TEXTILE MATHEMATICS

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ABSTRACT

The mathematics which we use in textile is known as textile mathematics. A **textile** is a flexible material consisting of a network of natural or artificial fibres (yarn or thread). Yarn is **produced** by spinning raw fibres of wool, flax, cotton, hemp, or other materials to produce long strands. **Textiles** are **formed** by weaving, knitting, crocheting, knotting, felting, or braiding.

In textile, spinning, weaving, knitting, embroidery and fashion designing is done with the help of textile mathematics. A wide range of mathematical concepts have been used as inspiration including graph theory, number theory and algebra. The mathematics which we use in textile is known as textile mathematics. In textile industry, graphs and pie charts are used to compare production rate of fabric year by year.

Most of the calculations made by a textile technologist consist of a series of relatively simple steps, mainly arithmetical and at times using elementary aspects of trigonometry, geometry Algebra. Some techniques such as counted-thread embroidery are naturally geometrical; other kinds of textile provide a ready means for the colorful physical expression of mathematical concepts. Embroidery techniques such as counted-thread embroidery including cross-stitch and some canvas work methods and needlework make use of the natural pixels of the weave, lending themselves to geometric designs.

Knitting Patterns inspired by Mathematical Concepts including Pi, Symmetry, topology, and more. We shape knitted fabric primarily by using increases and decreases. True to their names, increases add to the number of stitches in a row, and decreases lessen the number of stitches in a row. Both processes create mathematical curvature in the knitted fabric.

Key words: **Textiles, Mathematical Concepts, Weaving, Knitting**

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Geometry is the branch of mathematics concerned with the properties and relations of points, lines, surfaces, solids, and higher **dimensional** analogs. **Geometry** is used in fashion design in making shirt, dresses, pants skirts and more.

Need for Mathematics in Textiles

In any manufactured product no two articles are perfectly alike, For example, it is impossible to find two knots of yarn having exactly the same count, strength, evenness, length etc. this is because the raw material i.e. cotton itself varies from fibre to fibre within a bale, bale to bale, and season to season. The quality of the product in each process, therefore, varies according to the variation in the raw material used and degree of technical and refinement attained during processing. These variations can be solved through mathematical calculations.

A wide range of mathematical concepts have been used as inspiration including topology, graph theory, number theory and algebra. Some techniques such as counted-thread embroidery are naturally geometrical; other kinds of textile provide a ready means for the colorful physical expression of mathematical concepts. Embroidery techniques such as counted-thread embroidery including cross-stitch and some canvas work methods and needlework make use of the natural pixels of the weave, lending themselves to geometric designs.

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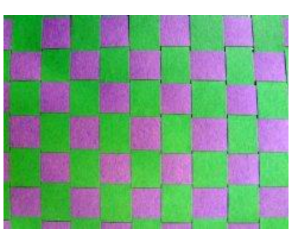
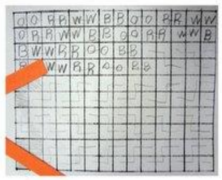
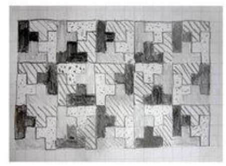
Weaving is a fun and creative way to explore real mathematical ideas. Simple "mat" weaving offers a way to experience basic concepts in geometry and number theory, while encouraging the development of representation and modeling techniques– fundamental mathematical skills.



A more challenging activity with just two colors, each aligned horizontal and vertically, is to weave a *tiling* of the plane. This activity definitely requires some planning. Once a type of "tile" is chosen, the weaver must figure out what kind of weaving pattern will produce the desired tilling of the plane. Here's where modeling and representation come into the process. With a blank grid, one can plan out the weave ahead of time, hopefully figuring out what kind of weaving pattern will produce the desired mat. A standard modeling approach can be used, or the weaver can develop their own representation—in both cases, the important mathematical skill of modeling is being developed. Here are some examples of different approaches to modeling various weaves.





Through trial (and error!), the weaver can refine their modeling process and their plans to produce the desired weave.





A fun mathematical follow-up to introductory weaving is to consider "Which kinds of patterns are weavable." An interesting and highly mathematical question is, **"**Would it be possible to produce these mats through weaving alone." With some basic supplies and a few simple techniques, significant mathematical ideas can be explored through weaving.

Yarn Count and Mathematics

Count is numerical express which indicates the mass per unit length or the length per unit mass of yarn.

1. Direct Count System:

The count of yarn expresses the n umber of weight per units in one length unit. If higher the count then coarser the yarn. This system is generally used for jute, synthetic fibre, silk fibre etc.

$$\text{Direct yarn count, } N = \frac{W \times l}{w \times L}$$

Where,

N denotes the yarn number or count,

W denotes the weight of the sample,

L denotes the length of the sample,

l denotes the unit length of the system, w denotes the unit weight of the system.

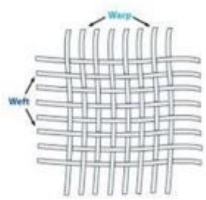
2. Indirect Count System:

The count of yarn expresses the number of length units in one weight per unit. Higher the count, finer the yarn. This system is generally uses for linen (wet spun), cotton fibre, worsted etc.

$$\text{Indirect system, } N = \frac{w \times L}{W \times l}$$

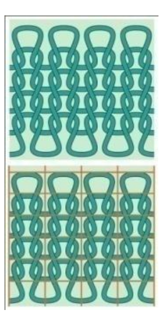
Where,
l indicates the unit length of the system,
L indicates the length of the sample,
w indicates the unit weight of the system,
W indicates the weight of the sample.

Thread count is the amount of threads woven together in a square inch. It is worked out by counting the lengthwise (warp) threads, and then the width-wise (weft) threads. Once counted, the amount of weft threads and warp threads are added together to form the thread count. (E.g. a fabric with 100 warp threads and 100 weft threads is said to have a thread count of 200).



Knitting Patterns inspired by Mathematical Concepts including Pi, Symmetry, topology, and more. We shape knitted fabric primarily by using increases and decreases. True to their names, increases add to the number of stitches in a row, and decreases lessen the number of stitches in a row. Both processes create mathematical curvature in the knitted fabric.

So what happens if we increase the number of stitches in a slower fashion? Each new round won't stretch around the previous round, and hence we will create a surface with **positive curvature**. The classic example of a surface with positive curvature is a sphere—at every point on the sphere the surface curves away in all directions. To crochet a sphere, the number of stitches in each round increases like sinθ sinθ, where θθ is the angle around the sphere. You can generate patterns for mathematically ideal crochet spheres here.



If you're crocheting with rounds of stitches, the most obvious shape that you can make is a circle. Each single crochet stitch can be thought of as a square. For the first round of stitches, we want to make a circle with radius 11. Therefore, the circumference will be 2π2π. In this case, we'll take π≈3π≈3 for simplicity, and so in the first round we'll have 66 stitches. When we add the second round, the radius of the circle is now 22, and so we need 4π4π stitches in this round, which, using our crude approximation of ππ, is 1212 stitches. For the next round, the circle has radius 33 and so the round has 1818 stitches. So in each round we add 2π2π, or 66, more stitches—the number of stitches in each round increases **linearly**.

Math and fashion designing

Math is a crucial element of **fashion design**. It is used to measure sample garments for fitting as well as to keep sizes consistent. In addition, an understanding of geometry is needed when mapping a two-dimensional pattern that has to be designed to fit on a three-dimensional body. The fashion industry is not just about clothing, shopping and models; it has a lot of math incorporated into the day-to-day operations. Measurements are necessary in order to create the clothing. They are vital to making sure the clothes will fit models showing the clothing. Some outfits are cut in a specific way and designed for a particular type of body. The measurements of the model and the clothing need to coincide, which is where using math comes in. Math plays an important role in calculating the profit. Stores that sell the clothing use math to decide how many of each piece of clothing they want to sell in each store. Designers need to decide the price of their clothing. In addition, the stores use math to decide how much to charge for the clothing and how and when to discount it. Math is used to calculate the amount needed to spend for fabric, thread and various other items needed in the fashion industry.

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