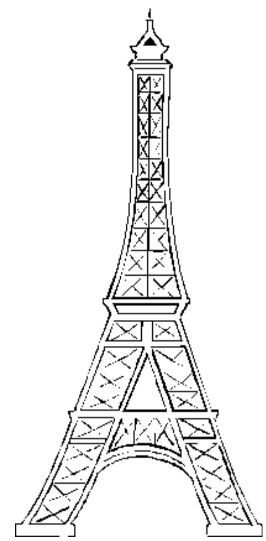
Appendix H, Part 2

CHARTING DETAILED IMAGES



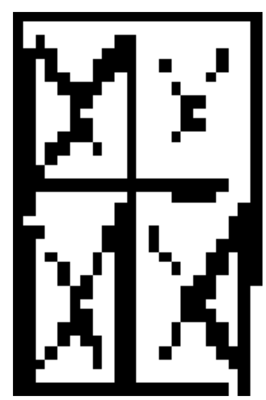
Suppose we see this image of the Eiffel Tower and want to work it up in a sweater. If we want to include all the details of the trusswork's cross-bracing, the image in yarn is going to have to be fairly large, and the stitches and rows are going to have to be fairly small.

How do we chart such a project? In one sense, the easiest way to do so is to first print the image at the exact size we want it to be in our project. We then construct and * print a grid and lay it on the image. If the grid cells aren't small enough to allow us to capture the image's details to our satisfaction, we construct a grid with smaller cells, and repeat from *.

We'll essentially do this exact brute-force technique, but we'll work with small sections of the image and use a bit of arithmetic to figure out how big the image would be in yarn at various stitch and row gauges.

Determine Grid Density

The first thing we need to figure out is how small the grid cells will have to be. If the image has lots of detail, like our Eiffel Tower, we're going to have to play around a bit.

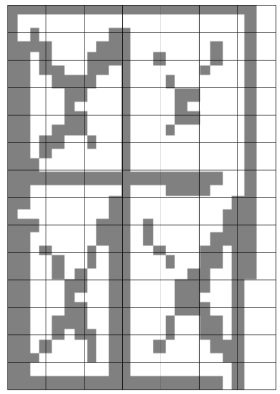


Since it's impractical for us to use an image as large as will fit on the page here in the book, let alone a multi-page fully life-size version, we'll do the equivalent by focusing on a small section that's been enlarged. The top two tiers of the trusswork will serve nicely.

Life-Size Worsted Weight Grid

Let's say our stranded gauges are five stitches and seven rows per inch. Note that we have to measure a swatch worked with stranded, not one-color, knitting because our gauges may not be the same in both techniques.

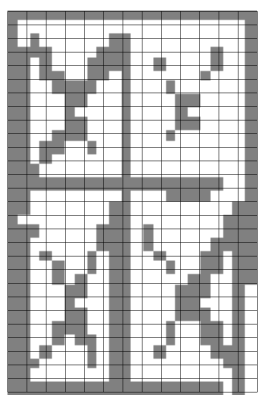
We print a grid with these gauges and stack it on top of our trusswork portion.



We can see immediately that we don't have nearly enough cells to capture the details of the X shapes. Exactly as we did in part one of the appendix with Mr. Smiley, let's compress the grid.

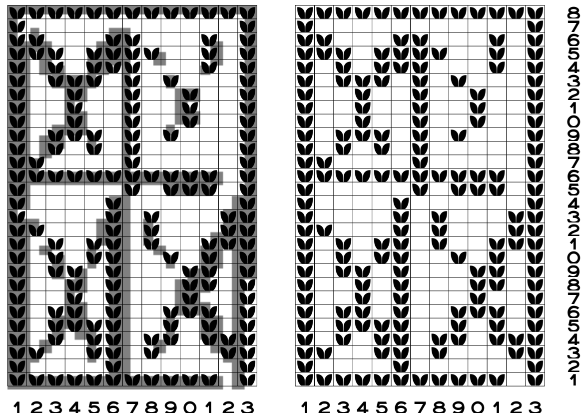
Compressed Worsted Weight Grid

What will we see if we have twice the stitches and rows on top of this little part of the image? Remember that when we double the number of columns and rows in the grid, that's the same as saying that the image will wind up twice as big in yarn as it is on paper.

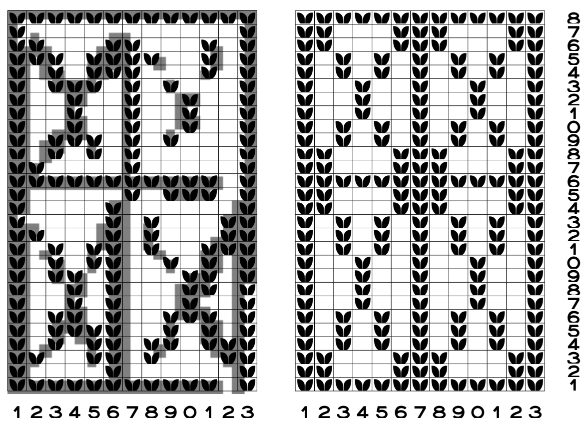


These cells are small enough to work reasonably well. Instead of using a dot like we did with Mr. Smiley, let's use stylized knit stitches from the knitting font. Since they'll fill the grid cells almost completely, we'll get a good idea of what the image will look like in yarn.

Choosing which cells to mark is somewhat subjective, so my general rule was to mark any cell that was at least half-filled with part of the image. In some places, I marked cells less filled than that, just to include some of the extra details.

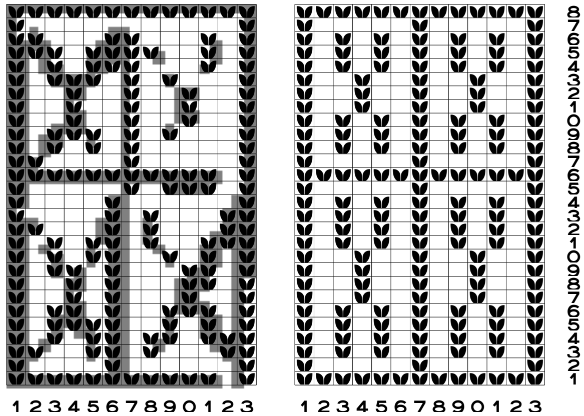


Because the image doesn't have continuous lines for the X shapes, some of us will decide this preliminary, mostly exact chart is too messy. What if we mark the cells based on having straight lines everywhere rather than on following the image slavishly? In other words, we can mark the cells we "know" should be marked, since the Eiffel Tower is made with straight steel beams that all connect to one another.

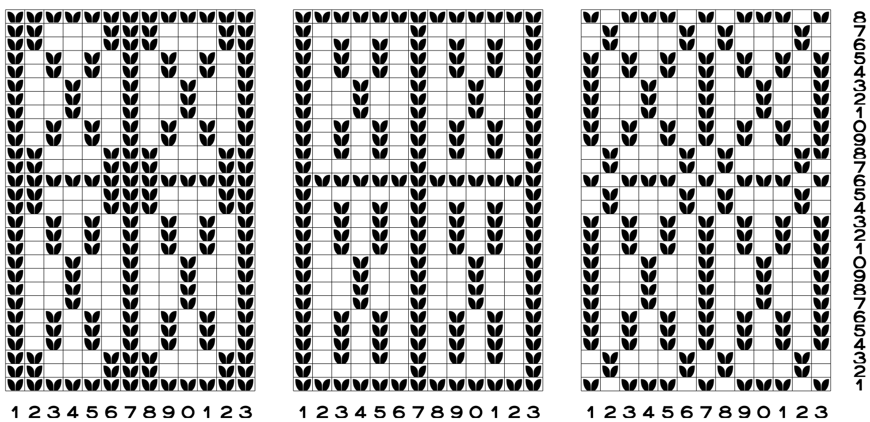


In this version, the X shapes are much clearer, and the trusswork around them is perfectly rectangular and completely filled in.

Some of us might now decide that the corners, where the ends of the Xs' arms meet the rectangular frames, are much too pronounced. Let's see what happens if we tweak the Xs to leave a background stitch all the way around them.



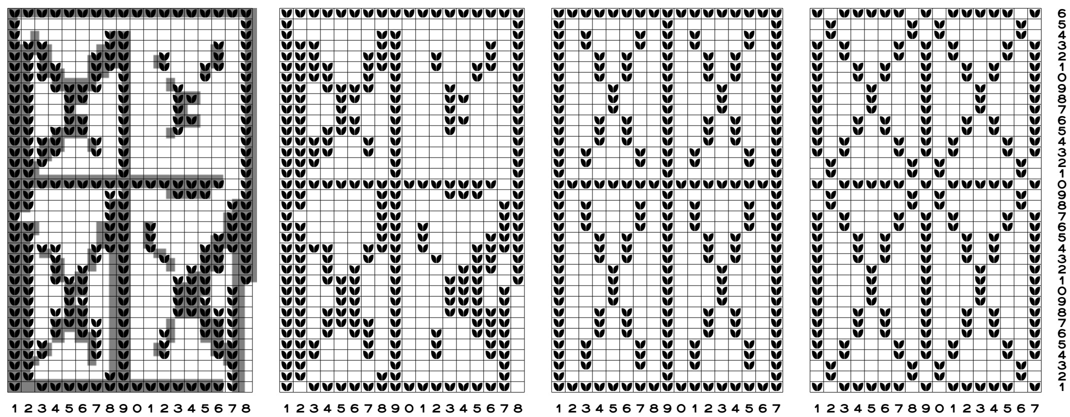
Another way to avoid the heaviness is to keep the Xs intact all the way to the rectangles' corners, but then remove from the rectangles any stitch that's next to a stitch of an X. Let's compare all three versions.



We can continue to play around with the chart, trying more and more options, until we found one that we really like.

Switch to Fingering Weight

Let's now experiment with a thinner yarn. Suppose our stranded fingering swatch has seven stitches and nine rows per inch. These gauges mean that a life-size fingering weight grid will have fewer stitches and rows per inch than our compressed worsted weight grid at ten stitches and fourteen rows per inch, so there's really no point starting there. Instead, we'll immediately compress the fingering weight grid double, to fourteen columns and eighteen rows per inch.



These charts are similar to the previous set: one that closely matches the image, one with the Xs isolated from the surrounding rectangles, and one with the Xs run all the way into the corners but with adjacent stitches removed from the rectangles.

Compressing a grid gives us more stitches to capture an image's details even better, but if we compress the grid too much, the image may wind up taller and/or wider than will fit on our project.

Fortunately, we can use the ratio or proportion of the height of the bit we charted and the height of the entire image to determine how tall our image will be in yarn.

A Word About Proportions

We took a section of trusswork out of the small image at the beginning of this second part of the appendix and made it much bigger. Doing so meant we didn't have to deal with multiple sheets of paper containing the full life-size tower and a corresponding number of sheets of grid paper. What we need to do now is figure out how big the entire tower would be in yarn if we enlarged and charted the full image the same way we just enlarged and charted the small piece of trusswork.

We need to measure two heights from the complete image: that of the full tower and that of the trusswork we used under our trial grids. The more accurately we make these measurements, the more accurate our calculated ratio or proportion will be. Instead of using the original small image of the Eiffel Tower, we'll use the much larger version on the next spread. For the moment we only need to measure the "tower height" and "trusswork height." We'll use the "top height" a bit later.

Measure the Heights

For details on measuring down to sixty-fourths of an inch on a ruler marked with sixteenths, see the section "Measuring Accurately" at the end of this part.

When we use that information, we find that the full tower is 7.6875 inches tall, and the trusswork section is 0.5625 inches tall.

The Tower-to-Truss Proportion

As we can tell by simply looking at the image, the full tower will be some number of times taller than the smaller trusswork section is. To get the exact ratio or proportion, we simply divide the first number by the second.

tower-to-truss proportion = full tower height ÷ trusswork height

When we fill in our careful measurements

tower-to-truss proportion = 7.6875 in ÷ 0.5625 in = 13.67

However tall we determine the trusswork section will be in yarn, the full tower will be 13.67 times taller.

Determine the Image Size in Yarn

We drew various sample grids over an enlarged bit of the image, and we've figured out how many times taller the entire Eiffel Tower is than the bit we put under the grids. Let's now figure out how big the full tower will be in yarn in both worsted and fingering weight.

The Height

Since we wound up using compressed grids in both yarn weights, we need to take into account those compression factors as we determine how tall the Eiffel Tower will be in yarn.

In Worsted Weight

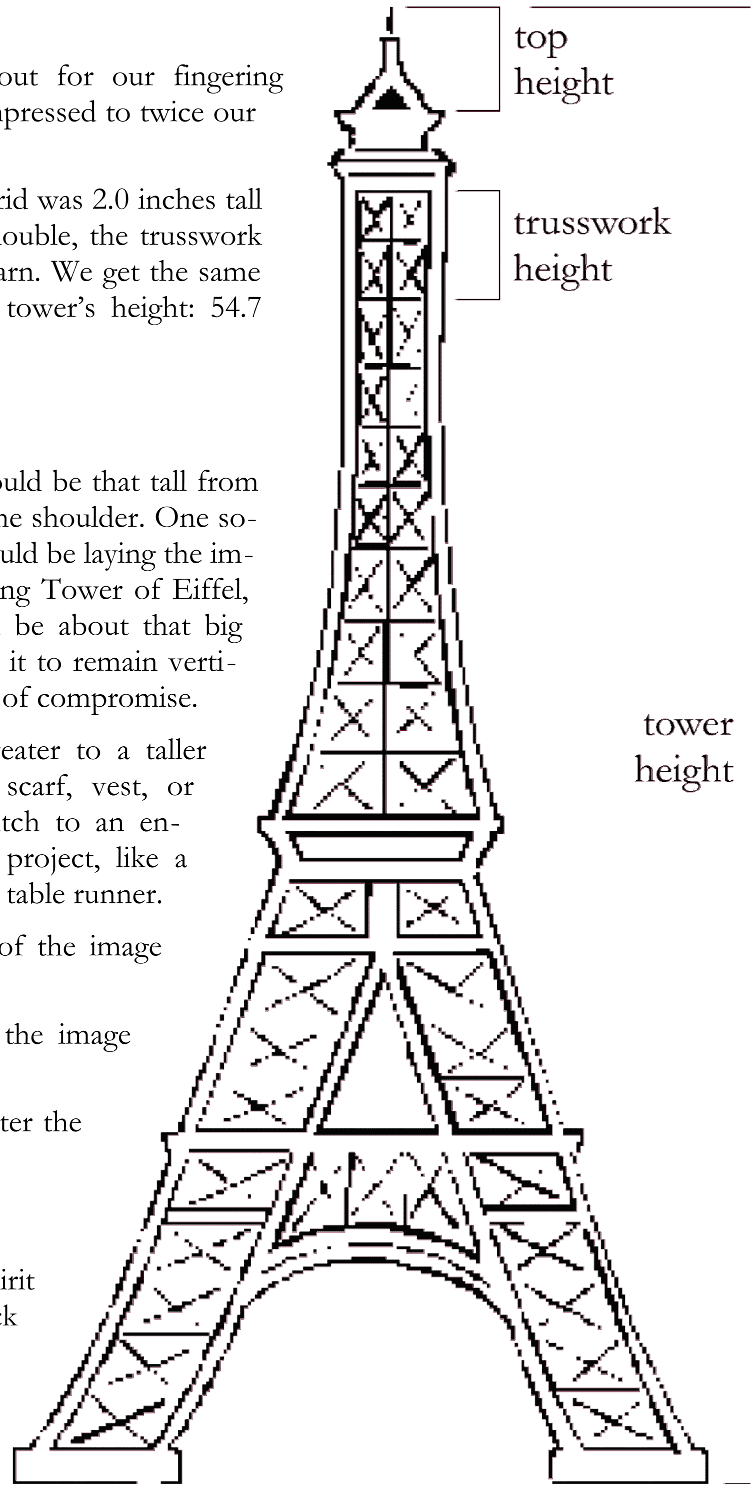
In our compressed worsted weight grid, we had twice as many grid columns and rows per inch as we have in our yarn stitch and row gauges. That means the height of the trusswork section in yarn will be twice as tall as we see it here under the grid on paper.

When we measure the charted trusswork's height, we see it's 2.0 inches tall, but because the grid is compressed double, which is twice life-size, in yarn the trusswork will actually be 4.0 inches tall. That means the entire Eiffel Tower will be our ratio of 13.67 times that height, which comes out to 54.7 inches.

In Fingering Weight

How do the numbers work out for our fingering weight grid, which was also compressed to twice our gauges in yarn?

Since the image under the grid was 2.0 inches tall and our grid was compressed double, the trusswork will again be 4.0 inches tall in yarn. We get the same value as before for the entire tower's height: 54.7 inches.



Now What?

Not even an XXXL sweater would be that tall from the bottom edge to the top of the shoulder. One solution for this particular case would be laying the image on its side as the, er, Leaning Tower of Eiffel, since an XXXL sweater would be about that big around at the chest. If we want it to remain vertical, we need to make some kind of compromise.

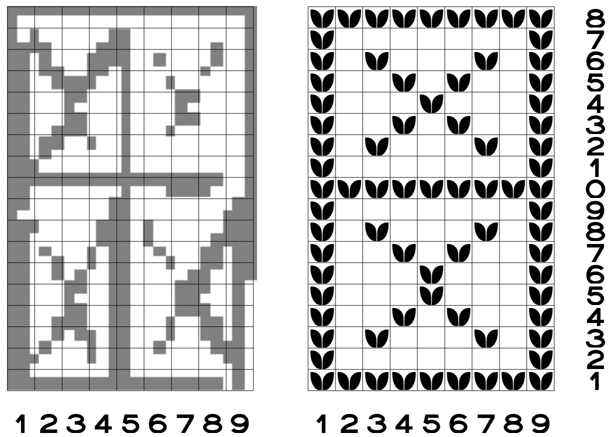
- We can change the sweater to a taller garment, like a dress, scarf, vest, or poncho, or we can switch to an entirely different kind of project, like a blanket, wall hanging, or table runner.
- We can simplify some of the image details.
- We can omit some of the image details.

Let's look at the options that alter the image itself.

Simplify the Details

In this option, we keep the spirit of the image while paring back some of its complexity.

Here's the trusswork in a life-size fingering weight grid at seven stitches and nine rows per inch, but we charted only one X instead of two in each of the two tiers.



Since this grid is life-size, the trusswork's height in yarn will the same as it is here on paper, which is 2.0 inches. We multiply that height by the tower-to-truss ratio of 13.67, so in our project, this simplified Eiffel Tower will be 27.3 inches tall.

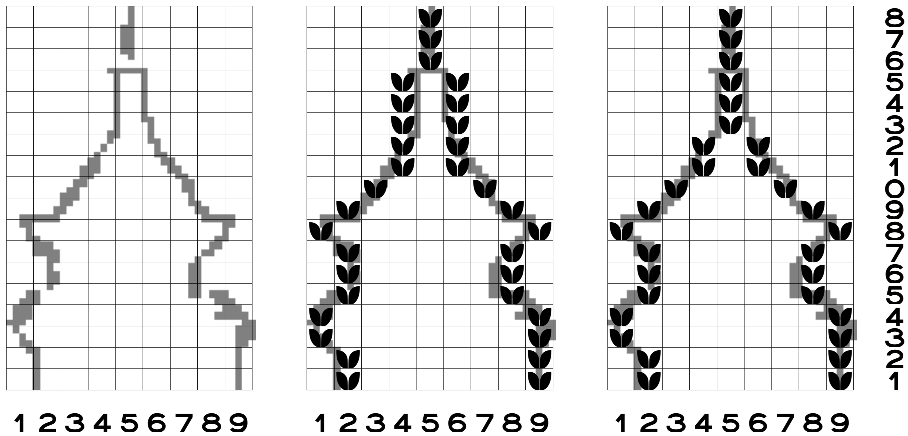
If we can simplify the rest of the image to our satisfaction, then this version would fit on most adult-size sweaters, though the sweater might be a bit long for a shorter person.

Omit Some Details

What would happen if we use just the outline of the Eiffel Tower? Because of the iconic shape, even such a greatly simplified version would still be recognizable.

Here's our life-size fingering weight grid at seven stitches and nine rows per inch placed on top of just the outline of the top part of the tower.[1] Since part of the top wraps exactly around stitch five, we could do either of the two variations on stitches four through six on rows thirteen through fifteen.

[1] The right edge's stitch symbols in rows one and two do not mirror-image those on the left side, because the Eiffel Tower image we're using is only a stylized drawing. It **looks** mirror-image, but if we fold the large version in half vertically and match up the bases of the legs, we can see just how "stylized" the tower is!



When we use the decimal values in the section "Measuring Accurately," we see that the bit from the very top to that easy-to-measure horizontal bump-out on row nine is a bit less than 1.09375 inches tall, so we'll decrease it to 1.08 inches. Because our grid is life-size, then in yarn this bit of the image will be that same height.

How tall will this simpler version of the entire Eiffel Tower be in yarn? We first need to get a new proportion or ratio, one that divides the tower height by the "top height" that we ignored earlier.

On that image, and using "Measuring Accurately," the top height is 0.546875 inches, which we'll round to 0.55 inches. When we calculate the new ratio, we have

tower-to-top proportion = full tower height ÷ top height
tower-to-top proportion = 7.6875 in ÷ 0.55 in = 13.98

We now multiply the yarn height of the charted bit of the top, 1.08 inches, by this tower-to-top ratio of 13.98, which tells us that the outline version of the Eiffel Tower will be 15.1 inches tall in yarn.

Because this height is so much smaller than we got for both the tower with the full details and for the simplified version, we could actually compress somewhat the life-size fingering weight grid and still have the resulting tower, which would then be correspondingly larger in yarn, fit on a sweater even for a shorter adult.

The Width

We've been so busy trying to fit the height of the image onto our sweater that we've completely ignored how wide it will be. It may turn out that the true limiting factor of the gauge we'll need to use is actually the image's width in yarn. Let's see how we determine that width, which requires a new proportion.

On the large image, the tower is 7.6875 inches tall. When we measure the legs, we find they're 3.625 inches wide, so this new ratio is

height-to-width proportion = tower height ÷ tower width
height-to-width proportion = 7.6875 inches ÷ 3.625 inches = 2.12

However wide our tower is in yarn, it will be 2.12 times taller.

Since we already know the yarn heights, though, it may be easier to think of this ratio the other way.

width-to-height proportion = tower width ÷ tower height
width-to-height proportion = 3.625 inches ÷ 7.6875 inches = 0.47

However tall the tower is, then its width will be 0.47 times that, or slightly less than half its height.

Widths in Yarn

Now that we know the proportions between the tower's height and width, or width and height, we can see how big our various proposed towers will be in yarn.

- In our compressed worsted weight chart, we determined our Eiffel Tower would have the enormous height of 54.7 inches. We multiply that value by 0.47 (or divide it by 2.12), so the tower will be a correspondingly enormous 25.7 inches wide. Unless we want the world's widest scarf, we'd have to say it's a shawl. But doing so means the tower would be horizontal instead of vertical when we're wearing it, so a shawl may not be such a great option after all. Maybe we'd like a wall hanging?
- In the version with the simplified details, with the top tiers of trusswork having only one X instead of two, we saw that in fingering weight, because we used a life-size grid, the tower would be 27.3 inches tall. Dividing that value by 2.12 (or multiplying it by 0.47) means the legs of the Eiffel Tower will be 12.9 inches wide. That width will fit nicely on even a small sweater, and it would also fit on a wide scarf.
- In the outline version, the height in yarn would be a mere 15.1 inches based on a life-size fingering weight grid. We multiply by 0.47 (or divide by 2.12) that height and find that the legs will be 7.1 inches wide. We could stack several Eiffel Towers on a scarf, or we could include other design elements on an adult-size sweater. In a sweater for a child, the entire tower would fit on many of the larger sizes.

Force the Image Size in Yarn

So far in this second part of the appendix, we've been at the mercy of our grids. We tried two different yarn weights, which naturally needed two different grids, then we tried compressing the grids. For ease of explanation, we compressed both yarns' grids double, but "double" won't always give us what we need in our project. It's like we're starting from a random spot and hoping to get to the desired destination. What we really ought to be able to do is decide where we want to end, then backtrack to the proper starting point.

In knitting terms, can we start with how big we want the image to be in yarn, then force the grid to match? We can.

What's My Name?

Because we have lots of widths and heights and other values, let's be very precise in what we call each thing so that we avoid confusion and mistakes.

The Things We Measure

We've selected our image and made some swatches.

- We measure the dimensions of the image we want to chart, which we'll call the **image height** and **image width**.
- We measure our stitch gauge in yarn. It can be more convenient to count whole stitches in a fractional number of inches than to count fractions of a stitch in a whole number of inches. We can also measure over a wider swatch, counting across more than the typical four inches' worth of stitches. If our stitch gauge is most easily expressed as "29 stitches per 4 inches," then **swatch stitches** is the "29 stitches" part and **swatch width** is the "4 inches" part.
- We measure our row gauge in yarn. As with our stitch gauge, we can count whole rows in a fractional number of inches or fractional rows in some number of full inches, and we can also work more than four inches' worth of rows. Supposing we would most naturally say our row gauge is "28 rows per 3 inches," then **swatch rows** is the "28 rows" part and **swatch height** is the "3 inches" part.

Measuring Our Swatch

Note very carefully that swatch stitches is ***not*** the total number of stitches across our swatch, swatch width is ***not*** the total width of our swatch, swatch rows is ***not*** the total number of rows in our swatch, and swatch height is ***not*** the total height of our swatch.

Exactly as with measuring the height and width of the image, measuring our gauges accurately will help us get in yarn the outcome we desire. If we make a larger swatch and stay away from the edges as we measure, we'll get more accurate gauges.

The Dimension We Choose

Now we define how big the image will be in our project, picking either its height or width.

Sometimes it will be more convenient to pick the desired height, and sometimes it will be more convenient to pick the desired width. It depends on whether the image is tall or wide and whether the project is tall or wide.

We'll use **yarn height** and **yarn width** for the image's dimensions in the project. Whichever of height or width we select to fit the image in the project, we can determine the other value very easily.

The Numbers We Calculate

In addition to the image's "other" dimension in the project, we need to determine four more values.

- We need to figure out how many stitches the image will require in our project, which we'll call **yarn stitches**.
- We need to figure out how many **yarn rows** the image will need in our project.
- We need to figure out how wide the columns will be in the grid we put on top of our image. We'll call that number the **cell width**.
- We need to figure out how tall the cells in the grid will be, which we'll call the **cell height**.

Note that the number of cells we need across the width of the grid is the same as the number of stitches the image will need across the width of the project. In the same way, the number of grid rows will be the same as the number of yarn rows.

Once we know all these numbers, we'll be able to create the grid and chart our image.

Example 1: Pick the Yarn Height

We'll continue to use our Eiffel Tower, but let's make the gauges more interesting, then we'll work through all the easy arithmetic.

- Our image is 7.6875 inches tall and 3.625 inches wide.
- Our stranded stitch gauge is 29 stitches in 4 inches.
- Our stranded row gauge is 28 rows in 3 inches.

We need to choose how tall our image will be in yarn in our finished object. Let's select a yarn height of 26.5 inches.

Yarn Width

Since we chose the height our image will be in our project, we need to figure out how wide the image will be in our project. Our simple equation uses the same principle of the proportion or ratio we saw before.

yarn width = yarn height × image width ÷ image height
yarn width = 26.5 inches × 3.625 inches ÷ 7.6875 inches
yarn width = 12.50 inches

Yarn Rows

We use the row gauge numbers to see how many rows we'll need in yarn for our image. Remember that *swatch rows* and *swatch height* refer to our swatch's row count and height as we would normally express our row gauge: "28 rows in 3 inches."

yarn rows = yarn height × swatch rows ÷ swatch height
yarn rows = 26.5 inches × 28 rows ÷ 3 inches
yarn rows = 247.33 rows

If we get some fraction of a row, we must round either up or down. We usually round down when it's less than half a row, as it is here, and up when it's half a row (0.5) or more, but we always have the option to round in the other direction if doing so would work better for our image and/or our project.

One such situation would be when the image is mirror-image top and bottom, and we want only one row dividing those two halves. Other images will work better with two such rows, and for some images, it wouldn't matter which way we round. The most important thing is to make sure the number of rows works well for our image, regardless of any general "rule."

Here we'll round to 247 rows.

Yarn Stitches

This time we use stitch gauge information from our swatch. Remember that *swatch stitches* and *swatch width* refer to our swatch's stitch count and width as we would normally express our stitch gauge: "29 stitches in 4 inches."

yarn stitches = yarn width × swatch stitches ÷ swatch width
yarn stitches = 12.50 inches × 29 stitches ÷ 4 inches
yarn stitches = 90.63 stitches

As with the number of yarn rows, we must round fractions of a stitch either up or down.

In this instance, we would normally round up because we have more than half a stitch (we'd round down if the fraction were less than 0.5), but we always have the option to round the other direction if doing so would work better.

One such situation would be when the image is mirror-image left and right. Some images need exactly one dead-center stitch dividing those two halves, so we would round to the nearest odd number instead of rigidly following the rounding "rule." Other images will work better with two such central stitches, so we'd need to round to the nearest even number. For some images, it wouldn't matter which way we round. The most important thing is to make sure the number of stitches works well for our image.

Here we'll simply round in the usual way to 91 stitches.

Cell Height

Now that we know the number of rows we'll work in yarn, we can easily determine how tall each row of our grid needs to be, because we need the same number of grid rows and yarn rows.

cell height = image height ÷ yarn rows
cell height = 7.6875 inches ÷ 247
cell height = 0.031 inches

Cell Width

Since we know how wide in stitches the image will be in our project, we can easily determine how wide each column in our grid must be.

cell width = image width ÷ yarn stitches
cell width = 3.625 inches ÷ 91
cell width = 0.040 inches

Example 2: Pick the Yarn Width

Let's use the same values for our image dimensions and yarn gauges, but this time we'll limit the image size in yarn by specifying the width we want. Our image is still 7.6875 inches tall and 3.625 inches wide, our stitch gauge is still 29 stitches in 4 inches, and our row gauge is still 28 rows in 3 inches. Let's select a yarn width of 9.25 inches.

Yarn Height

Since we chose the width our image will be in our project, we need to figure out how tall the image will be in yarn. Our simple equation uses the same principle of the proportion or ratio we saw before.

yarn height = yarn width × image height ÷ image width
yarn height = 9.25 inches × 7.6875 inches ÷ 3.625 inches
yarn height = 19.62 inches

Yarn Rows

We use the row gauge numbers along with the yarn height we just calculated to see how many rows we'll need in yarn for our image.

yarn rows = yarn height × swatch rows ÷ swatch height
yarn rows = 19.62 inches × 28 rows ÷ 3 inches
yarn rows = 183.12 rows

We'll round the number of rows to 183.

Yarn Stitches

We use stitch gauge information from our swatch.

yarn stitches = yarn width × swatch stitches ÷ swatch width
yarn stitches = 9.25 inches × 29 stitches ÷ 4 inches
yarn stitches = 67.06 stitches

We would round this value as works best for the image and the project, and here we'll simply round in the usual way and say we'll have 67 stitches across our image.

Cell Height

Once we know the number of rows we'll work in yarn, we can easily determine how tall each row of our grid needs to be.

cell height = image height ÷ yarn rows
cell height = 7.6875 inches ÷ 183
cell height = 0.042 inches

Cell Width

Since we know how wide in stitches the image will be in our project, we can easily determine how wide each column in our grid must be.

cell width = image width ÷ yarn stitches
cell width = 3.625 inches ÷ 67
cell width = 0.054 inches

If the "Other" Dimension Is Too Big

There is a chance that our image won't fit in our project based on the dimension, whether width or height, whose value we had to calculate.

- If we selected a height because the image is fairly narrow, we may find that when we determine the yarn width, it will be wider than will fit in our project. In that case, we pick a narrower width and work through the arithmetic again, now calculating the yarn height.
- If we selected a width because the image is fairly wide, we may find when we calculate the yarn height that the image will be taller than will fit in our project. Now that we know that the yarn height, not the yarn width, is the limiting factor, we select a height small enough to fit in our project and re-calculate all the values, including the yarn width.

Make the Grid at the Website

We use the grid cell height and width we just calculated to generate the grid. Since the website is based on metric values, it technically wants our stitch and row gauges per ten centimeters, which is a tiny bit less than four full inches. Usually the difference is not worth fussing over, but if we want to get the most accurate grids possible, then for those of us who measure in inches, we have to convert our gauges to their equivalent over ten centimeters using some very simple arithmetic.

Ten centimeters divided by 2.54 centimeters per inch is 3.937 inches, so we ought to enter our stitch and row gauges per 3.937 inches. However, we don't need to be distressed by this very strange value, nor do we have to try to somehow count the number of stitches and rows in 3.937 inches. We can count and measure fractions of stitches, rows, and inches the exact way we've always done, then use arithmetic to determine the values we need to use at the website.

Sts Box

We measure our stitch gauge in inches however we like, then find the most exact value to put in the website's Sts box with

Sts = 3.937 inches × swatch stitches ÷ swatch width

Since we got 29 stitches in 4 inches, then the value we use for Sts is

Sts = 3.937 inches × 29 stitches ÷ 4 inches = 28.54

That's our number of stitches per ten centimeters, exactly as the website wants the value, and the website allows us to use decimal fractions like this one.

Rows Box

Whatever number of rows we measured over whatever height in inches, we do essentially the same simple arithmetic to determine the number we put in the website's Rows box.

Rows = 3.937 inches × swatch rows ÷ swatch height

Since our row gauge was 28 rows in 3 inches, then

Rows = 3.937 inches × 28 rows ÷ 3 inches = 36.75

That value is technically our row gauge per ten centimeters, but we don't need to measure our swatch in centimeters.

Match the Grid Size to the Image Size

If the image we'll put under our grid is life-size, then we use the Sts and Rows values we just calculated, and we set the Reduction pull-down to "1/1."

If our image is smaller than life-size, though, we need to compress the grid. We'll probably be unable to use any of the website's values in the Reduction pull-down, so we'll leave it set to "1/1" and instead alter the values we use for Sts and Rows.

Determine the Scaling Factor

We determine the scaling factor for Sts and Rows with another simple bit of arithmetic. We need to see how much smaller the image is that we'll put under the grid compared to the size it will be in yarn, and we already know the two values we need.

If we selected the height we want the image to be in yarn, then the scaling factor is

scaling factor = yarn height ÷ image height

If we selected the width we want the image to be in yarn, then we find the scaling factor with

scaling factor = yarn width ÷ image width

Example 1: 26.5 Inches Tall in Yarn

Our image is 7.6875 inches tall on paper, but we want it to be 26.5 inches tall in yarn. We determine the scaling factor as

scaling factor = yarn height ÷ image height
scaling factor = 26.5 inches ÷ 7.6875 inches
scaling factor = 3.45

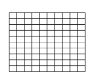
What does this value mean? There are at least two ways to understand the scaling factor.

- It means the image in yarn will be 3.45 times taller than it is on the sheet of paper we put underneath the grid.
- It means that we need 3.45 times as many grid cells both horizontally and vertically in each inch of the scaled grid compared to the number of cells we'd have in a life-size grid. Compressing the grid this way means that we don't need to have the image at life-size to chart it properly.

For our stitch gauge of 29 stitches in 4 inches, we determined that the Sts value is 28.54. We multiply that value by our scaling factor of 3.45, so we put "98.46" in the Sts box to get that number of columns per 3.937 inches of grid.

For our row gauge of 28 rows in 3 inches, we determined the Rows value was 36.75, and we multiply that number by the scaling factor of 3.45, which means we put "126.79" in the Rows box.

Let's look at a bit of grid at those gauges. (table width = 28.79 pt, row height = 2.24 pt)



Those are mighty small grid cells.

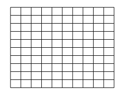
Example 2: 9.25 Inches Wide in Yarn

Our image is 3.625 inches wide on paper, but we want it to be 9.25 inches wide in yarn. We determine the scaling factor as

scaling factor = yarn width ÷ image width
scaling factor = 9.25 inches ÷ 3.625 inches
scaling factor = 2.55

For our stitch gauge of 29 stitches in 4 inches, we determined that the Sts value is 28.54. We multiply that value by our scaling factor of 2.55, so we put "72.78" in the Sts box to get that number of columns per 3.937 inches of grid.

For our row gauge of 28 rows in 3 inches, we determined the Rows value was 36.75, and when we multiply that number by the scaling factor 2.55, we must put the value “93.71” in the Rows box. (table width = 38.95 pt, row height = 3.02 pt)



These grid cells are a bit bigger than the first example, but they’re still pretty small.

Working from the Example Grids

For an eye-opening exercise, we can create full-sheet grids using those two sets of Sts and Rows numbers. While the ten-by-ten grids we see here seem reasonable, full-page grids at those cell sizes look fairly intimidating.

Because many of us would find it difficult to work from either of these marked grids, we can mark the initial grid, then create a grid with larger cells and transfer our marks to it cell by cell. If the image is detailed, copying the marks to the second grid will be fairly laborious.

Remember, the only time we must use a proportional grid is when we’re **charting** the design. Once we know which stitches make up the design, we can re-chart the marks into any grid at all, even one with square cells. That’s because the cells we marked originally were marked based on the proportions of the stitches’ height and width. For the grid we **work from**, we can change the marked cells’ shape any way we want and still get a proper result in yarn.

Image Size Affects Grid Cell Size

What happens if we start with a bigger image? Our sample image was only 7.6875 inches tall, and we saw how short the grid cells had to be.

If we enlarge the image with a photocopier, then our grid cells can also be bigger. Let’s see how much bigger we can make the grid cells while still keeping the image on a single sheet of grid paper.

Let’s walk through the numbers from our first example, where we want the Eiffel Tower to be 26.5 inches tall in our project.

A Ten-Inch Image

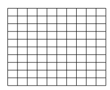
If we take our image to the copy shop or library and enlarge it to ten inches, which allows half-inch top and bottom page margins, how large will the grid cells be?

When we enlarge the height from 7.6875 inches to 10 inches, that’s an increase of 10 divided by 7.6875, which is 1.30 or 130 percent. The image width will increase by the same percentage, so it will go from 3.625 inches to 4.71 inches. The enlarged image, at 10 by 4.71, will therefore fit on one sheet of letter paper.

We still need the same number of yarn rows and grid rows as before, but because the image now has larger dimensions, the cells will also be larger.

cell width = image width ÷ yarn stitches
cell width = 4.71 inches ÷ 91
cell width = 0.052 inches

cell height = image height ÷ yarn rows
cell height = 10 inches ÷ 247
cell height = 0.040 inches



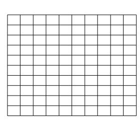
These cells are taller, but they still might not be big enough for many of us to work from the grid after we've marked it. (table width = 37.27 pt, row height = 2.91 pt)

A Thirteen-Inch Image

If we enlarge our 7.6875-inch-tall image to a sheet of legal paper, we can make it 13 inches tall if we keep half-inch top and bottom margins. The image's height grows by 13 inches divided by 7.6875 inches, which is 1.69 or 169 percent. The image's width will grow by the same amount, so it will be 6.13 inches wide, which is narrow enough to fit on one sheet of legal paper.

cell width = image width ÷ yarn stitches
cell width = 6.13 inches ÷ 91
cell width = 0.067 inches

cell height = image height ÷ yarn rows
cell height = 13 inches ÷ 247
cell height = 0.053 inches



These cells are a bit larger, but many of us would have trouble working from this grid after we marked it. (table width = 48.50 pt, row height = 3.79 pt)

Use the Largest Image Possible

Clearly, the bigger the image we put under the grid, the bigger the cells can be and the easier it will be for us to both mark the cells and work from the marked grid.

For our example image, we could enlarge the image by more than double and still have it fit on a single sheet of legal paper.

But what if our image is not so tall and narrow? Let's imagine a new image, still 7.6875 inches tall but 5.8125 inches wide. If we enlarge this image by the same percentages as before, to about the largest heights possible on sheets of both letter and legal paper, then the image will be 7.56 inches wide when it's ten inches tall and 9.82 inches wide when it's thirteen inches tall.

When we enlarge this wider image's height to ten inches, it still fits—barely—on a single sheet of letter paper, but when we make it thirteen inches tall, its width is almost two inches wider than will fit on one sheet of legal paper.

Turn the Grid Paper to Landscape

What if we turn the legal paper to landscape orientation? Since the image is only 9.48 inches wide, its width will now fit because the landscape grid area will be thirteen inches wide. But in landscape, a sheet of legal paper will, assuming half-inch margins, have a grid area only 7.5 inches tall. Since the image is thirteen inches tall, we'll still need two sheets of paper, with about half of the enlarged image on each sheet.

If we want to use a steel board with skinny magnets to mark our place on the chart as we work, we'll have trouble positioning the magnets on part of each row because the metal boards are usually the size of letter paper. That will leave three inches of the chart flopping around. For that part of the chart, we could use a Post-it note or movable transparent tape to indicate the current row.

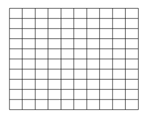
But for this image at this enlargement, we have another option. Note that instead of turning a piece of legal paper landscape, we could actually turn a piece of letter paper landscape, since it would have ten inches of grid width if we use half-inch margins. As with the legal paper, we'd need two sheets, since the grid height is again only 7.5 inches and the image is thirteen inches tall.

For either size of grid paper, though, we need only one sheet of the chart at a time, since the full width of a row would fit on that one sheet.

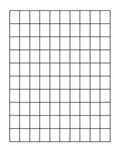
One Critical Detail If We Go Landscape

We can't simply "turn the paper to landscape," though, whether we're using letter or legal paper. If we do, then our cells will also be "turned to landscape." Our row height will become our column width, and our column width will likewise become our row height.

Let's look again at the bit of grid we had when we enlarged our image to thirteen inches. (table width = 48.50 pt, row height = 3.79 pt)



If we turn the page, our grid looks very different. And clearly, we can't stack this grid on top of our image and get the desired result. (table width = 37.90 pt, row height = 4.85 pt)



If we want to turn the sheet to landscape, which makes the grid area wider than it is tall, then we must swap the values of the Sts and Rows boxes. If we don't swap the values but still turn the sheet sideways, the cells will be narrower than they are tall, which will always give us an incorrect result. If our stitch and row gauges are identical, then of course we can use the grid sheet in either orientation without any problem.

Lesson Learned

To make the website print the grid properly on a sheet of paper in landscape orientation, we have to swap the values of the Sts and Rows boxes. Whatever Sts value we determine we need, we put it in the Rows box, and whatever value we determine for Rows, we put it in the Sts box.

Limit Cell Size and Minimize Chart Size

We've seen enough numbers and sample grids to recognize that we need to make our image large enough that our chart will have cells easy to mark and work from, but we've also seen that in some cases, the chart will need more than one sheet of grid paper.

Can we find an image size that hits our personal sweet spot? We need a grid whose cells are at least our minimum height, but we also want to minimize the number of sheets of grid paper we need to chart our image.

Those two requirements mean that once we choose our minimum cell size, we need to see how many sheets of grid paper the chart would then need. We also have to enlarge accordingly the image we slide under the grid. If the chart size is close to fitting on a single sheet, or at least the width of one landscape sheet, we might be inclined to shrink the cells slightly below our usual limit for the trade-off that we only need one sheet of grid paper at a time.

As we saw in part four's "More Charting Tips," since we work in rows, our goal will almost always be to need only one sheet of paper per row, rather than having to change to a different sheet of grid paper partway across each row. If we can fit a full row on one sheet of paper, then once we complete all the rows on that sheet, we simply switch to the next sheet of grid for the next umpteen rows of the chart. Yes, our chart no longer fits on a single sheet of grid paper, but the most important part of it does: the width of one row.

So really, we want it all:

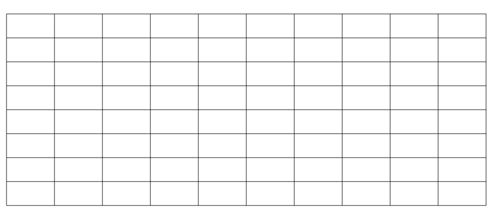
- cells big enough to work from easily
- the fewest number of sheets of grid paper

Let's see if we can achieve both these goals at the same time.

Decide on Our Minimum Cell Height

Each of us will of course have different limits on how small our chart's grid cells can be. We'll focus on limiting their height, because we nearly always have more rows than stitches per inch.

After some experimenting, we decide that regardless of our gauge in **yarn**, we want at most eight rows per inch in our **working chart**. That means each chart row will be an eighth of an inch tall. Here's a sample bit of grid with an arbitrary column width.



The grid columns' width is arbitrary at this point because we haven't yet specified our **yarn** stitch and row gauges. We're just seeing how tall our **chart** rows will be. Once we know the ratio of our yarn gauges, we can adjust the grid columns to be the proportional width they must be to match our minimum grid cell height.

We must also remember that our grid's cells will be the exact size of our stitches only if we draw our grid at life-size. If the grid is compressed smaller than life-size, then we must make the proportions between the cells' height and width match the proportions of our two gauges in yarn while also taking into account the amount of compression we need to use.

Determine Cell Width

We've set the minimum chart row height we'll allow at 8 rows per inch. How many columns we'll have per inch depends on the ratio of our yarn gauges.

Yarn Gauge Ratios

If we measure both our gauges per one inch, then our ratio is very simple.

stitch height-to-width ratio = stitches per inch ÷ rows per inch

But if we measure stitches and/or rows over more than exactly one inch, which is by far the better thing to do, then we have to use the number of inches as well. To keep the calculation from wrapping to a second line, we've omitted *swatch* from all the names after the equals sign.

stitch height-to-width ratio = stitches × height ÷ width ÷ rows

Let's keep using our gauges of 29 stitches per 4 inches and 28 rows per 3 inches, giving us a ratio or proportion of

stitch height-to-width ratio = 29 × 3 ÷ 4 ÷ 28 = 0.78 or 78 percent

However wide our stitches are, our row height will be only 78 percent of that measurement. This ratio also applies to the size of the grid columns and rows we need in our chart. Since our chart will have only 78 percent as many columns per inch as rows per inch, then at this combination of stitch and row gauges, the chart have 78 percent of 8 rows per inch, which is 6.24 columns per inch.

We could also determine the ratio the other way. If we reverse the order of the gauges, then if we have measured both gauges over one inch, our calculation is simply

stitch width-to-height ratio = rows per inch ÷ stitches per inch

But if either or both of our gauges are measured over multiple inches, then we have to use those numbers of inches in our arithmetic. As before, *swatch* has been left out of the names after the equals sign.

stitch width-to-height ratio = rows × width ÷ height ÷ stitches

When we put in our numbers from our gauges

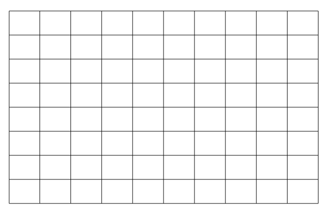
stitch width-to-height ratio = 28 × 4 ÷ 3 ÷ 29 = 1.29 or 129 percent

our grid columns will be 1.29 times wider than they are tall. This ratio or proportion also means that, at this combination of gauges, we'll have 1.29 times the number of grid rows per inch as grid columns per inch.

The Cell Width

Since we're limiting the chart to showing at most 8 rows per inch, each grid row will be exactly 0.125 inches tall. Our grid cells will be 1.29 times wider than our cell height, making them 0.161 inches wide.

We can double-check that width by seeing the ratio between the cell height of 0.125 inches and the width of 0.161 inches, which should match the 78 percent height-to-width ratio we just calculated. Since 0.125 divided by 0.161 is 0.78, which is equal to 78 percent, we know we have the correct cell dimensions.



Determine the Chart's Size

The next step is to see how big our image and the chart would need to be at our minimum grid row height of 0.125 inches. Using the numbers from example one, where we picked the yarn height as 26.5 inches, we need 91 stitches and 247 rows to chart our image at 29 stitches per 4 inches and 28 rows per 3 inches.

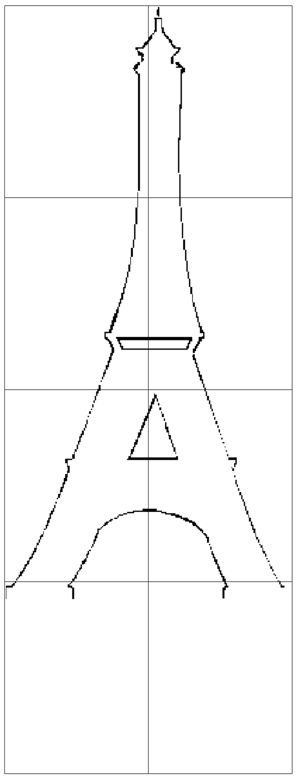
- Since each chart row must be 0.125 inches tall, we need a grid whose height is 0.125 inches per row times 247 rows, which is 30.88 inches.
- Since each chart column is 0.161 inches wide, we need a grid whose width is 0.161 inches per column times 91 columns, which is 14.65 inches.

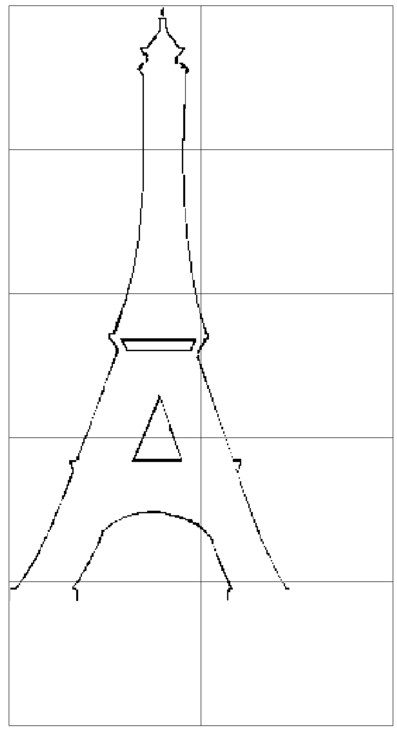
The image we slide under the grid must have the same dimensions as the grid.

Let's see what our chart will look like if we lay out a grid in the four combination of paper size and page orientation we used before. We'll continue to use half-inch margins on all four edges of the sheet.

Letter Paper

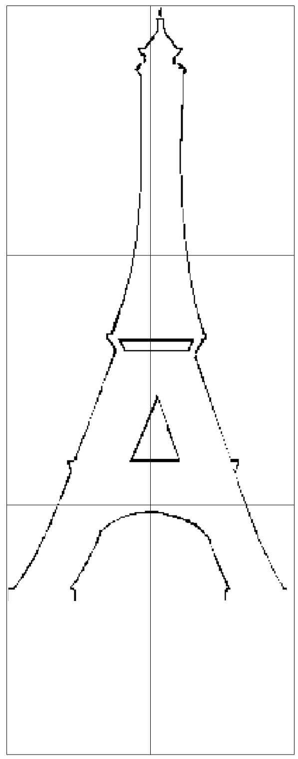
The grid area is 10 by 7.5 inches, represented by the rectangles when we set the grid sheets in portrait (left) or landscape (right).

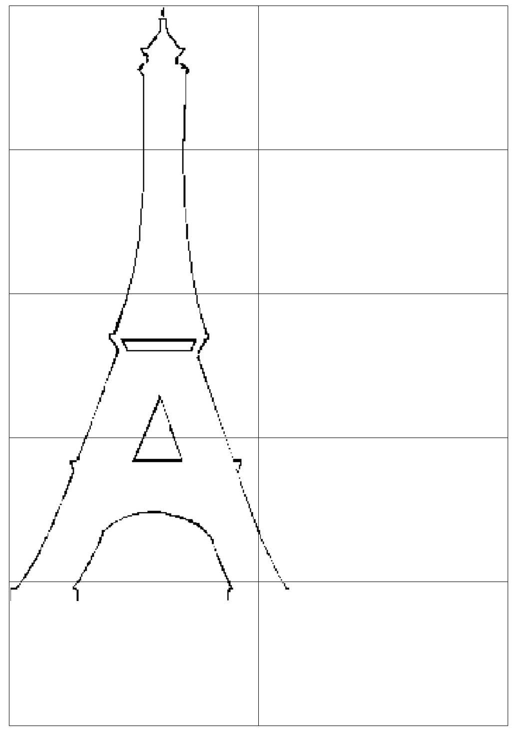




Legal Paper

The grid area is 7.5 by 13 inches, and we can lay out the grid in either portrait (left) or landscape (right).





Choose a Combination

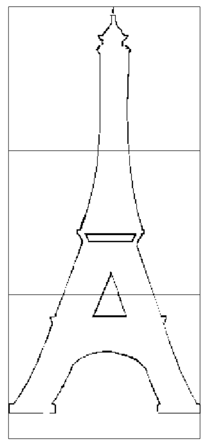
The only combination that comes close to fitting the width of an entire chart row on one sheet of paper is using legal paper in landscape orientation. For about the first thirty rows of the chart, we need very narrow bits of two sheets to complete the bottom of the right leg. Once we complete that portion of the bottom, we need only one sheet per row for the rest of the image.

In all four of these combinations, we need the same grid cell size, our minimum cell height of 0.125 inches and the column width that corresponds to the proportion of our stitch and row gauges, which is 0.161 inches.

Force the Chart Smaller

What if we don't have any legal paper and don't want to buy an entire ream merely to have the few sheets necessary to chart this image? In that case, we need to look at how much smaller the grid cells would have to be if we force the image to fit on a grid of letter paper turned landscape.

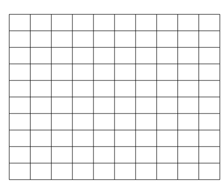
We know our image is 3.625 inches wide, and the width of the grid area on landscape letter is 10 inches. That means we need to enlarge by 10 divided by 3.625, which is 2.76 or 276 percent. When we enlarge the image, its height grows from 7.6875 times that same enlargement factor of 2.76, which is 21.22 inches. The grid area is just 7.5 inches tall, so we need almost three full sheets of paper for the entire chart.



Our chart will, however, now be just one sheet wide on letter paper. But to force the chart to this smaller width, we don't change only the image. We must also shrink the grid cells. How small will the grid cells be?

Since we need 91 stitches to fit across 10 inches of grid, each column's width will be 10 inches divided by 91 stitches, which is 0.11 inches. Now for the important number: how tall will each grid row be?

Since our image must be 21.22 inches tall, we divide that height by the 247 grid rows we need. That means each grid row is 0.086 inches tall. Let's look at a scrap of this new, slightly compressed grid. (table width = 79.12 pt, row height = 6.19 pt)



If we divide this row height by our preferred minimum height, 0.086 divided by 0.125, we see that this new grid has rows that are only 69 percent, a bit over two-thirds, the height that we decided was our minimum. If we decide this grid is too small, then we have to fall back to using two sheets of letter paper in landscape.

However, as we saw in the earlier diagrams, we actually need only about a sheet and a half at the fullest width of this particular design, and about halfway through row-wise, the image narrows enough that we'll need only one sheet.

Measuring Accurately

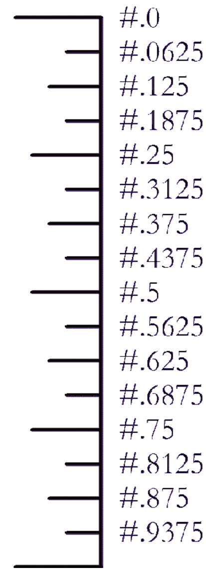
If we want accurate results, we'll need to measure our image as accurately as possible. The smaller the image is that we slide under our grid and the larger we want it to be in yarn, the more accurately we need to measure.

Unless we have a ruler with very fine markings, we need to mentally divide the sixteenths of an inch on an ordinary ruler in half or even in fourths. Let's see what that means.

To the right is a close-up of a ruler marked in sixteenths. The # is the lower of the two numbers of full inches. If the top line #.0 is the four-inch mark, then we're measuring between four and five inches, so every # represents the number four.

Let's work through the details with this sample line.

Decimal Values of Sixteenths of an Inch



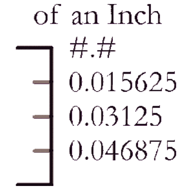
When we put a ruler against this line, it's four inches and partway between five-sixteenths and three-eighths. That means the decimal part of the measurement is between #.3125 and #.375 inches, with the # being 4. But where in that sixteenth of an inch does it fall? Is it nearly in the middle between those two marks, or is it closer to one or the other?

In other words, we need to try to split the sixteenth into smaller parts, in halves, thirds, or fourths.

Fourths (and Halves)

We can divide the distance between two sixteenth marks into four parts by mentally drawing three extra lines between the two black marks, as shown by the gray tick marks in the sixty-fourths close-up.

Decimal Values of Sixty-Fourths of an Inch



The first # in #.# means our full number of inches, and the second # means the decimal fraction from our sixteenths close-up. For our example line, the #.# is 4.3125 for the full number of inches plus the decimal version of five-sixteenths. Now we add to that value the decimal equivalent next to the gray tick mark closest to the end of the line. Since the line ends about a quarter of the way between five-sixteenths and three-eighths, then we add 0.015625 to 4.3125, for a total line length of 4.328125 inches. We can use that exact value in all our arithmetic, or we can round it to 4.33 inches.

If the edge of the image is more or less centered between the two marks of sixteenths of an inch, that's the same as the second tick mark on the sixty-fourths close-up, so we add 0.03125 to the lower of the two sixteenths. If those two values are 3.5 and 3.5625, then our measurement is 3.5 plus 0.03125, for a total of 3.53125 inches. We can round that value off to 3.53 if we like.

Thirds

Sometimes it will be easier to split a sixteenth of an inch into three parts, which effectively lets us measure to forty-eighths of an inch.

As before, the #.# represents the whole number of inches and the lower of the two sixteenths. So if the image's edge is about two-thirds of the way between 2.25 and 2.3125 inches, then we add 0.04167 to 2.25, for a total of 2.29167, which we can round to 2.29 inches.

Decimal Values of Forty-Eighths of an Inch

Measure in Decimal Inches Directly…

Trying to estimate fractions of a sixteenth of an inch and converting them to decimal values for the rest of the arithmetic we need to do is, well, let's say inconvenient. There's quite a bit of room for error if we get happy fingers while we're punching numbers in the calculator. There is an alternative, though, that makes it much easier for us to get accurate decimal fractions of an inch, no calculator required: we use a ruler marked with tenths of an inch.

Office supply and hobby stores usually sell such rulers, which are used to create highly accurate engineering drawings. My Staedtler Mars 9871934 engineer's triangular "scale" has six separate rulers splitting inches into ten, twenty, thirty, forty, fifty, and sixty pieces. Learning to use the fiftieth scale makes it a snap to measure all the way down to 0.02 inches, which makes the arithmetic fairly easy.

…Or Go Metric

We can also measure in centimeters, then convert the value to inches by dividing by 2.54. If we decide to use a centimeter ruler, we should make sure that our conversions make sense by doing quick checks with an inch ruler.

For example, if we measure 9.55 centimeters and divide by 2.54, we get 3.76 inches. We should double-check to make sure the image really is a hair over three and three-quarters inches. If we had happy fingers with the calculator and got a value of 2.69 inches, our unfamiliarity with centimeters may hide the fact that the result is wrong. But when we hold an inch ruler against the image, we'll see immediately that we made an error, since the inch measurement should be somewhat less than four inches, not slightly more than two and a half inches.

