BLUEBIRD MATH CIRCLE
Alliance of Indigenous Math Circles

Issue 32 Recap
Hiding in Plain Sight: Vyshyvanka Codes

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NEWSFLASH Join LIVE Bluebird Math Circle with friends and family.

August 24th, 5-6 PM MDT online.

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Introduction

After a peaceful welcome with the song of a bluebird, Donna Fernandez introduced our math circle. Before we tell you all about it, here are our tools and supplies:

- The newsletter https://aimathcircles.org/issue-32-vyshyvanka-codes/
- Image search for the festive vyshyvanka shirts https://www.google.com/search?q=vyshyvanka+day&source=lnms&tbm=isch
- The interactive tool for coding messages in cross-stitch patterns https://www.ornament.name/creator
- The same tool, with the interface translated into English: https://ornament-name.translate.goog/creator?_x_tr_sl=uk&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=sc

We hope this helps you lead this activity for your family or group!

Warm Up: Letter Snowflakes

Our first little task was to turn our typical rectangular paper into squares. That one fold shows why papercrafts like origami are such respected hobbies among mathematicians.

- Folding well embodies math values like precision and attending to patterns.
- You can present the fold as a math problem: How do you make a square out of a rectangle?
- You can also ask for a proof: How do you know it's really a square?

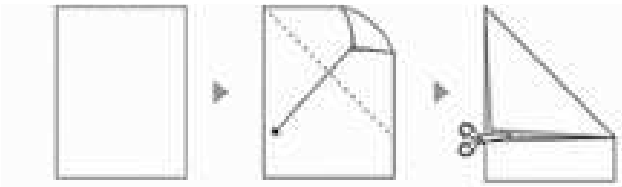


Image from education.com

We continued with so-called snowflake folds, that is, repeatedly folding through the middle of the paper:

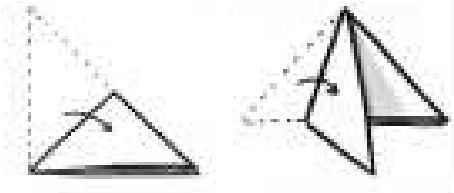
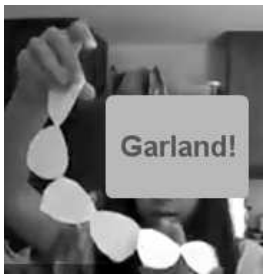


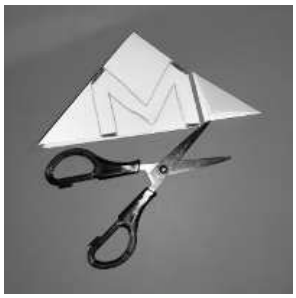
Image from twinkle.com

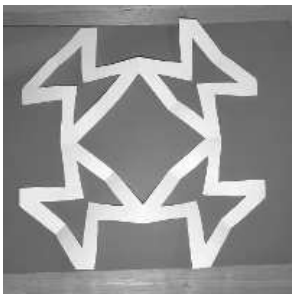
It's nice to ask short questions along the way. How many layers do you have now? Which of the three corners is the middle of your paper? How many little triangles will you see when you open the paper? The questions guide participants to *anticipate* their shapes, and to look for various math properties. These micro-problems are also self-checking: just unfold and look! That boosts math confidence.



Next, participants drew chunky letters that touched all three edges of their triangles. The letters must touch not only at a point, but along some interval. The alternative is still mathematically interesting: some or all of the paper layers come apart, and we can make garlands.

In the following example from the newsletter, we highlight the intervals where the letter **M** touches the edges of the triangle:



Here is the letter **F** snowflake by Donna Fernandez:

There are a lot of interesting choices within this deceptively simple craft. Each choice leads to artistic effects and mathematical explorations:

- How to rotate the letter ⇒ explore the symmetry of geometric shapes
- How thick to make the letter ⇒ focus more on the thin lines or chunky shapes
- How to deal with the loops like D or B ⇒ lots of topology, which is the branch of math that studies loops, holes, and spatial connections
- Straight or curvy fonts ⇒ the type of geometric shapes we could make
- Making letters symmetric or not ⇒ more or fewer symmetries in the design

Donna pointed out that letters have a long straight line, like F or B, work well when that line coincides with a side of the folded triangle. That trick helped Bodhi to make this snowflake, where curved lines form a pleasing "organic" design:

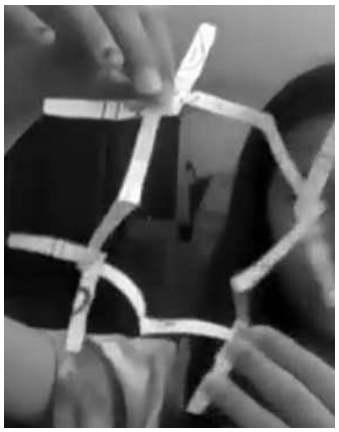


Donna: "I like the middle part, where it kind of swoops in!"

In practice, this abundance of choice makes the activity "sticky": participants didn't want to quit it, and we saw sustained engagement. People linger in the microworld of letter snowflakes because their creations keep surprising them, are sweet to look at, and fun to handle. That's our opportunity to anchor a lot of math ideas and math terms. Here's a vocabulary list:

Actions	fold, unfold, line up, cut, predict, imagine
Things	sheet, layer, fold, edge, corner, middle
Concepts	point, line, angle, multiplication, fraction, reflect, line symmetry, rotate, rotational symmetry, model

And here are some puzzling snowflakes the participants created! Can you guess their letters? The answers are at the end.




Design 1 and Design 2 by Ophelia. This math friend was creating thin, angular designs that day. They are hard to decode!


Design 3 and Design 4 by Tatiana Shubin. Hint: It's the same letter!



Designs 5, 6, and 7 by three different authors. These letters have distinctive, recognizable features.

Family Circle: Vyshyvanka Codes

Vyshyvanka is an embroidered Ukrainian shirt. Each region has its own traditions for vyshyvanka colors and designs; you can see some of them in this map of Ukraine "embroidered'' region by region.

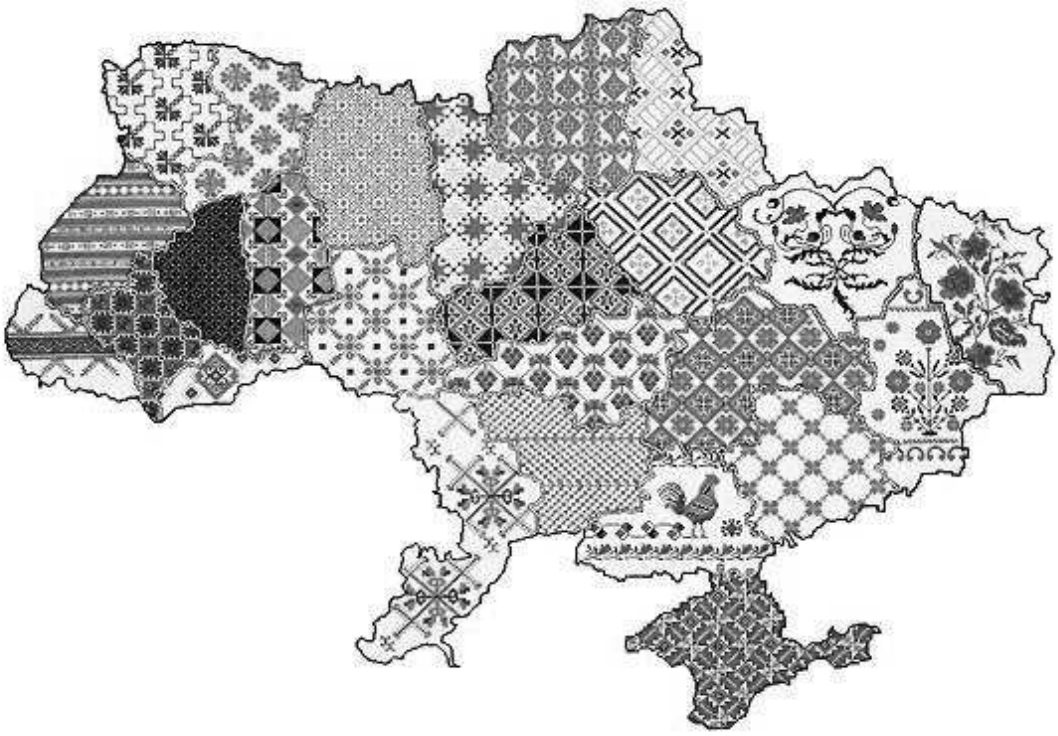


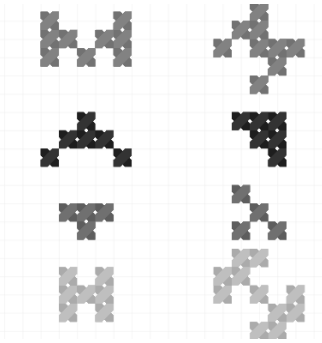
image by Qypchak on Wikipedia

Vyshyvanka Day is celebrated around the world every third Thursday in May. Search images with "vyshyvanka day" and you'll see many happy people (and cute pets) wearing these bright embroidered shirts.

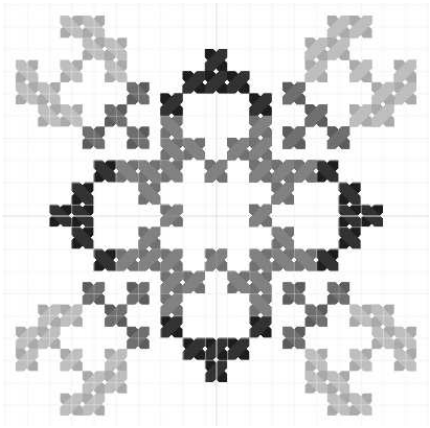
Photos by Vladimir Yaitskiy and Dsns.gov.ua on Wikipedia

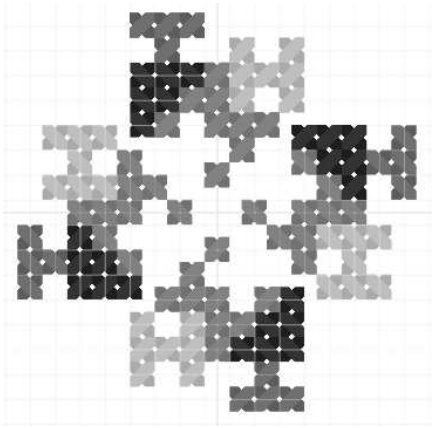
Now that participants grew their math eyes for reading letters hidden by paper-folding symmetry, they progressed from working with single letters to coding and decoding entire words. They used the interactive creator tool at https://www.ornament.name/creator

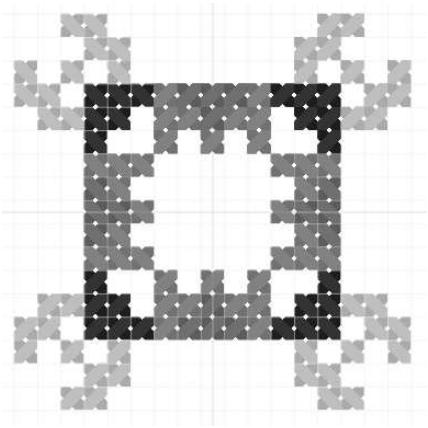
Traditional Ukrainian letter codes are very minimalist. They use only a few cross-stitches per letter. The letters are also abstract! Someone who isn't in the know, who hasn't seen the code key before is unlikely to read the message. For a taste, here are two versions of letters M, A, T, H in two geometric orientations. M and H are more readable; A and T are harder!



Here are three complete vyshyvanka designs spelling *math* in different ways.





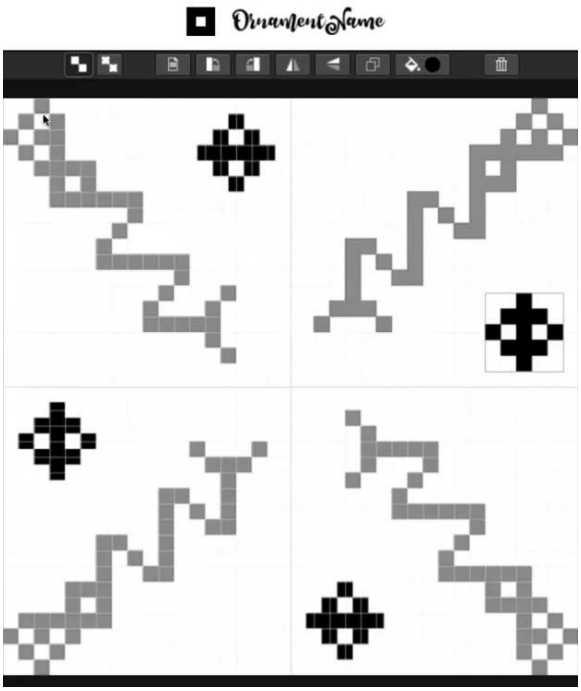


As with letter snowflakes, combinations of interesting choices multiply quickly! So there are a lot of possibilities for creative designs. How many? That's a good combinatorics question! Though we are tempted to claim that the possibilities are endless.

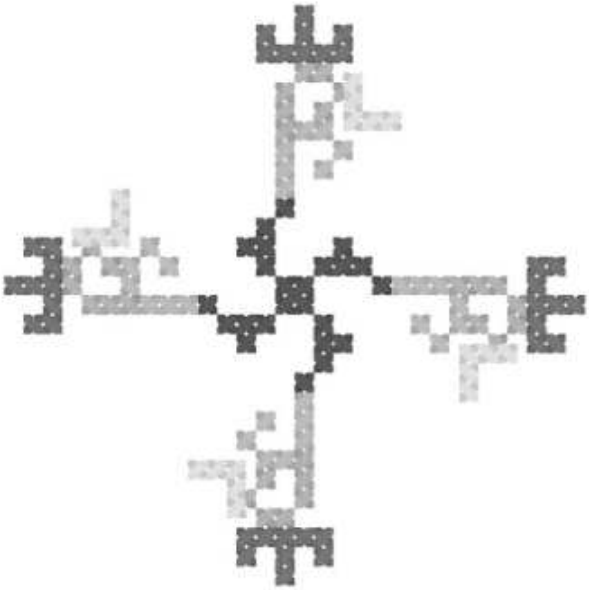
In this activity, computer-based mathematics shines. Of course, designing these pictures by hand, by drawing or cutting or stitching, is very meditative and satisfying. Slow hands-on work helps us to focus on patterns *within* each design. But software lets us move, reflect, and rotate entire blocks instantly. It helps us generate tremendous amount of designs in minutes. Our fast software helps us find similarities and differences *between* many designs.

Here is the coding/decoding key; you can decode the participants' creations, or leave them as pretty enigmas.

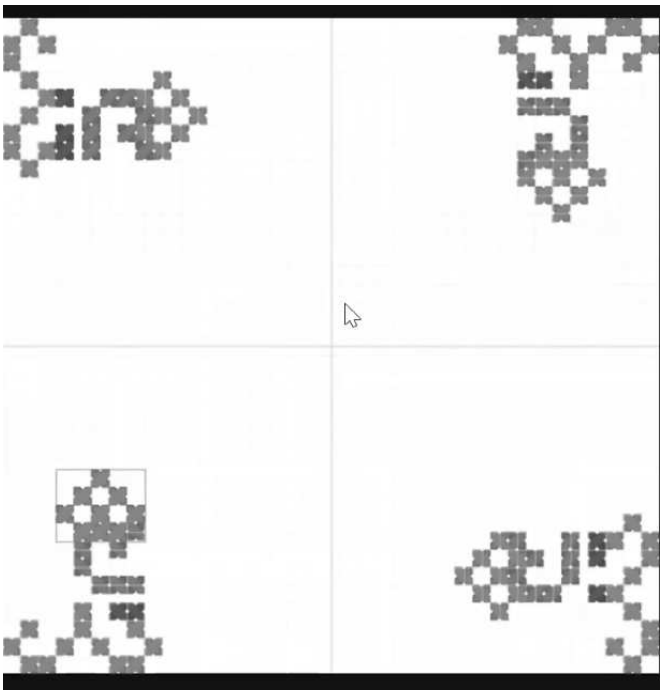
Donna made her word challenging: almost all the letters are red!



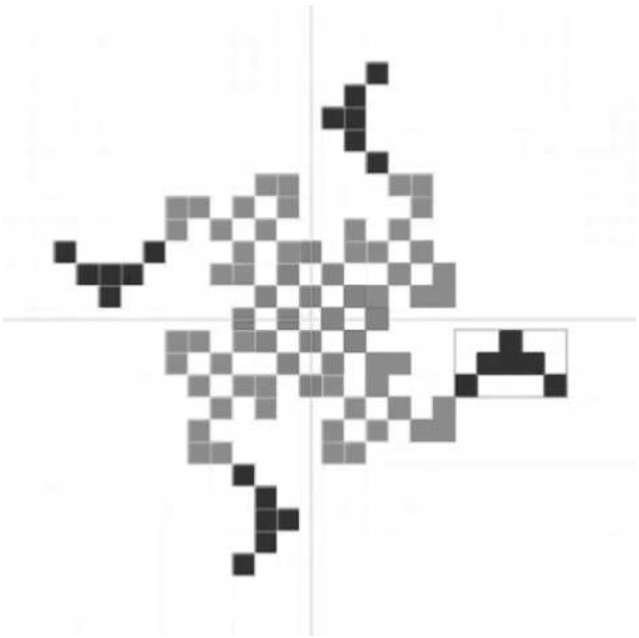
Tatiana colored each letter differently:



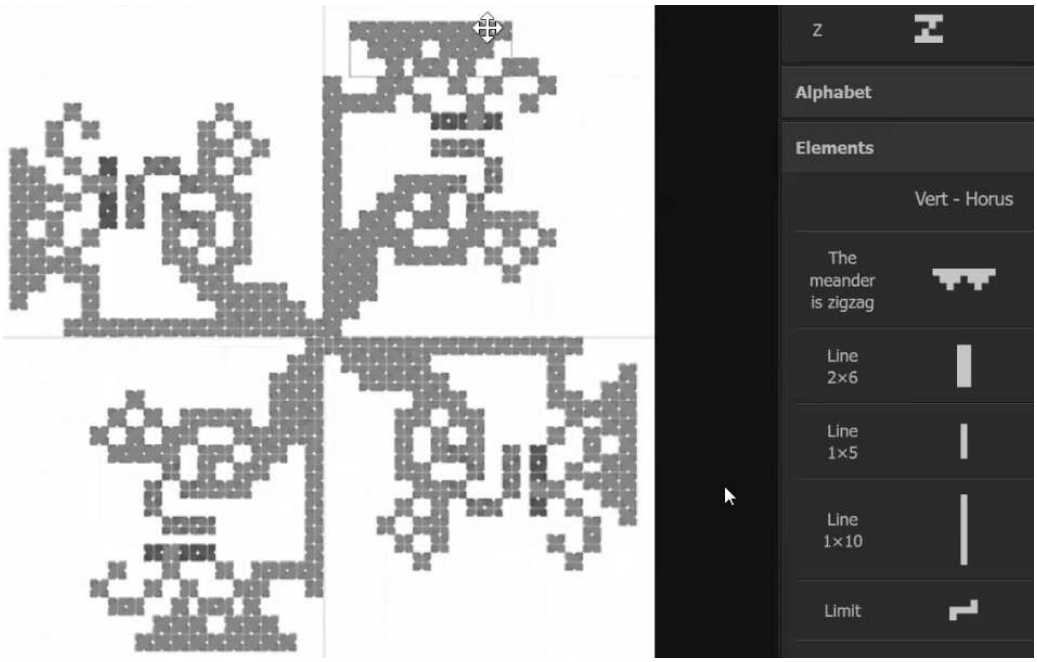
Ophelia's design spelled a word Donna recognized, because it shares some letters with hers:



Bodhi's snowflake has three colors but four letters. It's a marine animal Bodhi likes.



In Ophelia's next creation, extra decorative elements make the message very challenging to decode:



Here is a big math question we pondered about each of our vyshyvanka designs: Is it possible to re-create the design by cutting it out of the folded paper?

That question leads us to compare and contrast mirror and rotational symmetry. We used software to rotate one of our vyshyvanka designs, and once we hit the 90-degree rotation, the design looked exactly the same before. That's rotational symmetry. We couldn't formally prove that some vyshyvanka designs are impossible with paper-folding and -cutting, but several participants suspected that. A participant who loves origami wanted to keep trying with folds that are different from the snowflake folds through the midpoint. Write Bluebird if you find an example or prove that it's impossible!

Answers to letter snowflake puzzles:
Design 1 by Ophelia: **V**, with an extra decorative element (a little square).
Design 2 by Ophelia: **L** "It's an L, but it *looks* like it's an X, because there's a secret, really hard to see line right in the middle!"
Designs 3 and 4 by Tatiana Shubin are two different versions of **F**. Donna: "They don't look like mine!" Tatiana: "F is not for Fernandez, F is for fun." Maria: ""Fernandez' is for fun."
Design 5 by Cindy's child is **A**.
Design 6 by Cindy Bolla is **C**.
Design 7 by Daniela U. is **D**.

Share your ideas with other Bluebird Math Circle participants at **https://aimathcircles.org/Bluebird**

New Questions for Bluebird

I wonder what is the longest migration pattern of animals? And how do they know where to go? - from Donna Fernandez

How many bluebirds are there in the world? - from Tatiana Shubin

Do birds ever lose their eye sight? - from Daniela U.

BLUEBIRD SAYS—Intriguing questions. I will fly around and seek answers. Watch this space in the next flyer!

Submit your math-related questions at **https://aimathcircles.org/Bluebird**