Threaded Theorems: Hand Embroidery as Mathematics Outreach

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Abstract

Threaded Theorems is a 'Public Engagement with Research' activity designed to introduce advanced mathematics concepts to the public through the traditionally female practice of embroidery. Free mathematics-based embroidery patterns are published on the Threaded Theorems website. The templates are publicised through successful social media engagement, particularly in fibre arts spaces, encouraging women to be excited about mathematics in a familiar and beautiful context. The Threaded Theorems project has engaged hundreds of members of the general public over a one-year period, with many creating their own versions of the designs.

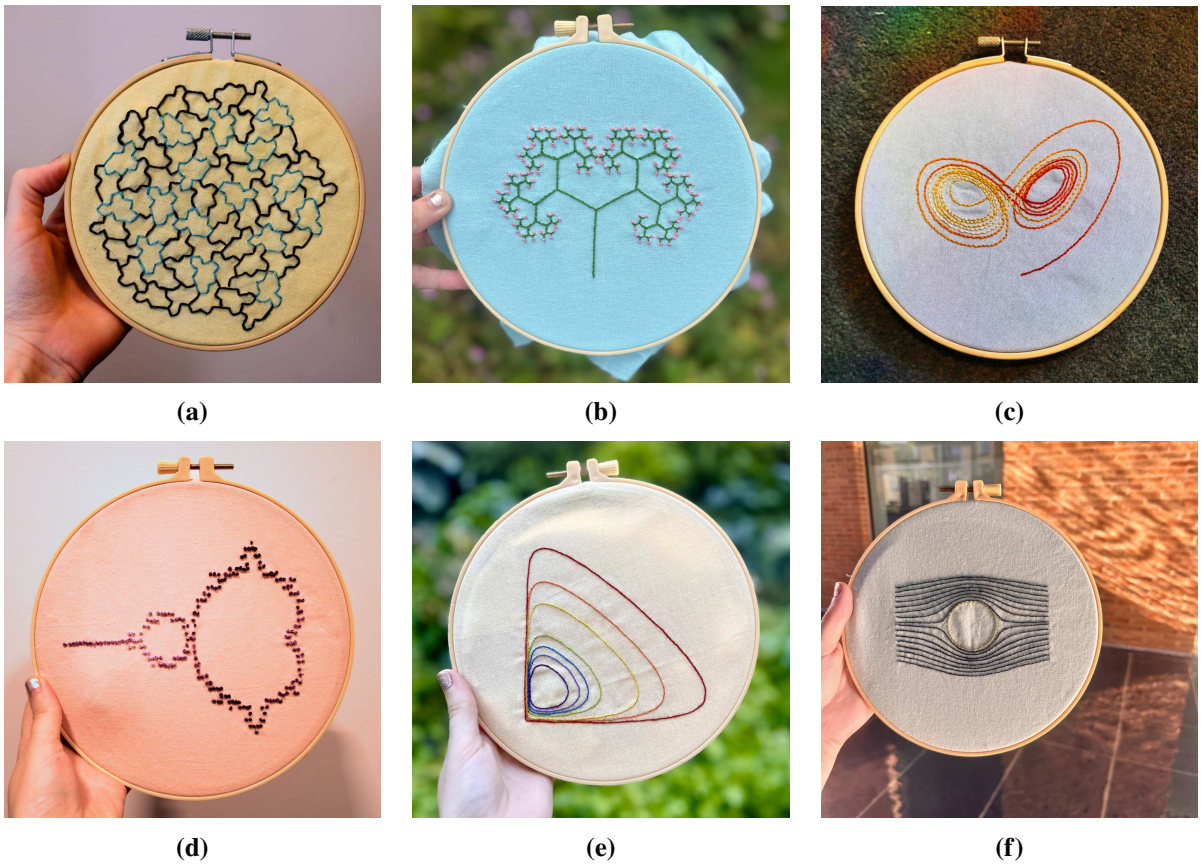
Mathematics and Embroidery

There is a persistent gender gap in engagement with mathematics at all career stages in the United Kingdom [3]. Teaching mathematics in a context relevant to the learner plays a significant role in developing mathematical belonging [9]. Fibre arts have been discussed as an example of Papert's concept of 'Mathland', a familiar domain where women explore maths in a life-long way [6]. Therefore, deliberately using embroidery to expose people to advanced mathematics concepts seems like a fruitful way to engender a sense of mathematical belonging and curiosity in women. Machine embroidery has frequently been tested as a 'gender-sensitive' way to introduce girls to coding through software applications like TurtleStitch and PocketCode [8]. The embroidery designs created in these programmes explicitly require mathematics in their creation. Mathematics is well-known to be fundamental to many fibre arts such as knitting, crochet, sewing, and cross-stitch [6]. In hand embroidery, specific geometric techniques like hitomezashi sashiko [1] and blackwork [2] also have well-studied underlying mathematics.

Little work has been done on studying or incorporating mathematics into free-stitch embroidery (that is, hand embroidery that does not follow specific rules of 'counted thread' techniques like blackwork). This paper describes *Threaded Theorems*, an outreach project designed to bring mathematics into the world of free-stitch hand embroidery through mathematical designs. There is precedent of highly successful science-themed free-stitch embroidery in disciplines like physics and anatomy, but there is no clear equivalent for mathematical free-stitch designs.

Threaded Theorems

Threaded Theorems was conceptualised as a response to an early 2025 grant call for 'Public Engagement with Research' activities through the Oxford Mathematics Engagement Grant (OMEGA) Scheme. From my own enjoyment of embroidery and experience searching for free embroidery patterns online, I was inspired to produce free embroidery patterns that illustrate mathematical concepts. The pattern documents contain clear designs that use beginner-friendly embroidery stitches and include information about the design's mathematical content. With the support of the OMEGA grant, I launched the Threaded Theorems website [5] with a handful of design templates and started various social media accounts to promote the patterns. The impetus for this project was to introduce crafty people (particularly women) to mathematical concepts. Therefore, the project branding and outreach strategy was oriented around reaching craft-focused spaces.



(a) **(b)** **(c)**

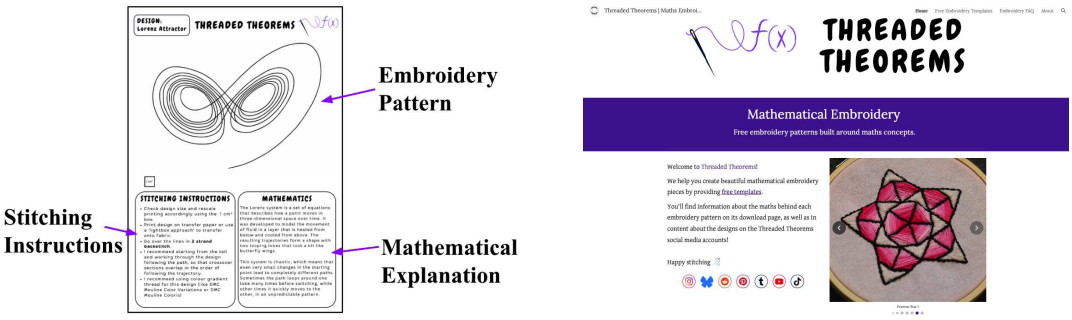
(d) **(e)** **(f)**

Figure 1: *Examples of Threaded Theorems designs published on social media. The patterns are respectively* ***(a)*** *aperiodic monotile,* ***(b)*** *binary tree,* ***(c)*** *Lorenz attractor,* ***(d)*** *Mandelbrot set,* ***(e)*** *predator–prey equations, and* ***(f)*** *Stokes flow.*

The initial run of embroidery patterns was based on mathematical concepts with an obvious visual element. In particular, these were designs often discussed in 'pop math' content such as tilings (Figure 1a), fractal patterns (Figures 1b and 1d), and dynamical systems (Figure 1c). Later, I introduced highly-visual concepts from my graduate applied mathematics courses, such as the phase-plane of the Lotka–Volterra model of predator-prey dynamics (Figure 1e) and the streamlines of Stokes flow around a sphere (Figure 1f). Appropriate designs have a clear two-dimensional line-based representation. Often, design choices must be made to simplify the mathematical structure into a representative form (such as using French knots to imply the edge of the fractal structure of the Mandelbrot set in Figure 1d).

To create an embroidery pattern document, the embroidery design is first sketched in Procreate, a digital illustration app, as a black-and-white line drawing. Then, I assemble a pdf template in the online graphic design platform Canva. This template includes space for the embroidery instructions and a blurb about the mathematical content in the design pitched at a layperson's level. An example template for the 'Lorenz Attractor' design is shown in Figure 2a.

The Threaded Theorems website homepage (see Figure 2b) has been optimised with keywords to perform well in searches for 'math embroidery'. On the website, an 'Embroidery FAQ' section provides guidance on how to use the patterns. The primary method for using an embroidery pattern is to either print the pattern on water-soluble transfer paper or to use a light box to trace the design directly onto the fabric.



(a) **(b)**

Figure 2: ***(a)*** *Example Threaded Theorems embroidery template (Lorenz Attractor design [4])* ***(b)*** *Homepage of Threaded Theorems website [5].*

Threaded Theorems social media accounts have had an incredibly positive reception over the last year as they have developed an organic following. Threaded Theorems has accounts on Instagram, Reddit, Tumblr, Bluesky, TikTok, and YouTube. Figure 1 features example images of completed embroidery pieces shared on these social media channels to advertise the project. In addition, time-lapse footage with voice-over explaining the mathematical content has been featured on the video-based platforms. Threaded Theorems was also included as an online resource for Maths Week England to be used as a classroom activity by English secondary school students.

Social media engagement has allowed the project to directly reach crafters with little to no scientific background. On Reddit, completed pieces are posted on the subreddit r/embroidery, a dedicated crafting space. Unlike platforms with algorithmic feed systems that push Threaded Theorems to maths-inclined audiences, r/embroidery users are likely to be unfamiliar with mathematical concepts. Feedback to the patterns has been overwhelmingly positive, with some examples from anonymous users highlighted below:

> "This is really cool! My mind is breaking trying to work out how they came up with the shape."
> "This is funky, I love it. Now I'm inspired to research this concept more because I have no idea what you're talking about but I want to know haha."

These users demonstrate an aesthetic appreciation for the designs, which then builds into a strong mathematical curiosity about the unfamiliar content. Mathematical embroidery is therefore an effective way of introducing high-level mathematical concepts to people who might otherwise never encounter them.

The most popular platform for Threaded Theorems content has been Tumblr which has amassed 220+ followers. Alongside standard blog posts, Threaded Theorems content was also targeted at relevant audiences through posting in the 'Sewing, quilting, embroidery, fibre arts' and 'mathblr' communities. On Bluesky (140+ followers), users have been active in making the patterns themselves and sharing their results. Notably, one user made a blog post on their personal website detailing their experience making the 'Aperiodic Monotile' pattern [7]. See Figure 3 for two examples of the 'Lorenz Attractor' embroidery pattern created by members of the public that were shared through Bluesky and Instagram respectively. Threaded Theorems projects that have been shared online are featured on the 'About' page of the website [5]. Feedback from users demonstrates a clear appreciation for mathematical embroidery as an exciting and engaging combination of two often distinct practices, for example:

> "Fascinating way to blend concepts, thanks for what you do :)" (Bluesky)
> "#this is quite literally the coolest thing I've stumbled upon in a long time... #I'm blown away #nearly in tears" (Tumblr, where users often provide commentary on posts in the tags section)

(a) **(b)**

Figure 3: *Examples of the Lorenz attractor embroidery pattern (Figure 1c) made by members of the public, reproduced with permission* ***(a)*** *Adrienne Hestenes,* ***(b)*** *Steffi, @houseofcraftyhudsons.*

Summary and Conclusions

The first year of the Threaded Theorems project has shown a significant impact as a form of public engagement with research by bringing mathematics explicitly into the traditionally female practice of free-stitch hand embroidery. By creating aesthetically-pleasing and freely available embroidery patterns, hundreds of people have engaged with advanced mathematics concepts. For future work, I intend to extend the assessment of this project to track downloads of the Threaded Theorems templates to get a better sense of how many people are creating the patterns themselves.

Acknowledgements

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