The WOOLERY®
Your Fiber Journey Starts Here!

Weaving Math 101

Learn how to plan your own weaving projects and never run out of yarn! Arm yourself with the power of math and sample making so you know exactly how much yarn you need for a weaving project every time. This is not a beginner weaving class that includes how to warp a loom or weave a project. Instead, this will give you the mathematical tools to plan your next project from scratch!

Camp Woolery Facebook Group

We will be hosting discussion and answering your questions on our Camp Woolery Facebook Group. Come introduce yourself!

Join Here: https://www.facebook.com/groups/455950598840395

Facebook Office Hours

We will be most active in the Facebook group Monday - Friday from 12pm - 5pm EDT

Class Schedule

July 25th - August 7th
Facebook Live Q&A July 27th 2pm Eastern, August 3rd 2pm Eastern

Important Links:

Camp Woolery Info Page:
https://woolery.com/camp-woolery/

Weaving Math 101 Kits:
https://woolery.com/weaving-math-101-kit.html

Weaving Math 101 YouTube Playlist:
https://www.youtube.com/playlist?list=PLpmnt-0F93C5iR8R5YKYXwKNTVIqiKOEU1

Woolery Shop:
https://woolery.com

The Woolery YouTube Channel:
https://www.youtube.com/channel/UCpVqe1fzws0Zg39GiAyawzw

Welcome!

Hey there! You like doing math, right? Pinning down all those numbers, and working out all those equations? Me too! (Or not...)

Although it may not be everyone's favorite part of the project process, knowing how to calculate how much yarn you'll need is an essential skill for dreaming up projects from scratch. Luckily, the math isn't half as scary as it often seems to be! It just takes some care to get the right numbers, and some practice to get used to doing it. If you're not a math-brained person, then you and I are in the same boat. So we're going to start with the very basics, and by the end of this, you'll have the tools you need to get the math down, and be sure your project turns out just right! Let's begin with a summary of the terms we're going to be using.

Welcome Video: https://youtu.be/XhjhKqkHZCk

Glossary of Weaving Lingo

Dent: This refers to the spacing in your reed or rigid heddle. For example, if you measure 10 spaces in one inch of your reed (or 5 slots and 5 holes in one inch of your rigid heddle), you have a 10 dent reed/rigid heddle.

EPI (Ends Per Inch): Refers to the number of threads in every inch of your project in the warp.

Warp: The yarn that is dressed on the loom (sleyed through reed, threaded through heddles, etc).

Ends/Threads: The individual strands of yarn in your project, in reference to your warp.

PPI (Picks Per Inch): Refers to the number of threads in every inch of your project in the weft.
Weft: The yarn on your shuttle, which you pass back and forth and beat into place.

Balanced: You will often hear references to "balanced" weave structures, such as a balanced plain weave. This means that your EPI and your PPI are the same**.**

Loom Waste/Thrums: The yarn that can't be woven in your warp. For example, the knots that hold the warp on the apron rods, and the last few inches that can't get woven at the end of a project.

Glossary Video: https://youtu.be/xua8W9dPR4M

Calculating Yardage

Now that we know a little more about the lingo, it's time to look at the math! This is warp calculation in its simplest form—there are things that you can (and should) consider when doing more complex projects, or things that require an absolute degree of precision, but these two equations are the basis for all of that! We're sticking with the simple stuff for this exercise, so let's have a look at those equations, and break them down.

Ends Per Inch x Width of project on the loom = Number of ends in project

Number of ends in project x Length of project on the loom = Yardage in warp

Super simple math! There are just a few things you have to figure out on your own before you get to this point (what your EPI will be, how wide your warp needs to be, and how long your warp needs to be), and then you can plug those numbers right in here. Let's do a simple example, to see how the math works out in practice:

10 ends per inch x 8 inches wide = 80 ends in the project (10 x 8 = 80)

80 ends x 2 yards long = 160 yards in warp (80 x 2 = 160)

And that's it! It really is that simple. Once you have those three variables figured out (EPI, width, and length), all you have to do is a bit of simple algebra to work out how much yarn you'll need for your project. Now, how about weft? Here's the dead-simple answer:

In general, it's safe to assume you'll need as much for your weft as you do your warp.

So in this case, we'd need 160 yards of yarn for our warp, as well as 160 yards for the weft, for a grand total of **320 yards for the whole project**.

Let's do another pretend-project, and this time, there will be a very small extra step right at the end.

15 EPI x 20" wide = 300 ends (15 x 20 = 300)

300 ends x 40 inches long = 12,000 inches in warp (300 x 40 = 12,000)

Notice something strange? Seems like a lot, right? That's because we've measured our warp length in inches, this time! So, let's do our final step of converting inches to yards.

12,000 inches ÷ 36 inches per yard = 333.33 yards (12,000 x 36 = 333.33 repeating)

Since we've ended up with a decimal there, we'll round up to the nearest whole number, and that gives us 334 yards for our warp! So bearing in mind that we'll need as much for our weft, 334 x 2 = **668 total yards** for our project.

One more faux-project, this time, with the consideration that we'll be using multiple colors in the warp. I'll give you a hint: the math is exactly the same, you just do it for each color! But before we can determine exactly how much of each color we'll need, we've got to do the first half of the math to figure out how many ends we're working with, so we can appropriately divide them up between our, say, 3 colors. Let's say that we want a 16" wide project at 4 yards long, using an 8 dent reed. So, the first half:

8 (EPI) x 16 (inches wide) = 128 (ends)

Now that we know how many total ends are in our project, we can split them up into color groups however we want! Let's split them in all different numbers of ends, just for the sake of math. We'll do 50 ends of Color A, 30 ends of Color B, and 48 ends of Color C. (50 + 30 + 48 = 128) Now, all we have to do is plug these numbers into the "number of ends" part of the second half of the equation, for each one, and we'll have the yardage we'll need for every yarn color!

Color A: 50 (ends) x 4 (yards long) = 200 (total yards of color A)

Color B: 30 (ends) x 4 (yards long) = 120 (total yards of color B)

Color C: 48 (ends) x 4 (yards long) = 192 (total yards of color C)

Ta-da! If you want to do a solid color for your weft, add up those numbers (200 + 120 + 192 = 512) to get the total yardage you'd need because, again, we're assuming we'll need just as much total yardage in the weft as we do the warp. And now you're off to the races!

Disclaimer!!!

There are some cases where you'll need significantly more weft than warp, or the opposite—for example, in weft-faced or warp-faced weave structures, which are significantly unbalanced structures. This worksheet is meant to be the most basic of mathematics for weaving, useful for plain weave and most simple twills. There will be additional math and considerations for structures that are unbalanced, or which require special techniques! Using the math presented here as a jumping off point for those things is great, but they will ultimately require their own samples and calculations, and that will be all up to you to figure out, when you get to that point!

Calculating Yardage Video: https://youtu.be/xbKoAKW7LoY

Sampling

Everyone's least favorite thing to hear, and I understand why! No one wants to spend money and time just to spend more money and time later on what feels like the exact same thing. However, I can't possibly overstate the importance of sampling. Without having done a project with the exact same yarn and structure and finishing technique before, and either remembering or writing down your results, you can never truly know how a yarn will behave in a finished woven piece!

Shrinkage will vary depending on the structure, fiber content pairing (for example, cotton in the warp, and bamboo in the weft), and type of finishing you choose. Colors might run that you never expected. What if the structure isn't what you wanted after all? What if you regret not using that other weft? What if you hate the drape (or lack thereof) in the finished fabric? You can start to see why making a small sample can save you a lot of time and heartache!

Does it take time? Yes. Does it take some money? Absolutely yes. Can you get away without doing it? Sure! There's no rule out there saying that you must make a sample before you're allowed to weave something. But when in doubt, and before making huge projects, and if you need to know exactly, precisely what your end result will be before you commit—sample, sample, sample. Most times, it's truly the only way to get an answer you're looking for.

My samples were woven in Uneek Cotton and Uneek Monokrom yarn.

Loom Waste

As mentioned in the glossary, there's always going to be some amount of warp that you simply cannot make into woven cloth. There are knots or loops that connect your warp to the front and back apron rods, there's the amount that you advance to where you stop getting a very good shed. These things can be mitigated by various techniques, but it'll never go away completely! That's just how weaving on a floor, table, or rigid heddle loom works! Other looms and weaving styles can be a different story entirely, but our focus is on the ones mentioned.

If you're weaving an item that you'd like to have fringe, you're in luck: your loom waste is a great resource for fringe. Just make sure you calculate for and leave enough length both in the beginning and end of your project to make the length of fringe that you want!

If you don't have fringe in your plans, you'll simply have to settle for some thrums. The only absolute, surefire way to know how much loom waste you need to account for is to (wait for it…) make a sample, and measure your waste. For example, if you find that you're left with 10" of unwoven length in the front, and 15" of unwoven length in the back, that's a combined total of 25" of loom waste ***per end***. These are just example numbers, yours can and will vary! Loom waste is somewhat like a fingerprint. It varies with technique, tie on method, how determined you are to squeeze your shuttle through that teensy shed to squeak out that last little bit of weaving… There's no magic number here. You'll just have to measure! Or guess at an obscenely high number, and be okay with having plenty of extra yarn leftover from a project. There aren't any rules against that! But really, you're just as well to just make a note for yourself to measure your loom waste the next time you weave something, and keep a note somewhere.

Sampling and Loom Waste Video: https://youtu.be/gRYhTWUMK7Q

Calculating Shrinkage

Another inevitability of weaving! There are a handful of things that won't shrink much at all once off of the loom, but they are indeed few, and not the sort of thing we're talking about in this exercise. Plain weave and twills are going to shrink! Certain fibers shrink more than others! Things shrink both when you take them off of tension, and when you finish/wash them! So, what if you want to weave a dishtowel that's 16" wide when washed? How much shrinkage should you account for, and how does that affect your yarn calculations, you ask?

Make a sample. (Did you guess that's what I was going to say?) While there are some general shortcuts that are floating around out there, this is another one of those things that you just won't know for sure until you sample, because the end result can vary so, so much depending on a plethora of individual factors. Okay, so we've made our pretend sample, and we found out that X yarn, in Y structure, with Z finishing shrinks by a total of 15%. How do we apply that to our math, and make sure that we have enough going in? Divide by the reciprocal!

The mathematical definition of reciprocal is: a mathematical expression or function so related to another that their product is one; the quantity obtained by dividing the number one by a given quantity. This is a fancy, math-brained way to say, for our purposes at least, that we take our shrinkage number, and take that away from 100. In our pretend sample, our shrinkage number is 15. So: 100 - 15 = 85. Now, add a decimal in front of it. 0.85 is our reciprocal!

Why decimals? Because we're talking in percentages, here. That's why we have to take away our shrinkage rate from a total of 100—we're assuming that 100 is our "whole". It helps me to think of it as a pie chart. You can also do this as decimals to start out, and take 0.15 (which is equal to 15%) away from 1! I just like to work in whole numbers, so I use 100 as my "whole", instead of 1. Either way works just fine!

Whichever way you get to your answer above, let's divide by the reciprocal! For our pretend project here, with the same yarn/structure/etc as in our pretend sample, let's say we want it to be 20" wide when finished. Let's divide that by the reciprocal.

20 (width in inches) ÷ 0.85 (reciprocal of our shrinkage number, 15%) = 23.52 (inches wide on the loom)

Yes, dividing a whole number by a percentage will give you a bigger number than when you started! So this means that in our pretend project here, we will want to calculate for a warp width of around 23.5 inches. The same concept applies to the length of your projects, because of course, things don't only shrink in one direction! Let's do another, and make it about our warp length instead.

Imaginary shrinkage rate of 30%. 100 - 30 = 70. Add the decimal… 0.70 is our reciprocal.

Imaginary project length of 6 yards. 6 ÷ 0.70 = 8.57 yards.

Bearing in mind that this number doesn't necessarily include things like loom waste, now you, too, can calculate your shrinkage accurately!

"But what if I don't know how to find the actual shrinkage amount, and all I have are before-and-after measurements?" Well, it just so happens that I've done some samples, and I've calculated my shrinkage from those samples. Let's have a look at them, shall we?

In fact I did three samples, all in the same yarn, but different EPI! I've done a sample at 8 EPI, another at 10 EPI, and yet another at 12 EPI. This is a perfect example of why sampling is so important—this is a DK weight yarn which I would have expected to work out very well in a 10 dent reed. I did a wraps per inch test and got ~20 wraps per inch, so cutting that number in half, I get ~10. By all accounts the 10 dent sample should be exactly what I wanted, but I actually like the look and feel of the 12 dent sample best! Funny how that works out, huh?

Now there may be reasons you may decide you like the look of the 8, or the 10 dent sample better. Maybe you like the drape, or the looseness of the structure, or whatever the case may be. Sampling gives us those answers in miniature. All in all, I probably used about a hundred yards of both my warp yarn, and my weft yarn to make all three of these samples, at absolute maximum. These come in skeins of 275yds each, so I still have ~175 yards of each that I can use for whatever I want!

Okay, enough praise of sampling. Let's have a good look at the freshly woven dimensions of these samples, in contrast with their washed counterparts.

8 Dent Sample

On the loom, My 8 dent sample was 5.5” wide, and 5.5” long (only counting where the weft is). Once it was washed up, it shrunk down to 5.125” wide, and, predictably, 5.125” long! A nice little square.

$$\frac{\text{On Loom Width Measurment - Washed Width Measurement}}{\text{On Loom Width Measurment}} \text{ x 100 = Shrinkage Rate}$$

So let’s do some shrinkage calculation. What we have to do is, essentially, calculate how much the on-loom dimensions decreased to get to the washed dimensions. The equation for that is a little more complicated, but if we do it in steps, it’s easy peasy!

Step 1: On Loom Width - Washed Width = Difference
Step 2: Difference ÷ On Loom Width = Decimal Number
Step 3: Decimal Number x 100 = Shrinkage Percentage

Got all that? Okay, let’s plug in some numbers, using my On Loom Width (5.5”) and Washed Width (5.125) for the 8 dent sample above!

Step 1: 5.5 (OL Width) - 5.125 (W Width) = 0.375 (Difference)
Step 2: 0.375 (Difference) ÷ 5.5 (OL Width) = 0.06818 (Decimal Number)
Step 3: 0.06818 (Decimal Number) x 100 = 6.818 (Shrinkage Percentage)

And there we have it! My shrinkage rate for this EPI, with this yarn, and washing vigorously in the washing machine is a little under 7%! You’ll use the exact same series of steps to calculate shrinkage for your length. These two numbers may vary in your samples like my other samples do, so make sure you calculate for both! My numbers here just happen to be identical in width and length, both on the loom and washed, so I won’t be bothering this time—I know my length shrinkage is also about 7%.

10 Dent Sample

My 10 dent sample was 4.5” wide, and 5” long on the loom. After washing, it is 4.25” wide, and 4.5” long. Let’s plug the widths into the sequence above!

Step 1: 4.5 (OL Width) - 4.25 (W Width) = 0.25 (Difference)
Step 2: 0.25 (Difference) ÷ 4.5 (OL Width) = 0.0555 (Decimal Number)
Step 3: 0.0555 (Decimal Number) x 100 = 5.555 (Shrinkage Percentage)

So we’re looking at about a 5.5% shrinkage rate in the width for this sample! What if we do it for the length?

Step 1: 5 (OL Length) - 4.5 (W Length) = 0.5 (Difference)
Step 2: 0.5 (Difference) ÷ 5 (OL Length) = 0.1 (Decimal Number)
Step 3: 0.1 (Decimal Number) x 100 = 10 (Shrinkage Percentage)

Look at that! Almost double the rate of shrinkage for the length as we're seeing for the width. Now we can see why it's so important to calculate for both! This could be for a lot of reasons. Maybe my beat wasn't super even, maybe there were tension differences, maybe I just tied my knots at the ends a little funny. All of these variables could contribute to such a huge difference in shrinkage rate for a plain weave project. Remember what I said about fingerprints? But, at least we know what to expect so we can plan!

12 Dent Sample

Last one, and my favorite end result overall! On the loom, this sample was 4" wide, and 3.5" long. After washing, it's now 3.75" wide and 3.25" long. And now we do some math! Width first:

Step 1: 4 (OL Width) - 3.75 (W Width) = 0.25 (Difference)
Step 2: 0.25 (Difference) ÷ 4 (OL Width) = 0.0625 (Decimal Number)
Step 3: 0.0625 (Decimal Number) x 100 = 6.25 (Shrinkage Percentage)

And now Length:

Step 1: 3.5 (OL Length) - 3.25 (W Length) = 0.25 (Difference)
Step 2: 0.25 (Difference) ÷ (OL Length) = 0.0714 (Decimal Number)
Step 3: 0.0714 (Decimal Number) x 100 = 7.14 (Shrinkage Percentage)

We're looking at a width shrinkage of 6.25%, and length shrinkage of about 7%. Cool stuff! Now we can take any of these numbers and apply them to our simple equations at the very start of this packet by dividing by the reciprocal!

Shrinkage Calculation Video: https://youtu.be/Jj7iPm-jpcA

And there you have it! It's far from everything that you'll ever need to weave, but it's definitely enough to get you started. With this handful of simple equations, you can find out how much yarn you'll need to make the basics, and soon enough, you'll be expanding upon what we've learned here together to make all sorts of things that you see in your dreams.

So, what's your next project?

Wrap Up Video: https://youtu.be/WuAwRsRGE_8