

Braided Christmas Hearts

Torben Mogensen

<http://www.diku.dk/~torbenm/hearts.pdf>

December 7, 2021

Abstract

For over 100 years, it has been a Danish tradition to make heart-shaped Christmas ornaments of coloured paper. Tradition says that the fairy-tale author Hans Christian Andersen originated the idea, and the oldest preserved Christmas heart dating from the 1860s is, indeed, from his hand and is exhibited in the H.C. Andersen museum in Odense, Denmark.

The tradition spread in the early 20th century and patterns evolved from the original simple square tiling to more complex patterns. The hearts are traditionally used as ornaments on Christmas trees and, since they can open as small baskets, they are sometimes filled with candy.

This is a short tutorial for making you own Christmas hearts in the Danish tradition, starting with the original checker-board patterns and continuing to more complex patterns. The aim is to make the reader able to design his or her own complex patterns.

1 The Traditional Christmas Heart

The oldest preserved Christmas heart made by the fairy-tale author Hans Christian Andersen in the 1860s is shown below:



© ⓘ ⓘ ⓘ Source: The H.C. Andersen Museum.

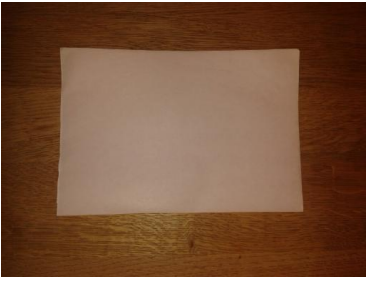


It is, like the hearts of today, braided from two folded and slitted pieces of glazed paper. Unlike modern hearts, Andersen's heart has no handle, so it can not be hung as a tree ornament.

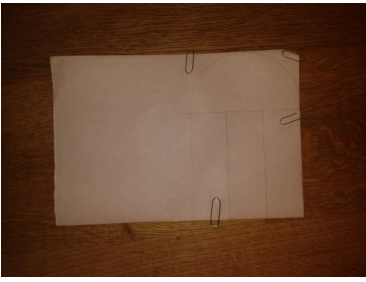
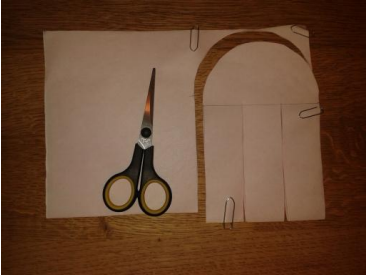


2 How to Make Braided Paper Hearts






In Denmark, you can before Christmas in most shops buy sheets of uniformly coloured glazed paper, but if you can't find glazed paper, you can use almost any sort of paper as a replacement. The paper just has to be sturdy enough to not break during braiding and stiff enough that the heart won't sag when hanging from its handle. Gift-wrapping paper is fine, as long as the pattern is not too obtrusive – a simple repeated pattern is best. You can make very small hearts from origami paper, but they are difficult to braid, so I would not recommend this as a starting project.




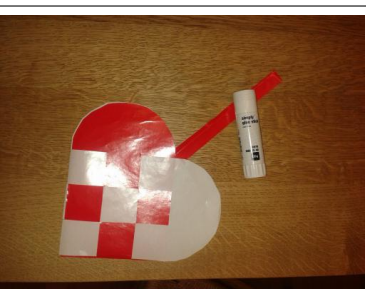

In addition to paper, you will need a pair of straight scissors, (preferably not too big), a ruler, a pencil, a round saucer, lid or mug with a rim diameter of between 9 and 12 cm (3.5 to 5 inches), a few small paper clips, and a glue stick.

We will start with a very simple heart. The procedure below has many steps, but they are each quite simple.

1.	Take two sheets of differently coloured paper, place one on top of the other and fold both down the middle, making a sharp crease, coloured sides facing inwards.	
2.	Aligned to the crease and one neighbouring paper edge, draw a square with side length equal to the diameter of the saucer, lid or mug. On the side of the square facing away from the crease, draw a semicircle using the saucer, lid or mug as guide.	
3.	Draw two lines from the crease to the opposite side of the square, so these lines divide the square into three equal-width strips.	

4.	Place paper clips to hold the sheets tightly together. Avoid crossing the lines you have drawn.	
5.	Cut along the two lines you drew in step 3. Cut 1–2 mm longer than the edge of the square, as this makes braiding easier. Take care that the two sheets don't slide when you do so (using the paper clips to help keep the sheets aligned). Cut the area bordered by the square and semicircle out of the paper.	
6.	After removing the paper clips, you should now have two folded sheets with slits. Separate these and re-fold at the crease so the coloured sides face out. Now comes the interesting part: The braiding. It is actually easier to do than to describe, so bear with the rather long-winded explanation. I will call the sheets “the red sheet” and “the white sheet” to distinguish them, but you are, of course, free to use any two colours you like.	
7.	Place the white sheet on the table with the slits facing left. Left-handed people may want to mirror the procedure from here onwards. Place the red sheet on top of this with the slits facing away from you and such that the two rectangular sections are over each other. In other words, so the two pieces of paper form a heart-shape with the point top-left.	

8.	Gently pull the white strip closest to you from under the red sheet so it is above the red sheet. Be careful not to make creases.	
9.	Lift the right-most red strip from under the white strip that you just lifted and slide the free end of the red strip <i>between</i> the two layers of the rightmost white strip.	
10.	Slide the free end of the white strip between the two layers of the middle red strip.	
11.	Slide the free end of the left-most red strip between the two layers of the white strip. Gently adjust the strips so the square sections align.	
12.	Now lift the middle white strip up and slide it between the two layers of the right-most red strip.	

13.	Slide the middle red strip between the two layers of the middle white strip.	
14.	Slide the middle white strip between the two layers of the leftmost red strip. Gently adjust the strips so the square sections align.	
15.	Repeat steps 10 to 12 with the last white strip. You should now have a complete braided heart that can open as a narrow basket. A few adjustments to the alignment of the strips may be needed to get a perfect shape.	
17.	Cut a thin rectangular strip of paper, fold it down the middle and glue it to the insides of the heart to form a handle for the basket.	
18.	<p>You can now hang the heart on the Christmas tree. Notice that the heart opens like a basket.</p> <p>Next, try braiding a heart with more slits, such as Andersen's heart above. The method is the same: Alternate slipping the strip you are braiding between and around the strips of the other colour, forming a checker-board pattern.</p>	

3 Other patterns

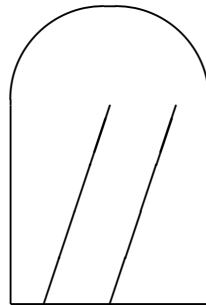
The classic braided hearts have checkerboard patterns as the cuts are equidistant lines parallel to the edges of the paper and the braiding is done by alternatingly sliding the strips through or around each other.

We can change this pattern in several ways:

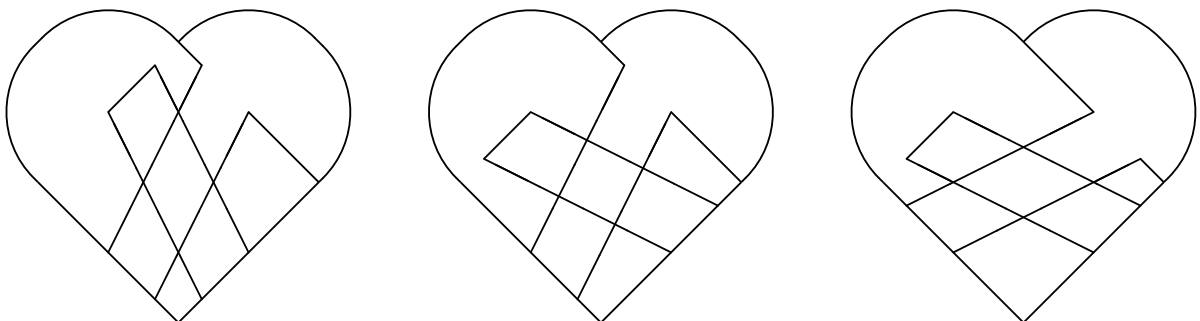
1. The cuts need not be equidistant. A common style is to make the strips more narrow in the middle than at the edges.
2. You can braid through or around several strips in a row. This can give patterns similar to what is seen in woven fabrics, e.g., dogtooth pattern. This works well when there are a many strips.
3. You can make slanted or non-straight cuts.
4. You can cut the two sheets differently.

You can also glue figures on the heart or cut out figures in one or both sheets, so the figure is not obtained by braiding. This can make it easier to obtain complex patterns, but it is frowned upon by purists, who believe the patterns should be obtained by braiding.

When you make non-straight or slanted cuts, the orientation of the sheets when braiding can matter. For example, if you cut according to the figure below

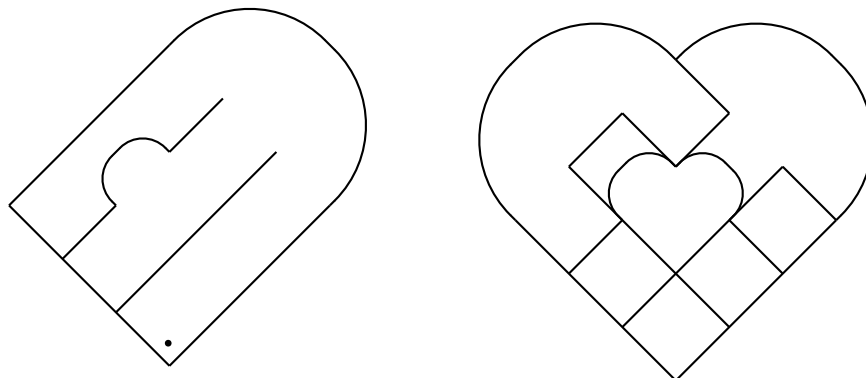


You can get three different hearts depending on how you orient the sheets:

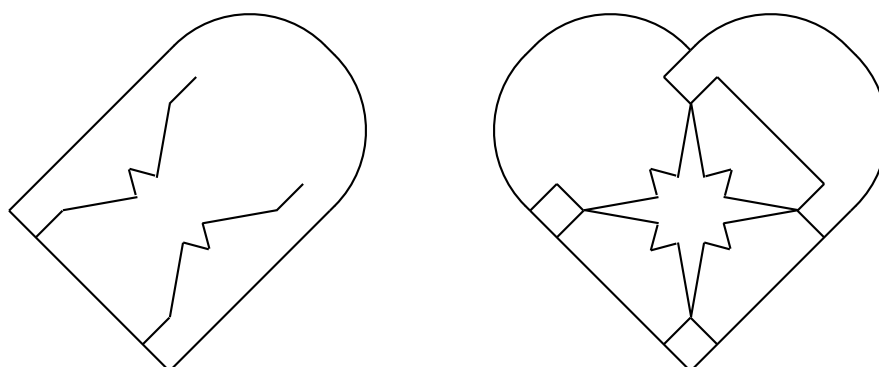


When orientation matters, I will in the cutting diagrams put small dots in the corners that should face toward the point of the heart. An example of this is shown below, where the two

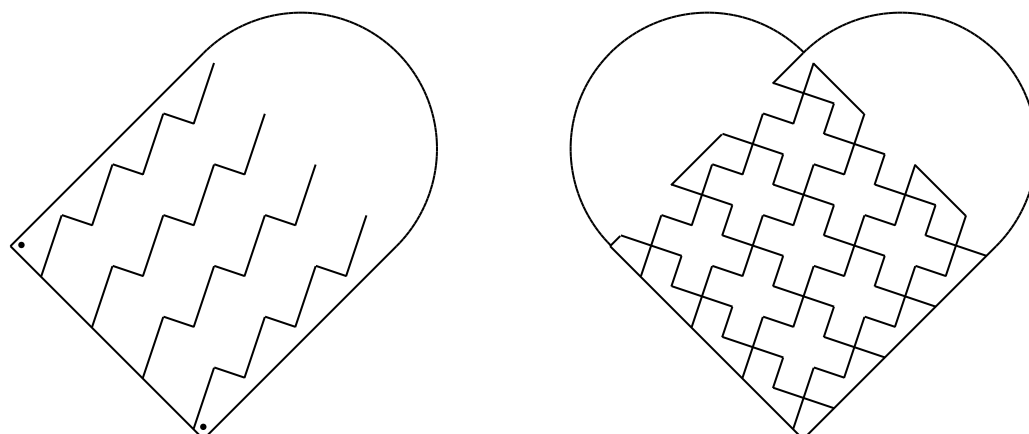
semicircular curves in the cuts shown on the left must face the right way to make the heart inside the heart shown to the right.



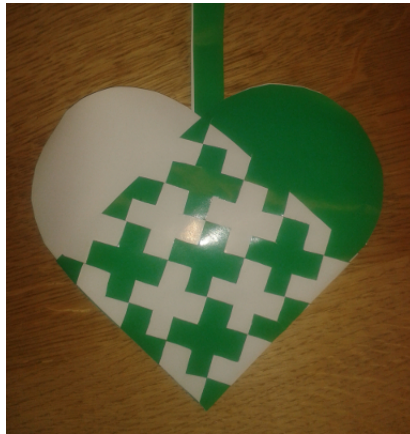
The strips do not need to be the same width. By making the middle strip wider than the outer strips, you have more space for the figure:



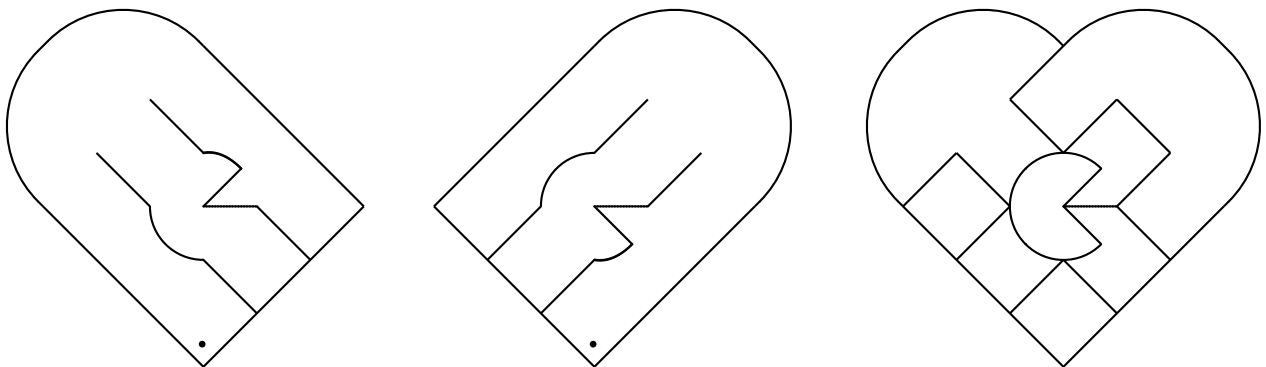
Sometimes, two identical sheets are oriented with different corners at the point of the heart. In this case, I will place a dot in two corners in the cutting diagram, like this:



which, when braided in paper, looks like this:



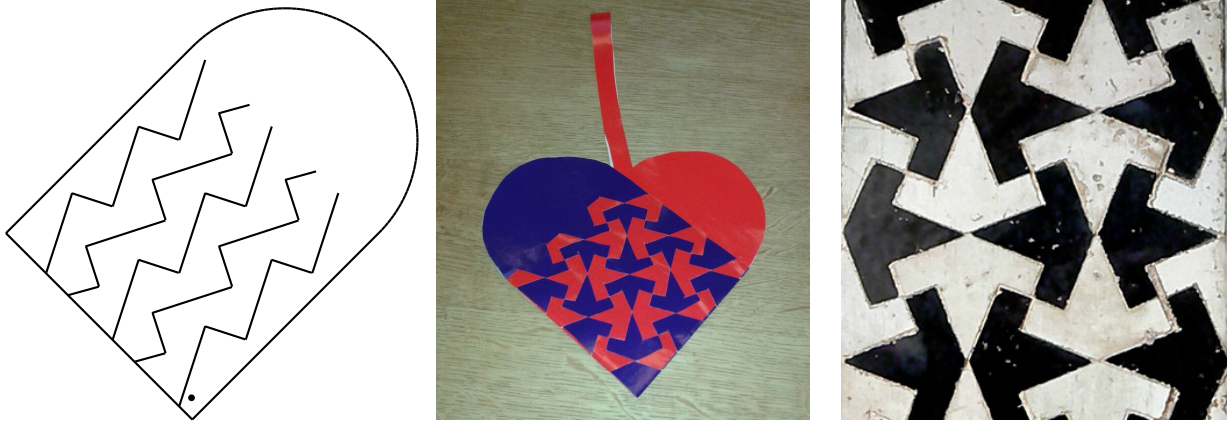
Up to now, we have used two identically-cut sheets of paper, which we have obtained by folding and cutting the two sheets together. Some patterns require two differently-cut sheets, in which case you need to fold and cut the sheets independently. As an example, the two sheets shown to the left below braid to become the Pacman-figure shown to the right.



Note that the horizontal line segment in the middle of Pacman's mouth occurs on both sheets. Since colours change in the braided heart whenever a line is crossed, two co-occurring lines in both sheets mean that the colours change twice when crossing these lines, which means that there is no net change. Hence, the area in front of Pacman's mouth is one colour even though it is divided by a line. This is seen in the photo below. If the cutting or braiding is imprecise, so the two line segments don't line up exactly, there will be a thin line of the opposite colour.



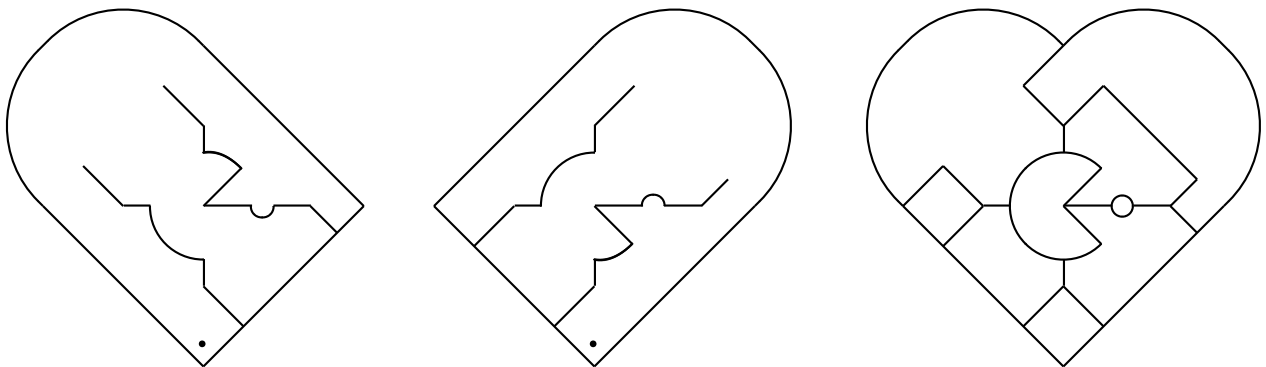
Some designs require the two sheets to be mirror-images of each other. You can cut these at the same time, if you fold one sheet with the coloured side out and put this inside a sheet that is folded so the coloured side is on the inside. After cutting, re-fold the outer sheet so the coloured side is out. You will now have two mirrored sheets. An example of this is the following pattern, inspired by the Alhambra tiling shown on the right. Note that it is somewhat tricky to braid, as the corners tend to snag, so it should not be your first braiding project.



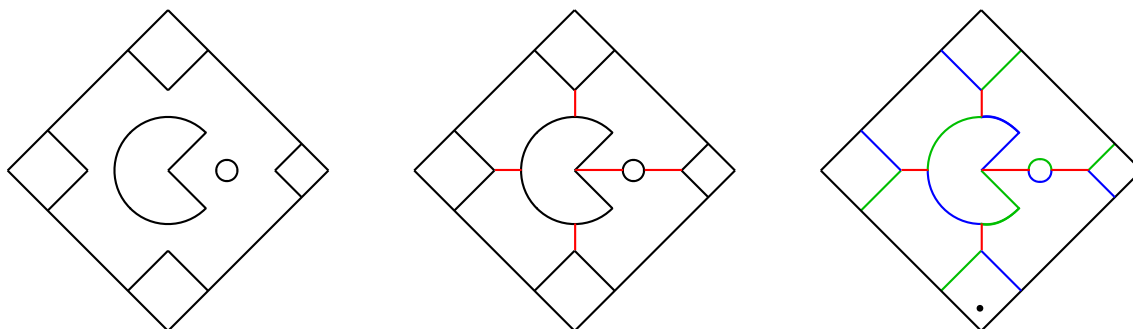
4 Designing Advanced Patterns

With the Pacman-heart, we observed that crossing a cut changes the colour, and that crossing two cuts simultaneously changes twice, which is the same as not changing. We will use this observation to make more complex figures.

We will start by making a more advanced version of the Pacman heart, where we add a bit of space around Pacman and add a “pill” in front of him.



The way we design such patterns is by first drawing a square and then in this square draw the lines where we want the colour to change, as shown on the left below. We then add (in red) in the lines where we don’t want the colour to change, as shown in the middle below. We then decide which of colour-changing lines should be cut in the left or right sheet, using blue and green, respectively, as shown on the right. We add the dot to indicate the corner that becomes the tip of the heart. On the left sheet, we cut along both the blue and the red lines and on the right sheet, we cut along both the green and the red lines.



The following rules must be obeyed when making patterns this way:

1. All lines that touch the bottom-left and top-right edges of the square must be green.
2. All lines that touch the top-left and bottom-right edges of the square must be blue.
3. Blue lines can cross green lines, but no two green lines may touch or cross, nor may two blue lines cross or touch.
4. The end of a red line must meet the ends of both a blue and a green line.
5. It must be possible to trace a path from the topmost green line that touches the bottom-left edge to the topmost green line that touches the top-right edge using only green and red segments. The same applies for all other pairs of green lines that touch opposite edges.
6. It must be possible to trace a path from the topmost blue line that touches the top-left edge to the topmost blue line that touches the bottom-right edge using only blue and red segments. The same applies for all other pairs of blue lines that touch opposite edges.

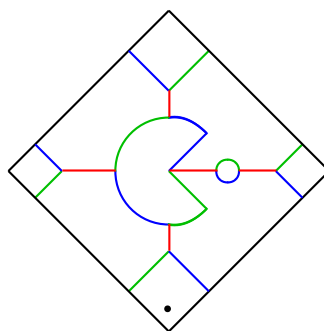
For complex patterns, it can be tricky to get all of this right, but if you don't, you will either not get the colour changes you want or your sheets may fall apart when you cut them.

All the hearts we have designed so far have the pattern mirrored on the back side. For example, one side of the Pacman heart will have Pacman facing right and the other will have Pacman facing left. This is usually not a problem, but if, for example, the pattern is a text, then the back side will show this text mirrored. You can ignore this and just display the heart with the "correct" side facing out, but you can with some effort make the back side show the pattern without mirroring. This requires several modifications to the process we have described above:

1. You must design the pattern mirrored. For example, if your desired pattern is the letter P, you must design \mathcal{P} using the process above. This is because we draw the pattern on the backside of the paper, which will be folded to become the inside of the heart.

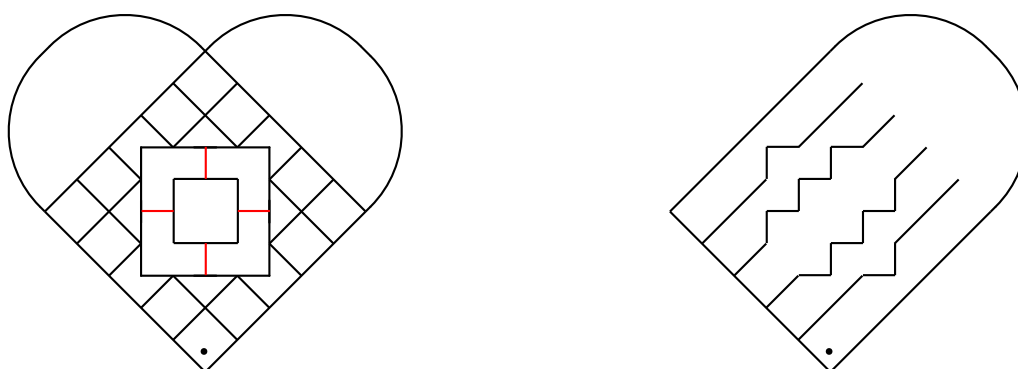
2. On the back side of the folded left sheet, draw the right-sheet pattern, as this will be the left-side sheet, when the heart is turned over. Similarly, draw the left-sheet pattern on the back side of the folded right sheet.
3. Unfold the sheets and cut along the lines. You can use a sharp knife instead of scissors, or you can cut a short slit at the folded edge before unfolding and then continue both ways from this when the sheet is unfolded.

Note that the places where the lines meet the folded edge must be the same on both sides of the folded sheet, as otherwise the cuts won't meet. This is not the case for the Pacman-heart, as the right-most blue line is not the same distance from the edge as the left-most green line, which will be on the opposite side of the sheet. So we need to modify the design so the left-most square of the design is the same size as the right-most square:

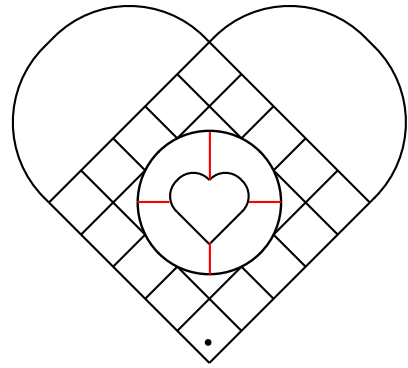
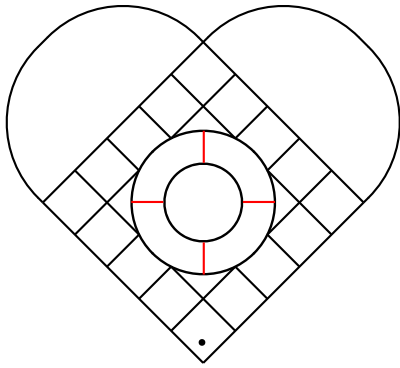


We can use the same idea to put different designs on the two sides of the heart: Draw the left-sheet pattern of one design on the back side of the right sheet and vice versa. But, again, care must be taken so the lines meet at the folded edge.

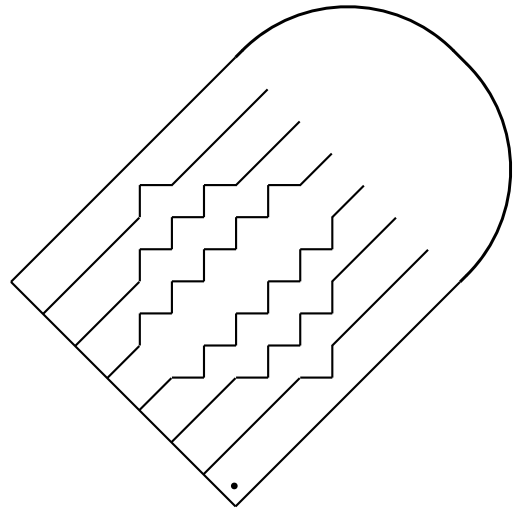
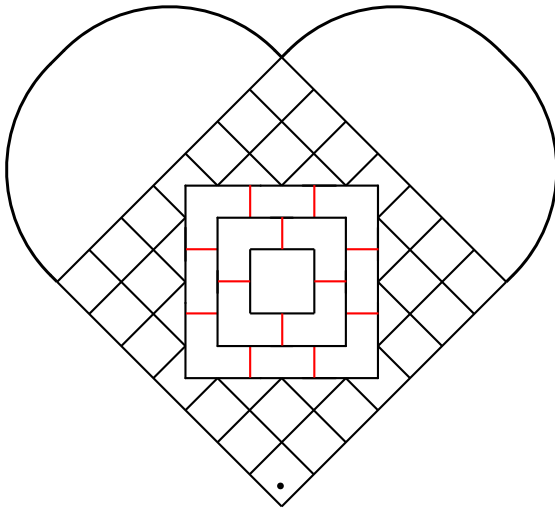
Most of the designs above have used three strips per sheet, but you can easily extend the same idea to designs using more strips. An example design and a cutting diagram is shown below. Since the design is symmetric, it uses two identical sheets.



You can morph the central square figure to get circles or hearts instead:

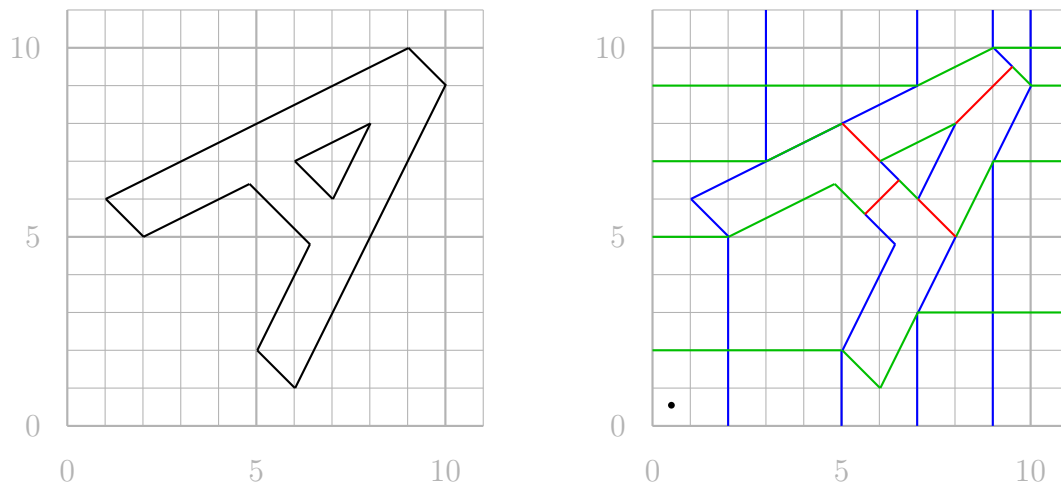


You can use the same principle to get more concentric circles or squares. Squares are easiest:

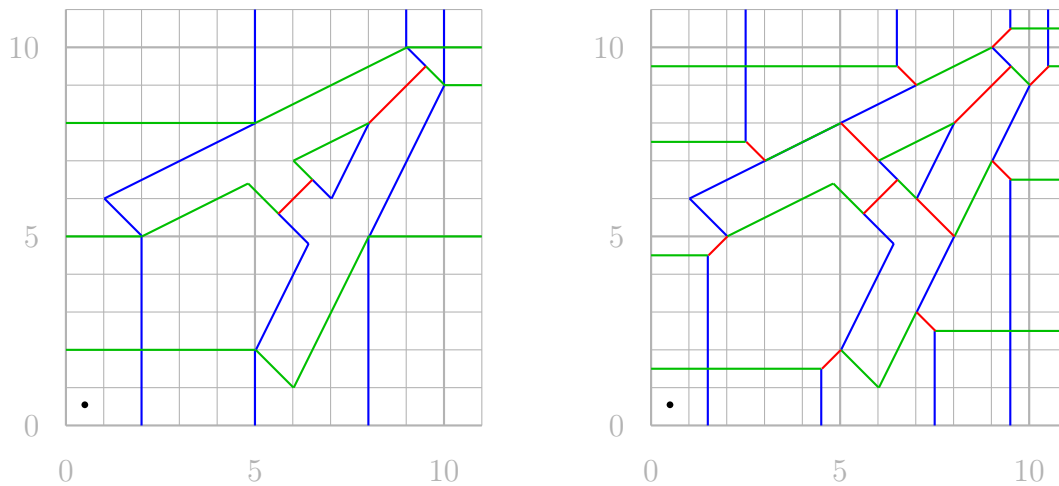


Instead of drawing the design on the back of the glazed paper as shown in the guide for the simple heart, you can draw your design on graph paper, fix it over the folded glazed paper using paper clips and then cut through both graph paper and glazed paper. If you make an assymmetric design like the Pacman figure, you can copy the three-coloured design sheet using a photocopier and fix one copy over one colour of glazed paper and the other copy over the other colour of glazed paper, orienting the two copies differently, so one copy has the blue lines meeting the folded edge of the glazed paper and the other copy has the green lines meeting the folded edge of the other sheet of glazed paper.

Here is an example of making a design using graph paper. We design the figure at 45° angle to the grid. Note that almost all endpoints of line segments are at grid points, which makes it easier to draw and cut exactly. The exception is the horisontal bar of the A, where the end points are chosen to give the bar the same thickness as the other parts of the letter. This is measured using a ruler.



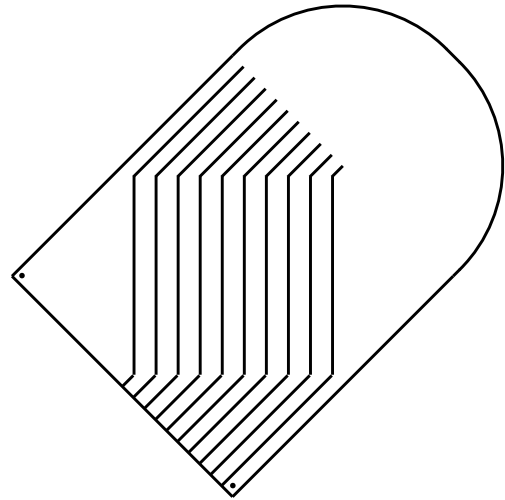
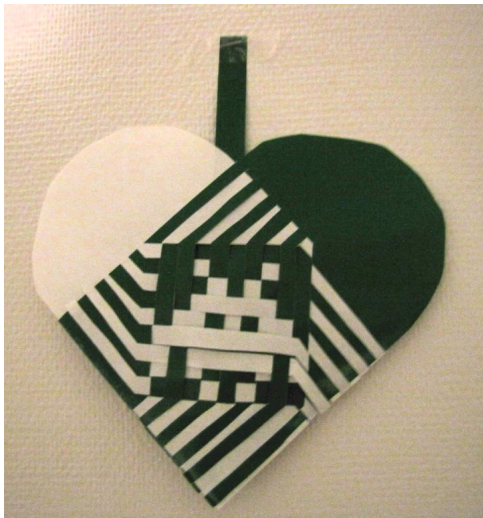
To get the “hole” in the A, I have used four red segments that will be cut on both sheets, hence giving no colour change. It is possible to make the hole using only two red segments, as shown below left, but that will make some of the strips very wide. It is mainly a matter of taste which you prefer. You can also use red segments to add some space around the A, as shown below right, which is a modification of the diagram above right..



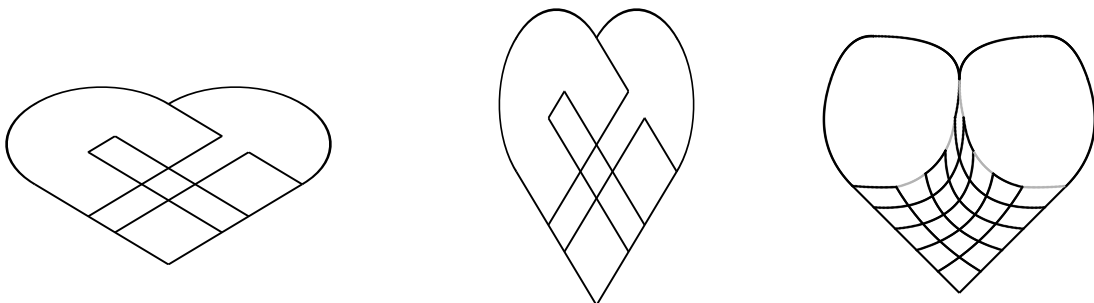
One additional thing to note when making designs: The strips that will become the bottom-left and bottom-right edges of the heart should not become much wider at the tip than the base. Otherwise, it can be hard to braid the last strip, as the tip must pass through a hole that is more narrow than the width of the strip. Ideally, the width of the last strip should remain more or less constant or taper towards the tip. The left and bottom strips in the figure above left are O.K, as they are wider at the base than at the tip. But if they were mirrored, it would be hard (though not impossible) to braid.

If you use any of the designs shown above, magnify them so the width of the square design area is 8-12 cm. Trying to braid them in the size shown here will be difficult, and small errors in cutting or braiding will be much more visible than when using a larger size. Generally, it is easier to get a good result from larger size, but if the size gets too big compared to the thickness of the paper, the hearts will be somewhat floppy and the semicircular section will tend to droop. Paper with a good stiffness compared to its thickness and which does not tear easily is preferable.

As mentioned on page 6, you can also braid through or around several strips at a time. This can be use to make pixellated figures like the space invader below. You simply braid the green strip over the white strip whenever you want a green pixel, and vice-versa if you want a white pixel. To make a horisontal/vertical pixel grid, we slant the cuts 45°, as shown on the right:

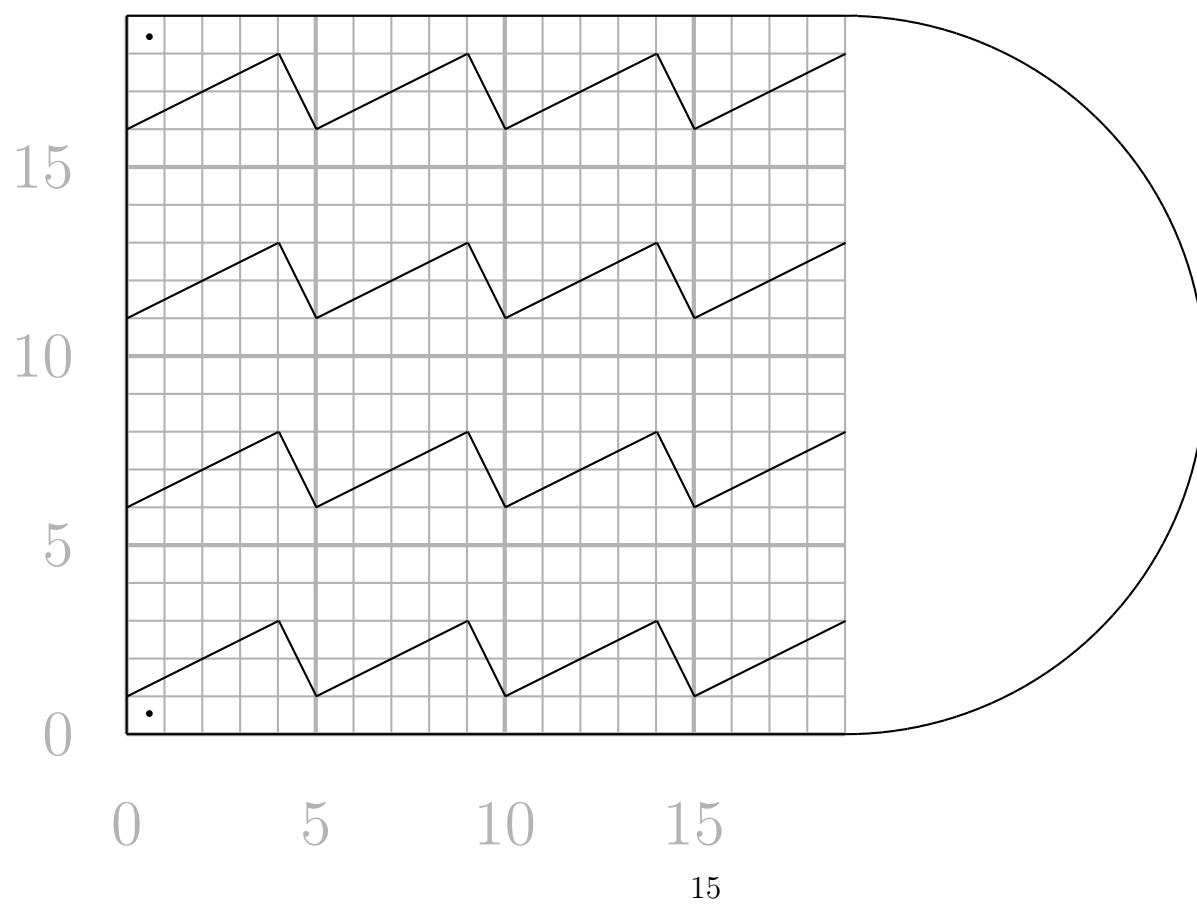
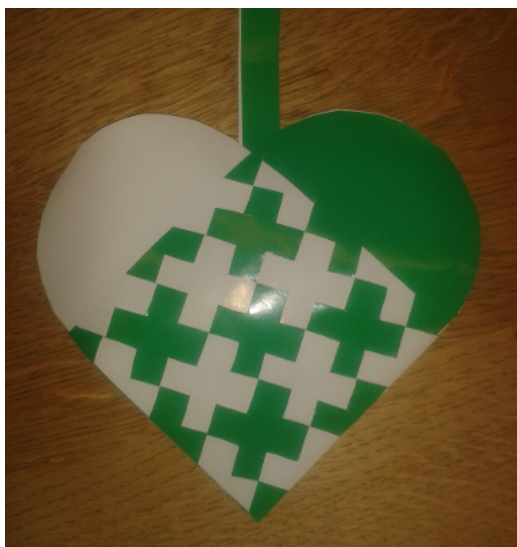


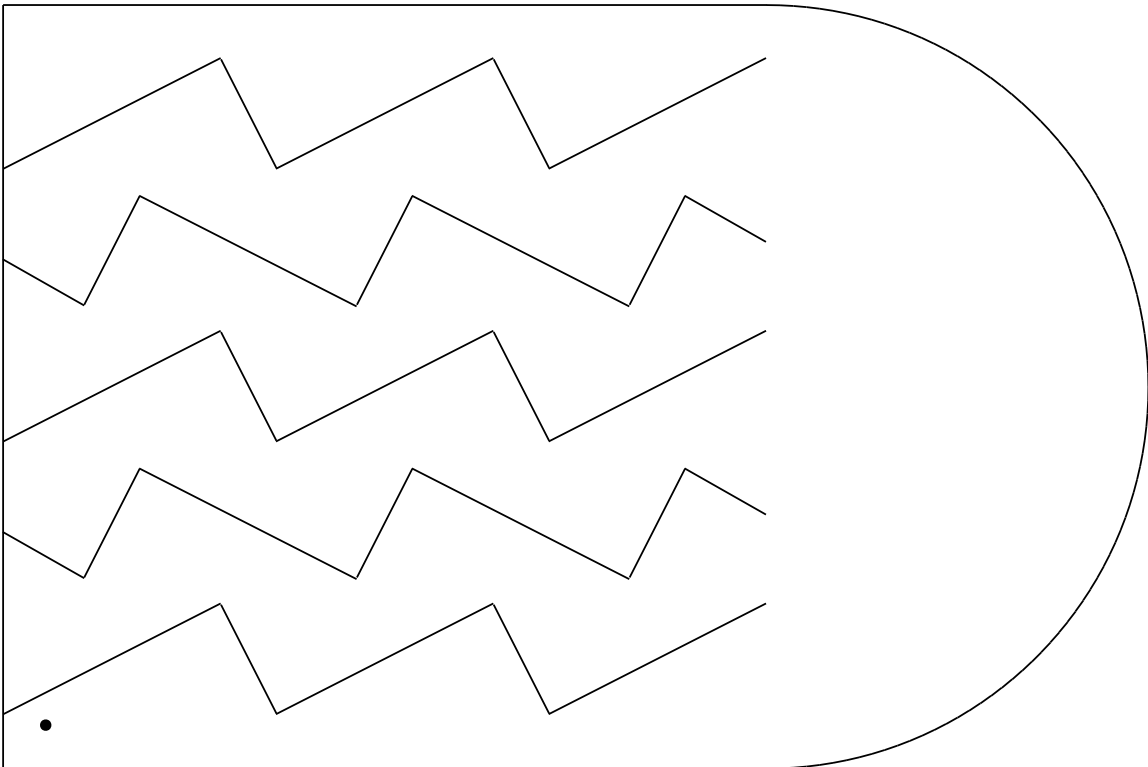
Finally, the design area does not need to be square. You can, for example, make it rhombic to make hearts that are wider or more narrow than the standard. Or curve the upper-left and upper-right edges. You can also change the shapes of the semi-circles.

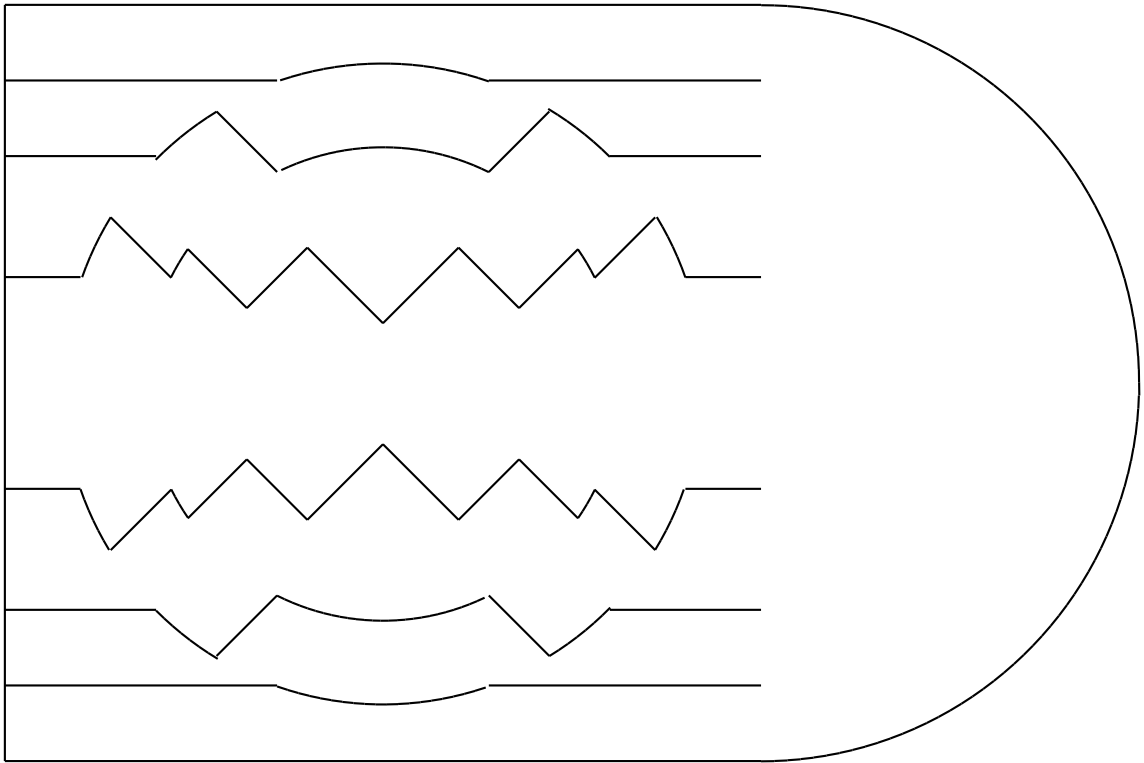


5 Templates for selected hearts

Here are some full-size templates for selected hearts.







Finally, a project for the ambitious. The template is somewhat bigger than the previous, as it requires *very* high precision both when cutting and when braiding. A good idea is to cut the sheets separately to increase precision. Even experienced heart braiders should expect to use more than an hour to cut and braid this heart. Use black and either gold or yellow. The bat will have the same colour as the corners, so be careful to start the right way (unless you want a yellow bat).



This template below requires a bit more explanation, as not all the green lines should be cut. Cut along the red lines, and when you meet a green line, cut upwards along the green line until you meet a red line again, and then cut along the red line until/if you meet another green line, which you then follow upwards, and so on.

