people worldwide. The US National Council of Teachers of Mathematics in its series *Classics in Mathematics Education* reprinted a book by Edith Somervell (with preface penned by M.E. Boole) entitled *A Rhythmic Approach to Mathematics* (1975) describing curve stitching as a "method for evoking the geometric instinct" of "creative and organizing power."

The project described here can be tailored to different grade levels: for example, primary school children will enjoy drawing what looks like an optical illusion and observing the variety of patterns created using different shapes as their starting point, all the while learning how to use a ruler (and perhaps a protractor). Junior high students will appreciate exploring the interplay and connections between various shapes, angles, and points and the intricate, interesting designs they can create (EL Education, 2025). Older students will recognize (Perfect Parabolas, 2025) and mathematically deduce the curves formed by these straight lines, while advanced students may take a shine to Bezier curves, connect their parametric representation with the differential equations they create, and have fun connecting them with the Weierstrass

Approximation Theorem and go down that rabbit hole. Therefore, a string art project can be suitable for a broad spectrum of ages, from young learners, like the elementary and junior high school children of Ms. Boole and Ms. Somerville, to advanced high schoolers, as it immerses the learner in an interactive learning experience that solidifies their mathematical comprehension, and sharpens their problem-solving, persistence, and creativity through an engaging visual process.

Project description

The curves stitched by Ms. Boole's students are examples of what are now called Bezier curves (Barnhart, 2022), after French mathematician Paul Bezier who in the 1960s developed a formula for a practical reason: the design of curves for the body-work of Renault cars. Bezier curves are parametric curves and can be used to draw pleasantly smooth shapes of a wide range of forms. This kind of maths is central to modern computer graphics, fonts, animation, and computer-aided design. A Bezier curve is defined by a set of discrete 'control points' and it is intended to approximate a real-world smooth shape whose mathematical representation is unknown or very complicated. In fact, while we can easily draw curves freehand, this process is much harder for computers, because they have to rely on a mathematical function that describes how they should be drawn. The functions often used for this task are Bezier's curves. For example, a quadratic Bezier curve has three points; it runs from a start point towards the first control point and bends to end at the endpoint. A cubic Bezier will have four points, two of which are control points: The two control points determine the direction of the curve at its ends, while the other(s) establish the shape of the curve. Once you have pinpointed the curve's origin and endpoint, you can situate the third (and other) point(s) to create the shape of the curve. By altering the control points, you alter the entire curve.

Using animations makes this process—rather confusing to explain in words—much clearer, and for this reason I usually give my students some time to play with the animations in these Desmos links (Bezier Curves, n.d. https://www.desmos.com/calculator/d1ofwre0fr; Cubic Bezier Curve, n.d. https://www.desmos.com/calculator/ebdtbxgbq0) and other links in the reference list during the initial stages of the project.

After introducing the project and talking about its history and mathematical applications, we usually read and discuss some articles together or in groups (Bfinegold, 2013; Gross, 2012; Kun, 2013; University of Cambridge, 2025); the article *Bezier Curves and Picasso* (Bfinegold, 2013) is usually very popular because it furnishes an animation that explains the curves well and the final drawing excites the students for its uncanny similarity to Picasso's dog. The webpage *Bezier-curves* (https://javascript.info/bezier-curve) provides other useful animations and explanations. Then I show some examples of string art (e.g., https://www.stringartfun.com/product-category/free/) and provide the students with several basic blank templates —easily available on the internet (e.g., https://mathwithmrh.squarespace.com/line-design) so they can try out and understand the task ahead: planning and constructing their own line design. They then construct other templates to practice ever more intricate and detailed designs while they brainstorm ideas about what to do with the shapes they create. This helps them get a much better understanding of the patterns they need to use to draw the design they have in mind and how they can put them together to construct the intended object. They can use whatever materials and tools they see fit and over the years the students have used many different ways to complete their project, such as wood, nails, and strings; or a board, pins, and yarn; posterboard, threads, and needles; paper and coloured pencils; or any combination of these (see examples below in Figures 1–3). For more detailed information about goals, thought processes, and final outputs of this project, the student authors here have agreed to share their reflections below.

Carter's reflections

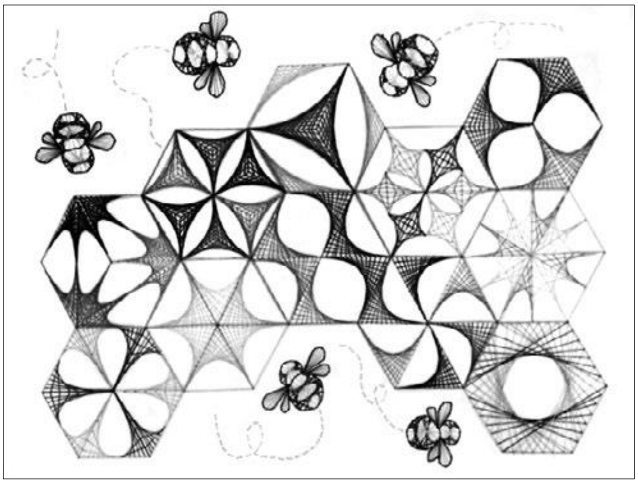
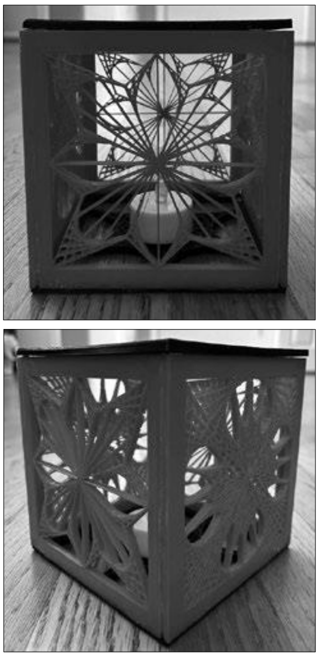


Figure 1. Carter's project.

The line design project is one of my favourite memories of math class at Holton because it not only pushed me to experiment with math concepts creatively but also was a very memorable and enjoyable experience. For me, the hardest part of creative projects is usually coming up with an idea, so I was a little overwhelmed at first. After sifting through lots of online examples and sketching out different designs, I ultimately decided on a beehive, mainly because of the versatility of hexagons. During my design process, hexagons were one of the most intriguing shapes to experiment with because of the many ways they can be broken up into smaller shapes to create unique designs. I chose to use sewing thread because its thinner and more durable than other options like embroidery thread or ribbon, allowing me more freedom to create smaller, more intricate designs. At the last minute, I decided that my project was missing something: bees. Figuring out how to create the bees using only line designs was possibly the most challenging and creative part of the process for me. Up until that point, I had only thought about patterns inside regular polygons, but bees have a much more organic shape. Overall, this project helped me gain a real-world perspective on the material covered in class and helped me approach math from a more creative angle. It's always amazing when two subjects, like math and art, can intersect to create something beautiful. My teacher always knows how to make math class fun and exciting, and the Line Design project is definitely no exception!

Nell's reflections



Figures 2A and 2B. Nell's Project.

My Design: My project was a 3D-printed cubic lantern with three different designs. From the start, I was fixed on incorporating 3D printing into my design. In Art-Tech last year, I learned how to convert my hand-drawn designs into files that could be uploaded into Tinkercad, and I thought I could apply the same technique to turn these complex designs into something 3-dimensional.

My plan–changed: My initial ideas were more complicated than my final product. I had wanted to do a Halloween lantern with a hexagonal base 'spider web' and six side panels, but I realized that would be a lot more difficult to achieve in a limited amount of time. I had tried using the line patterns to represent a bat silhouette, but after showing it to a few people who couldn't tell what it was, I abandoned the idea of making my art look like a specific 'thing' and instead focused on creating abstract patterns.

Process: I hand-drew my design with a black Sharpie on white paper so that it would create a clear black-and-white scan on my iPhone. I then used a free online SVG converter to make the image a vector file acceptable to upload to Tinkercad. I started out by making smaller prototypes of my lantern panels to test out how accurate and intricate the 3D printer could be and if there were any limitations. Along the way, I realised that two of the opposite side panels would need to be shorter in width for the other two panels to fit. After the printing of all the panels the way I liked them, I super-glued them together and used big glue dots to secure the candle.

Challenges: Well, when I was trying to use the line pattern to make it look like a bat, that was very frustrating. I also found it difficult to make sure my lines were thick enough to scan and hold their shape when printed, but also be intricate enough to create a complex design. The process of creating my project required multiple prototypes to be printed as well, and I'm so grateful for my tech teacher's assistance in the engineering/tech aspect of it all!

Reflecting thoughts: I think that my design ended up being simple yet complex.

The idea of it being a lantern that can illuminate my designs in the darkness represents how I strive to spread love and light in the lives of others.

I'll admit that maths used to be one of my least favourite subjects. But I'm realising that math is so much more than solving equations or learning formulas. It is abstract, and artistic, and can be applied to so many realms, including 3D design. I had never thought about how curves could be formed from straight lines and having the opportunity to explore that idea hands-on—and apply my creativity to create a beautiful, geometric illusion—was very exciting.

Chloe's reflections

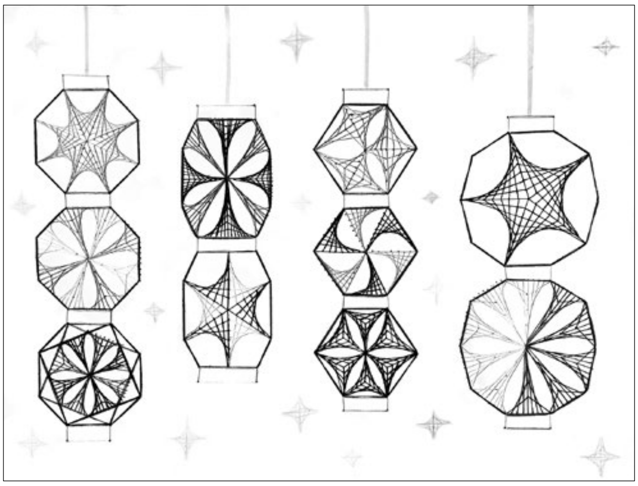


Figure. 3: Chloe's Project.

My design consisted of four variations of colourful Chinese lanterns—each section featured a complex and abstract pattern. In order to create my final design, I used card-stock, sewing thread, different sized needles, and a lot of tape.

During the process, I encountered lots of trial and error. For example, I sketched multiple designs for the lanterns, while altering the size, shape, spacing, and other details. I also faced lots of difficulties while sewing my design. My design was very intricate and had lots of components. I had complications while assembling and refining each aspect, down to even the stars in the background.

Before I finalised my design, I had several concepts in mind, but I ultimately chose to create this one. This project provided me with an opportunity to creatively express myself, and I wanted to incorporate an aspect of my culture through mathematics and art. I took a contemporary approach to creating traditional Chinese lanterns, by creating abstract patterns inside each of them. My choice of vivid colours and other artistic elements of my project reflects my personality, which I think is bright and intuitive.

This project made me think about math differently because I realized maths isn't just about calculations; it can be expressed in the form of art, such as graphing complicated designs and using artistic ability.

Conclusion

The String Art project has been a favourite of my Geometry students since its inception three years ago. I have always been impressed by their final product for many reasons. Certainly, their designs are visually appealing and project a strong connection between mathematics and art.

More importantly, each of the designs highlights the hard work, resilience, and growth mindset as well as the excitement, pride, and delight in problem-solving that shine through the students' reflections. In addition, this project allows the students to lean on and practice their visual discrimination and spatial abilities which are important components of their mathematical thinking. As a low-floor high-ceiling task, it caters to all ability levels as children can go as far as they like or choose, in the process realising once again that their learning depends on their own curiosity and effort. Finally, it exposes them to some new and different mathematics and to mathematical approaches that they would not usually encounter in the school curriculum.

In short, it's a keeper.

References

Barnhart, B. (2022, October 28). The birth of bézier curves & how it shaped graphic design. *Linearity Blog*. https://www.linearity.io/blog/bezier-curves/

Bezier Curves. (n.d.). *Desmos*. Retrieved from https://www.desmos.com/calculator/d1ofwre0fr

Bfinegold. (2013, July 18). *String art, Bezier curves, Picasso, and me.* Retrieved from https://blogs.ams.org/blogonmathblogs/2013/07/18/218/

Boole, M. (2004). *Philosophy and Fun of Algebra*. Project Gutenberg.

Cubic Bezier Curve. (n.d.). *Desmos*. Retrieved from https://www.desmos.com/calculator/ebdtbxgbq0

EL Education. (2025). *Line designs*. Retrieved from https://modelsofexcellence.eleducation.org/projects/line-designs?_gl=1

Gross. R. (2012, March 5). *Bridges, string art and Bézier curves.* Retrieved from https://plus.maths.org/content/bridges-string-art-and-bezier-curves

Kun, J. (2013, May 11). *Bezier curves and Picasso*. Retrieved from https://www.jeremykun.com/2013/05/11/bezier-curves-and-picasso/

Perfect Parabolas. (2025). Fsu.edu. Retrieved from https://www.math.fsu.edu/~rabert/TeX/parabola/parabola.html

Rösken, B., & Rolka, K. (2006). A picture is worth a 1000 words –the role of visualization in mathematics learning. In Novotná, J., Moraová, H., Krátká, M. & Stehlíková, N. (Eds.). *Proceedings 30th Conference of the International Group for the Psychology of Mathematics Education, Vol. 4,* pp. 457–464. Prague: PME

Somervell, E. L. (1975). *A rhythmic approach to mathematics.* National Council of Teachers of Mathematics

Tiwari, S., Obradovic, D., Rathour, L., Narayan Mishra, L., & Mishra, V. N. (2021). Visualization in mathematics teaching. *Journal of Advances in Mathematics, 20*, 431–439. https://doi.org/10.24297/jam.v20i.9136

University of Cambridge. (2025). *Finding the intersection envelope*. Retrieved from https://plus.maths.org/content/finding-intersection-envelope

Youcubed. (2017). *Visual math improves math performance –YouCubed*. YouCubed. https://www.youcubed.org/resources/visual-math-improves-math-performance/