Introduction to BP Character Design

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This article mainly introduces the method of designing character origami with box pleating. It is divided into three parts: "Basic Knowledge", "Common Skills", and "Simple Structure". Some people may think that the content is relatively simple and almost common sense, but I still wrote them down, hoping to give some help to those who have a certain foundation and want to learn the BP design, but can't get started. This article aims to open up some ideas for everyone, do not be limited by this article thinking, welcome everyone to study and discuss together.

Due to my limited experience the article is written roughly, and there is no folded model with each CP. If you want to see what they look like, you can take a piece of paper and fold it yourself. There are no design examples in the article. (What kind of structure, which skills are used, how to combine the techniques, how to determine the ratio, etc.) are things you to realize from desgining on your own.

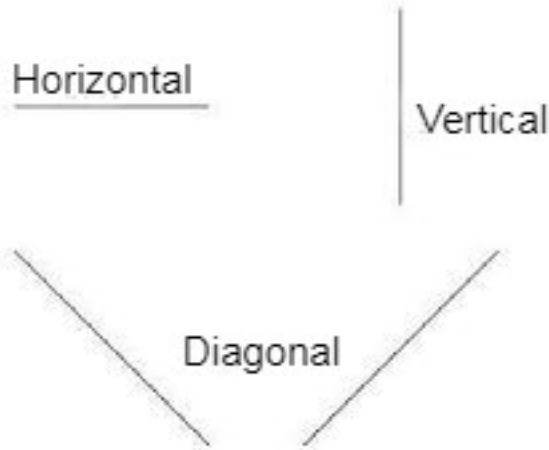
If there are any error, please tell me, thank you!

Translation and typesetting by @noneuclidean_
Additional help from @nicholaslow_origami and @theplantpsychologist

Basic Knowledge

First, basic lines

For convenience of description, we named the four basic BP lines as "horizontal line", "vertical line" and "diagonal line".

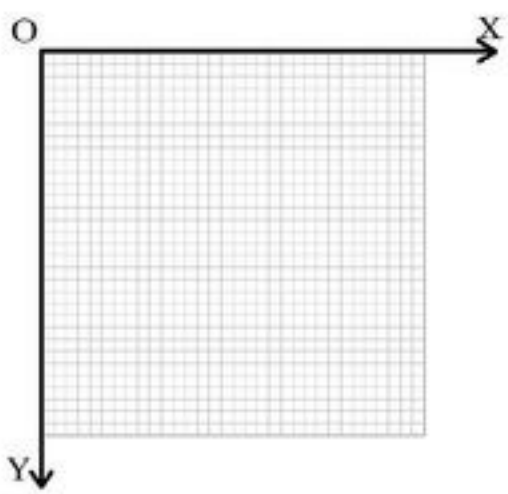


Second, circle packing

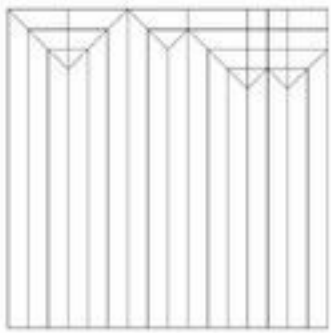
The radius of the circle = the length of the flap
The width of the river = the distance between the flaps.

Third, axis

1. x axis, y axis

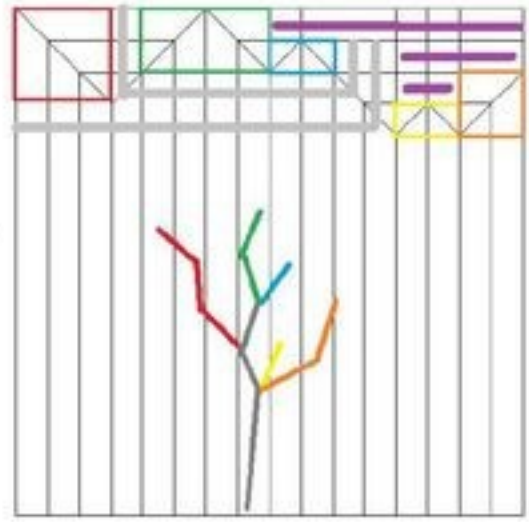


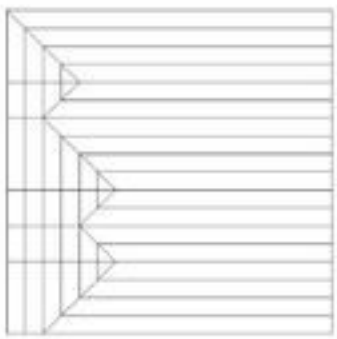
We naturally call the horizontal axis the x-axis and the vertical axis the y-axis.



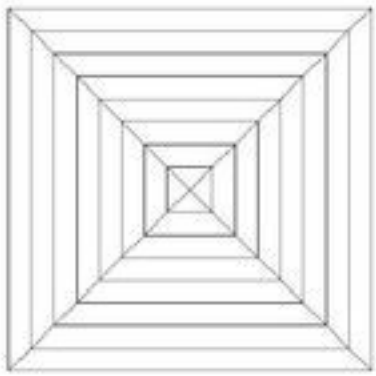
On a paper that has many vertical lines, we can easily make several branches on the x-axis.

Circles/rivers to branches





Similarly, on a paper that has many horizontal lines, several branches can be made on the y-axis.

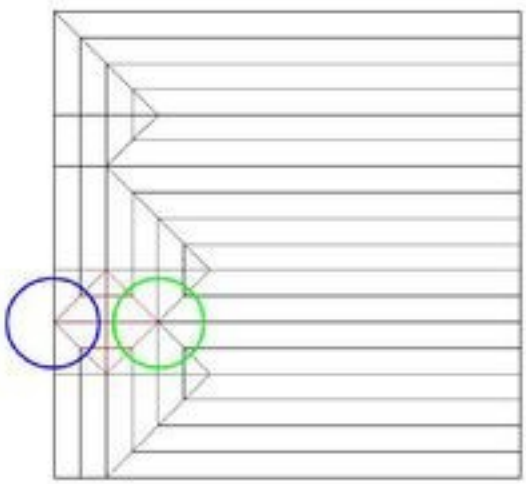


Thus, using horizontal and vertical lines and the two diagonal lines of a square, we can get this "cross-shaped" structure. In the "cross-shaped" structure, it is convenient to create branches on the x-axis and y-axis, used for

designing Chinese characters. But for complex designs, the shortcomings of this method are obvious:
(a) the edge of the paper is limited, and it cannot make enough branches
(b) the middle part of the paper is almost completely unused, so the thickness is increased, and the structure is loose.

So can we use the paper in the middle to create branches? Next, the z-axis with this function is introduced.

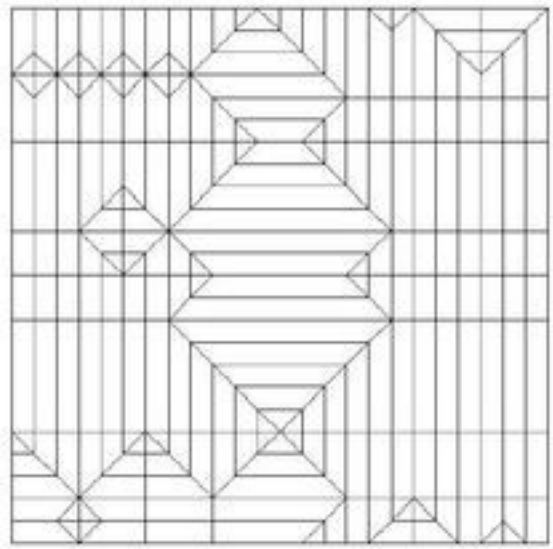
2. z axis



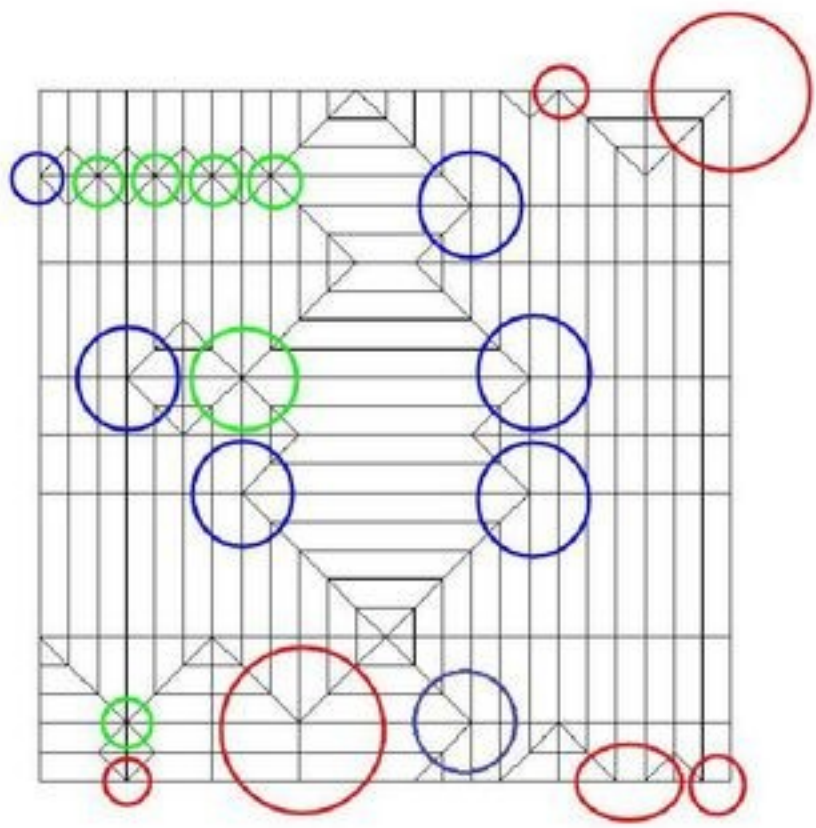
To the left of the green circle branch on the original y-axis, we create another branch (blue). The branch on the y-axis is now the blue circle branch, and the green circle branch has become an "internal branch".

Of course, since the blue branch and the green branch overlap each other, we can also regard them as one y-axis branch. However, for the convenience of the following description, we introduce a definition of the x/y axis branch: from the CP, the outermost branch on the x/y axis is called the x/y axis branch. In this way, the blue and green branches can be differentiated. Therefore, like the green circle branch, an "internal branch" that is not on the x or y axes is called a "z-axis branch."

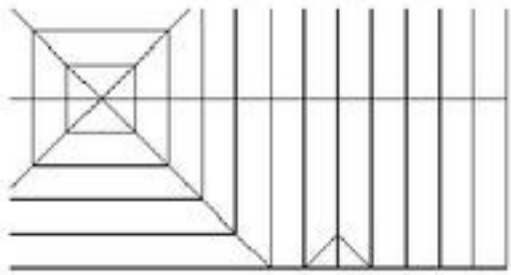
Let's look at the following CP:



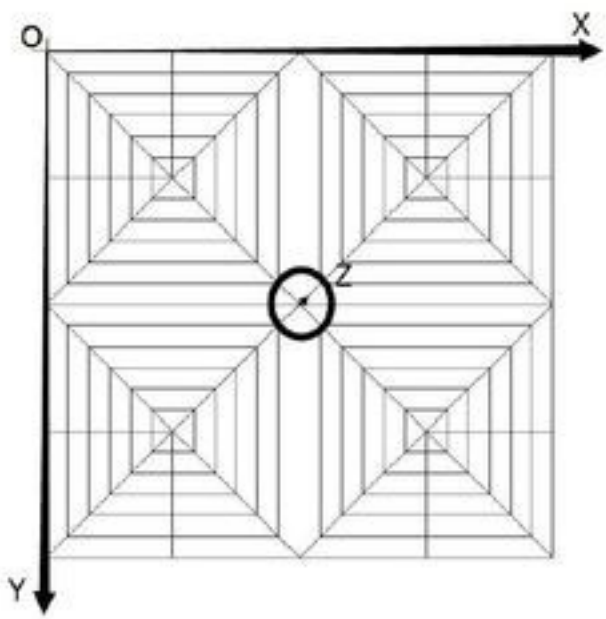
With red circles representing x-axis branches, blue circles representing y-axis branches, and green circles representing z-axis branches, the CP can be diagrammed as shown:



In fact, the blue circle and the two red circles in the lower right corner of the picture above are connected together, and the structure is the same only from the branch. (Obtained by the translation of this structure, which is explained in detail in later chapters)



Obviously, after the CP is collapsed, there are actually only two x-axis branches and no y-axis branches. But for ease of understanding, let's consider it as a structure of "two x-axis branches plus one y-axis branch".

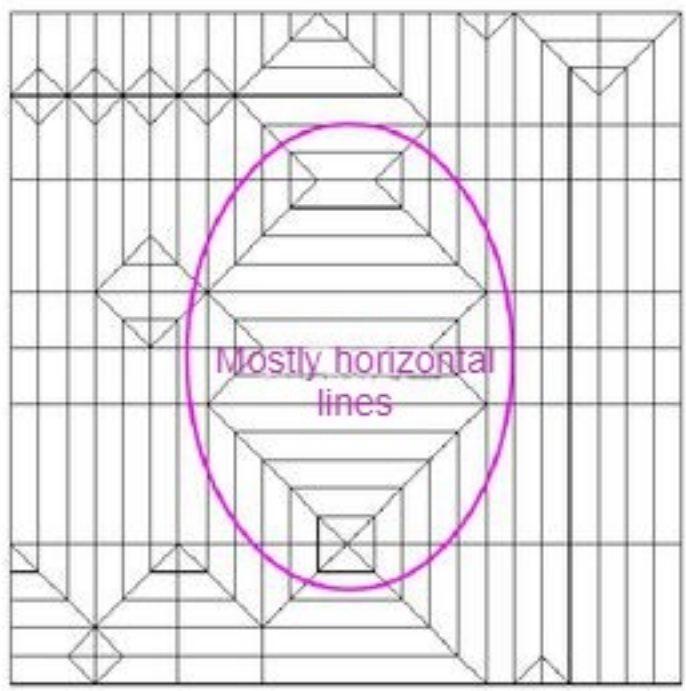


The four "cross-shaped" structures can be put together to obtain the well-known "octopus" structure. In the "octopus" structure, there are very distinct x/y axis branches and z axis branches. The advantages of the "Octopus" structure are also obvious: (a) There are many initial branches: (b) A large z-axis branch is developed, (c) The operating area of the paper is reduced, which is easier to manipulate and conceptualize.

Using the "octopus" structure to design characters is a good choice, but the most important thing is to learn the idea of "developing the z-axis", and considering the middle of the paper more when designing. Intuitively, the "'cross-shaped" structure is just a branch distribution in a plane, but when the z-axis is added in, the design becomes more "three-dimensional", the structure will be more compact, and the difficulty will naturally increase, requiring much trial and error to master

Fourth, horizontal axis, vertical axis

Check the middle part of the CP. If vertical lines are the main part, it is called "a design based on the vertical axis". If horizontal lines are the main part, it is called "a design based on the horizontal axis."

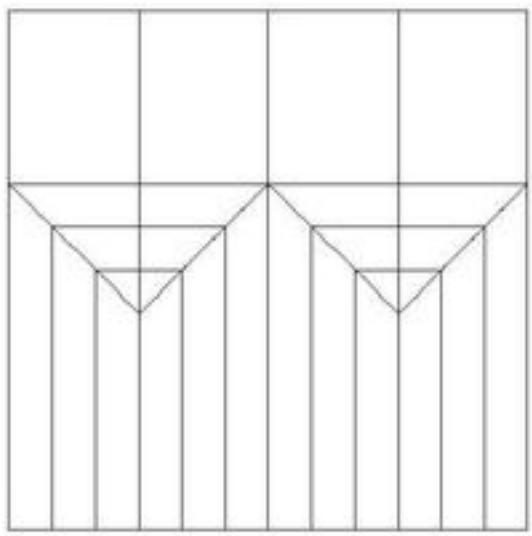


Because characters usually have bilateral symmetry, with distinctive characteristics from top to bottom (head, hand, body, feet), they are usually designed with a vertical axis.

Fifth, linear branches, wide branches

Linear branch: a branch with a width of one grid unit
Wide branch: a branch with a width of more than one grid unit.

For example, the upper half of this CP is a wide branch, and the lower half is a linear branch

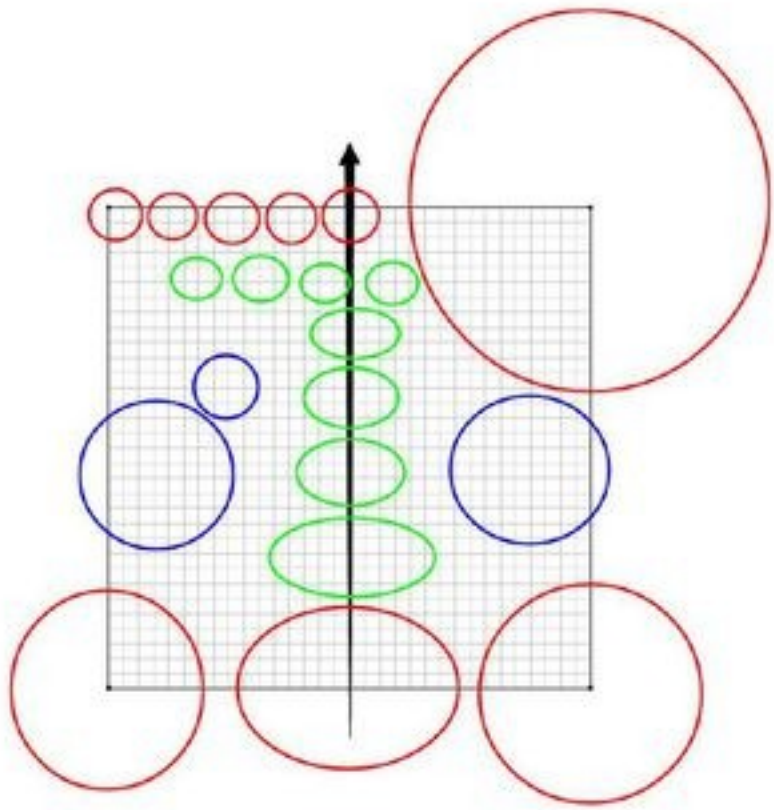


Fluidly combining linear branches and wide branches is also one of the basic skills of BP.

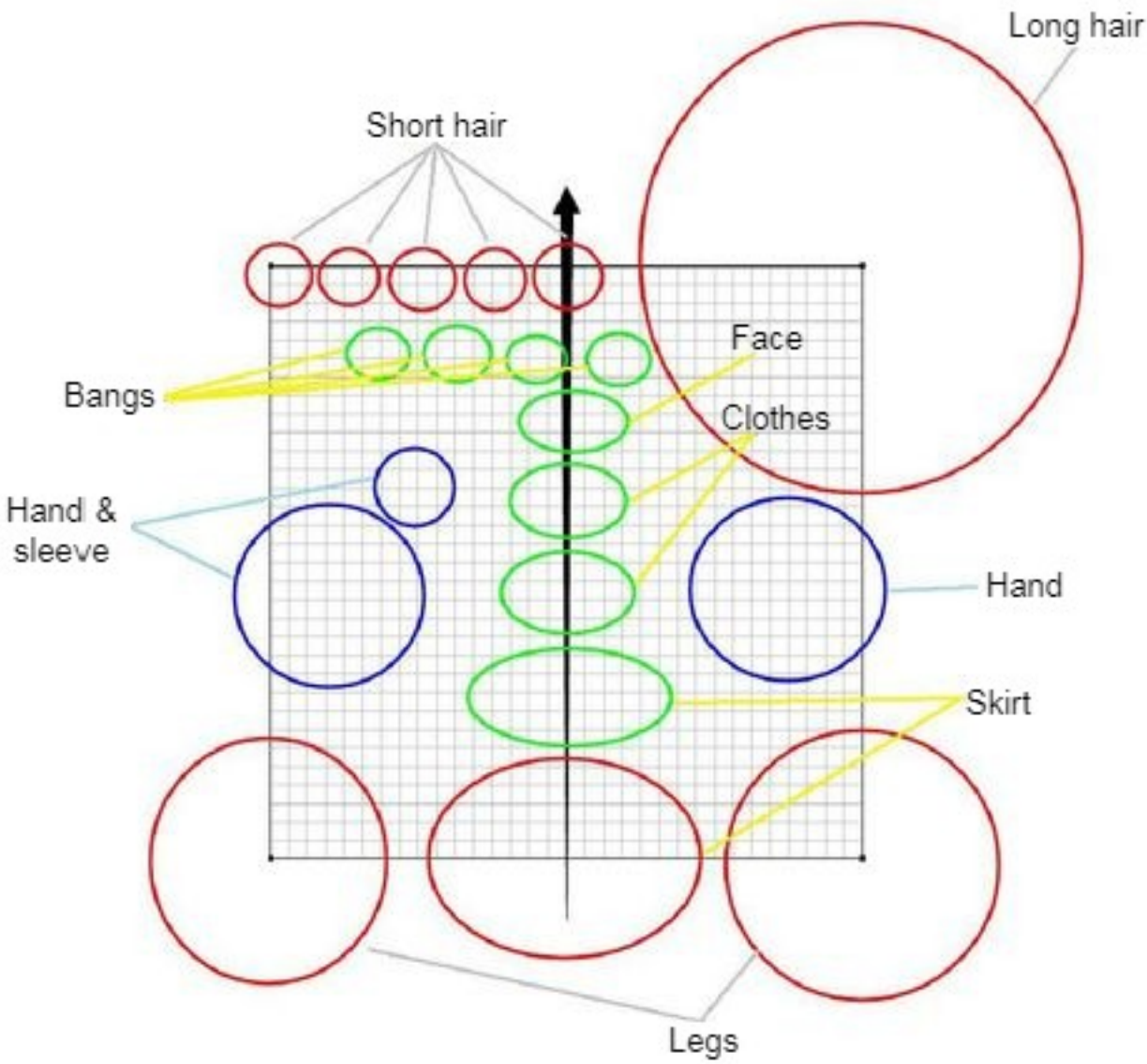
Sixth, structure and shaping

Structure and shaping are inseparable. Shaping depends on the structure that can be used for shaping, and the structure shows its subtleties because of shaping. Thinking about how to shape based on a structure is also an important part of the design. In other words, the structure is the overall design, and the shaping is the embodiment of the local detail design. Designing these details is often difficult, requiring a lot of experience and inspiration, which is inconvenient.

to discuss. But the overall structure of the basic BP characters is still representable. For example, the following is the most common structure (red circles indicate x-axis branches, blue circles indicate y-axis branches, and green circles indicate z-axis branches):



From top to bottom, the branches represent hair, face, hands, body, skirt, legs, without any additional items, and the clothing is very simple



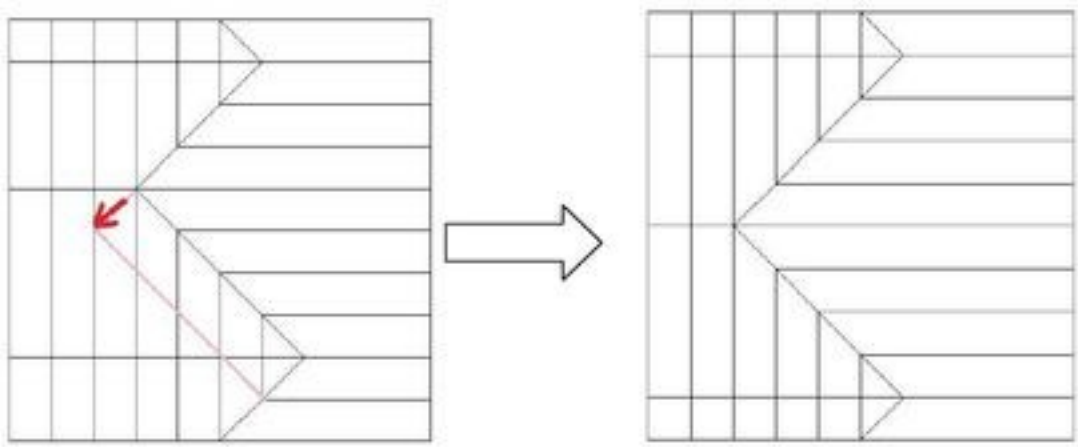
More structures will be introduced in later chapters.

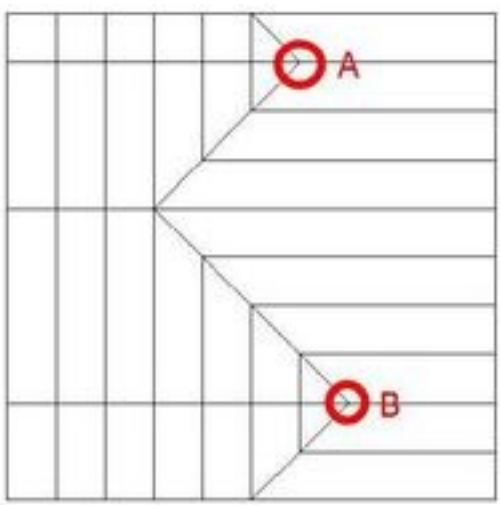
Common skills

First, pushing branches

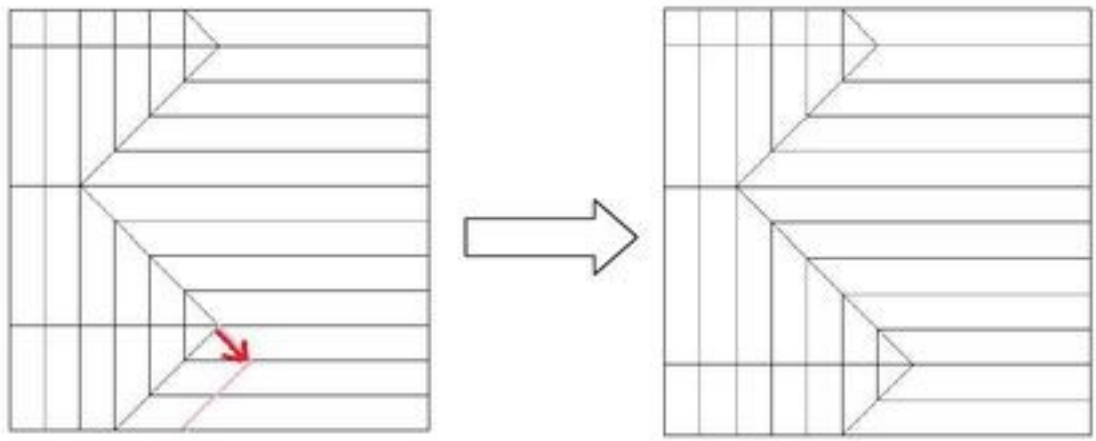
One of the most commonly used techniques is to adjust a branch's length and position by pushing the grid outward or inward. Each time you push branch, it will affect some of the branches around it, and you need to constantly adjust them.

The following is an example of pushing a branch one unit outward:



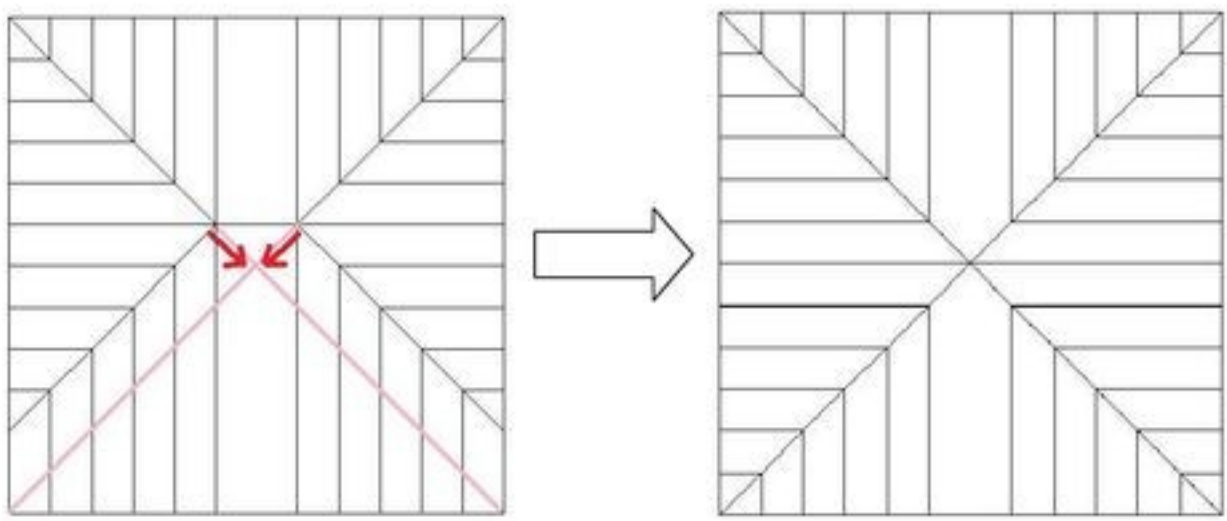


As you can see, the position of A has not changed, but the position of B has moved down and to the left by one unit. After collpasing, A and B are at the same point, but originally A and B were separated by one unit. If you want to make the branch longer by one unit, while keeping the relative positions of A and B the same, then you can push point B inward by one unit.

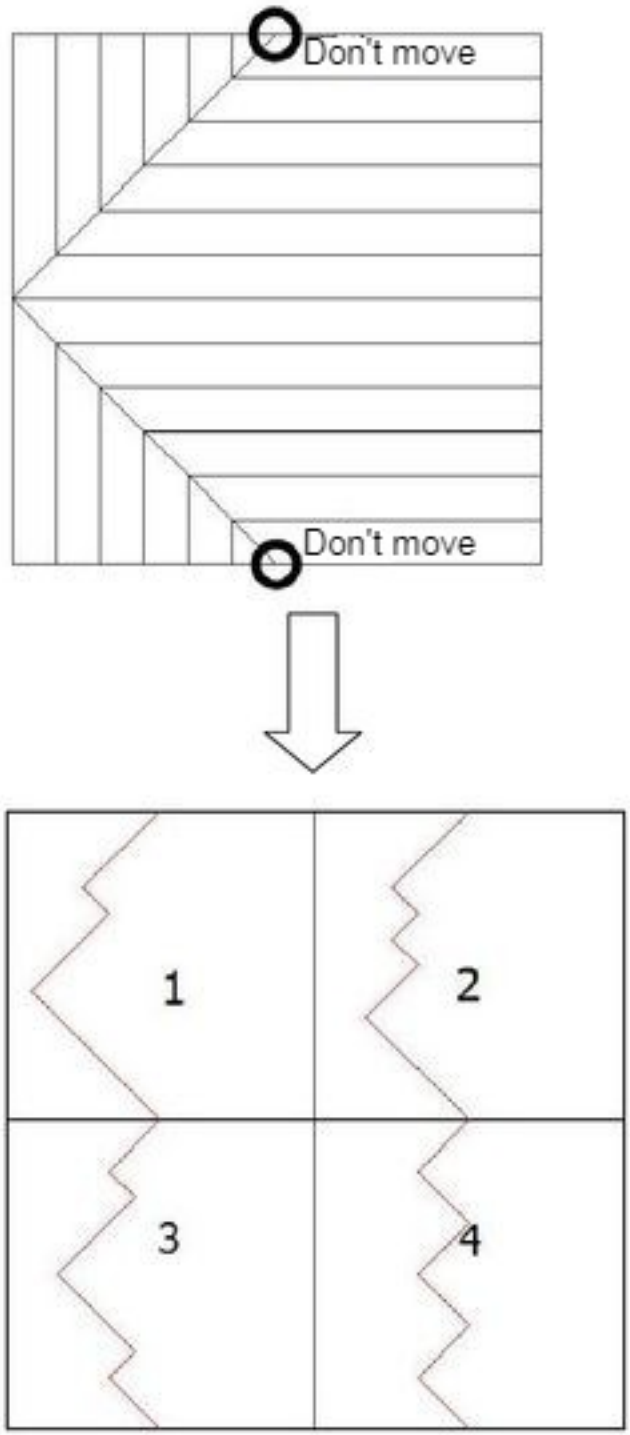


It can be seen that after two transformations, the relative positions of A and B have not changed, the branch has grown by one unit, and the total number of units at the bottom has decreased by two, which is also logical.

The internal branches on both sides of a vertical axis can also be pushed, and the structures on both sides are generally both affected.



Another application of this method is if the two endpoints of a branch are unchanged, and only the brach itself is modified.

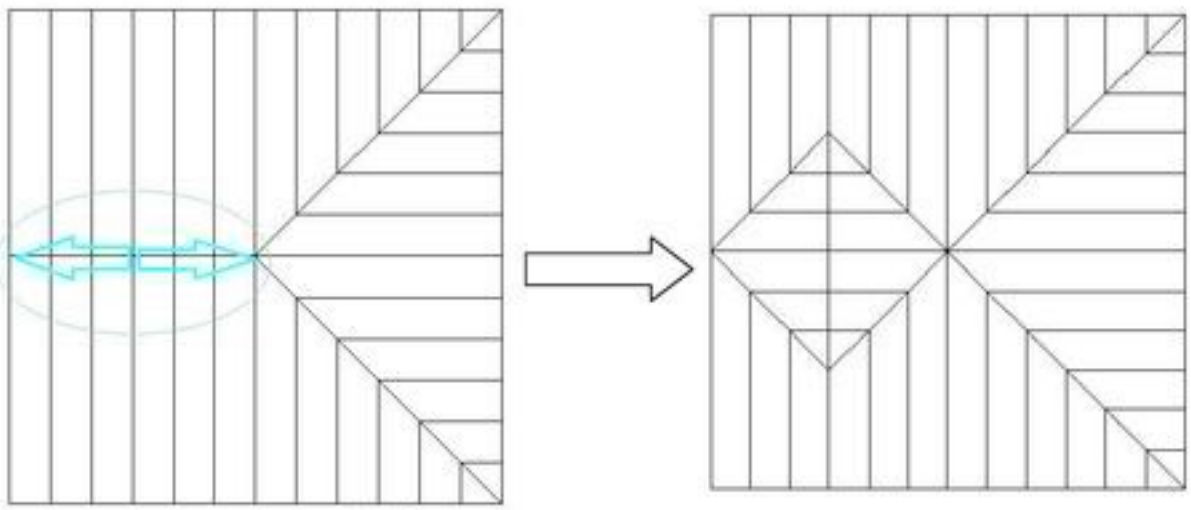


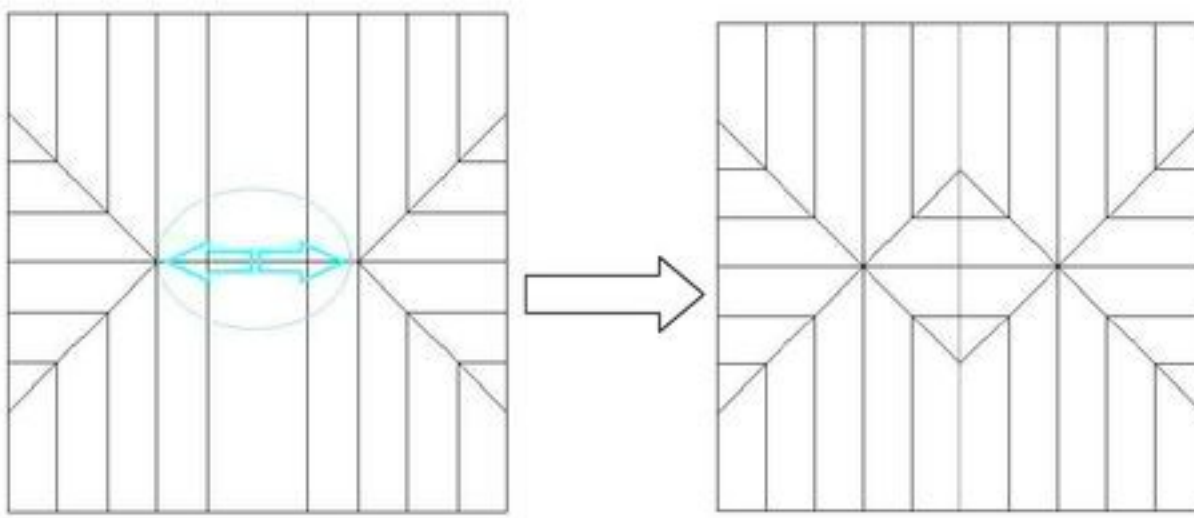
There are many different ways to change the branch, but in all cases the sum of the lengths of the branches before and after the change remains constant. This method is suitable for local adjustment.

Second, pulling branches

If there are many parallel lines in the same direction near a branch, and these lines do not form a branch, but are simply gathered together, then we can open them. This process is called "pulling branches". The most typical use of this technique is to the create hair for characters.

Here are two examples:

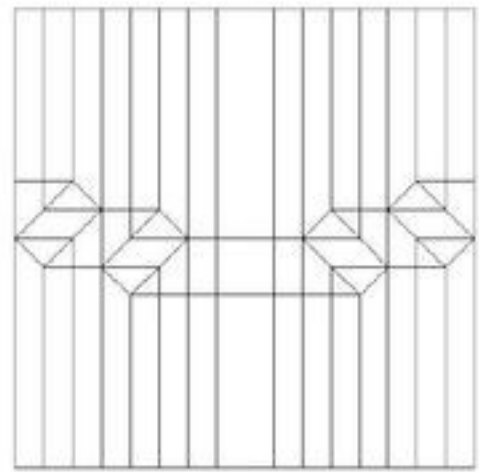


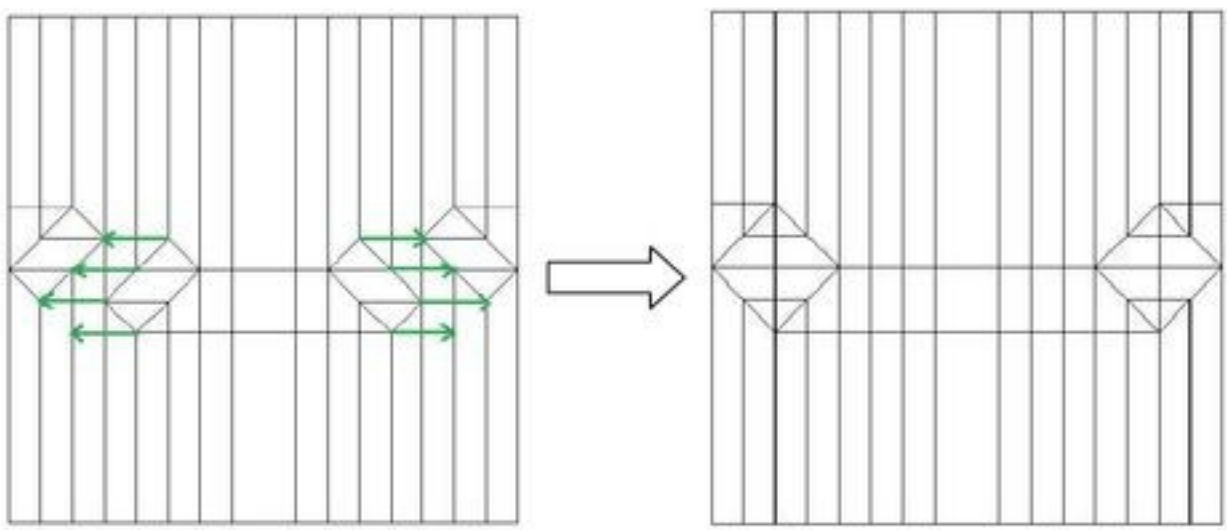


Third, translation

Sometimes the problem of excessive thickness of individual branches can be solved by the translation of the structure to keep the thickness uniform.

Taking this CP as an example, the structure produces a two-unit branch from the middle, but this branch is very uneven, with a thin tip and a thick base. We can perform structural translation on this CP, and the specific operations are as follows:



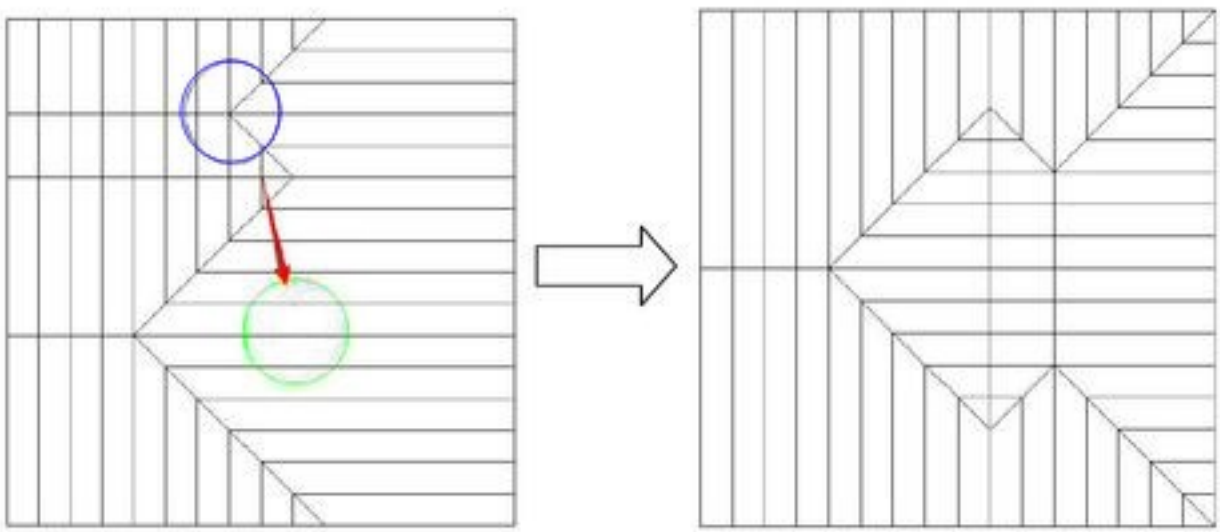


In this way, the thickness of the entire branch can be made uniform.

After the continuous adjustment of branches, the structure will inevitably become messy, so we can use this technique to optimize the structure.

Fourth, the use of the z-axis

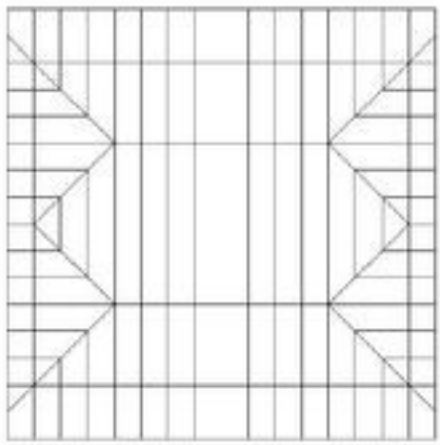
When you think that there is not enough paper on the outer edge of the paper, you can consider using the z-axis branch. For example, in the following is a five-unit hand + two-unit sleeve structure, you can move the blue ring (sleeve) to the green circle.



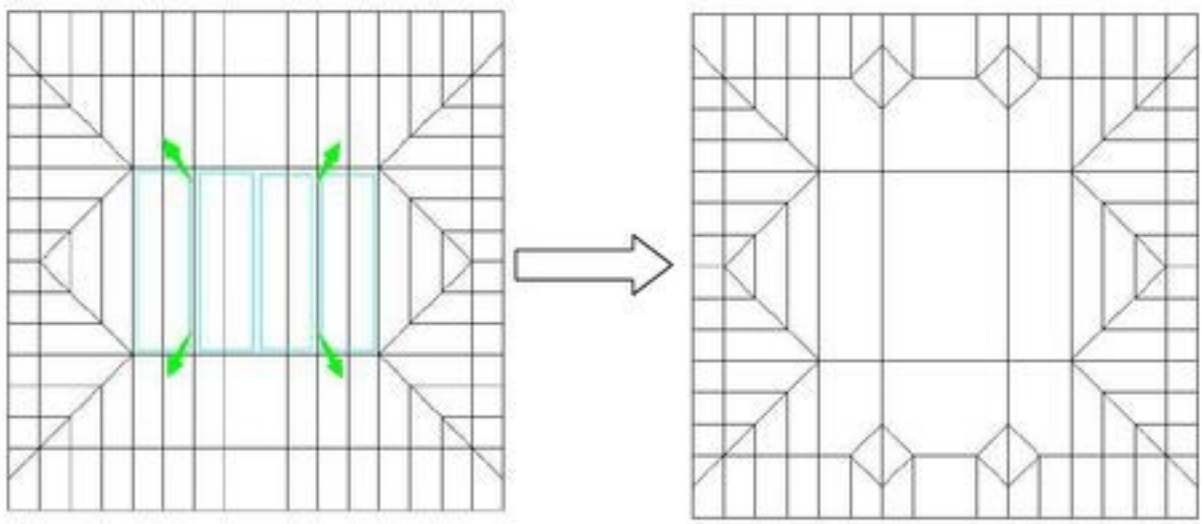
Comparing the two structures, the first type uses more paper in the y-axis direction, and the second type uses more paper in the x-axis direction. In actual applications, the corresponding structure can be applied in the direction with more available paper.

Fifth, widening

This is technique of opening a linear branch to make it into a wide branch is very important. It is generally opened on the horizontal or vertical axis. Let's take a vertical axis as an example:



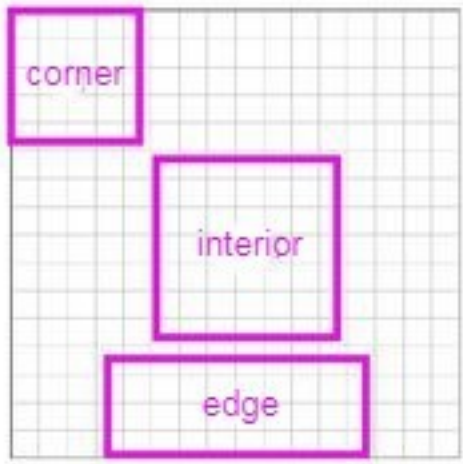
Obviously, the prerequisite for pulling out the paper is that there are enough vertical lines next to the vertical axis. Now we stretch the branches one unit to the left and one to the right.



In general, for a branch on the vertical axis, for every n squares drawn, 2n squares are used above and below the axis, for a total of 4n squares, which should be reserved in advance when designing.

Sixth, internal strengthening

First, let's compare the branches on the corners, edges and interior of the square

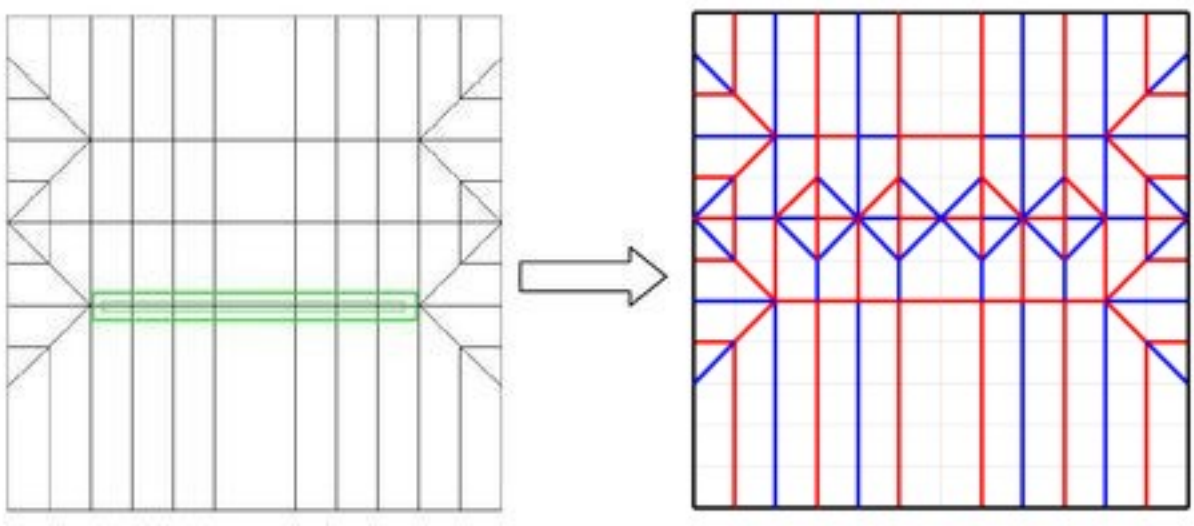


Corner: more flexible, but small in area

Edge: more flexible and large area

Interior: large area, but not flexible

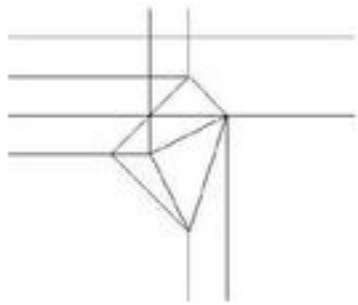
So we try to make the internal large-area branch into a branch on the edge, making it more flexible:

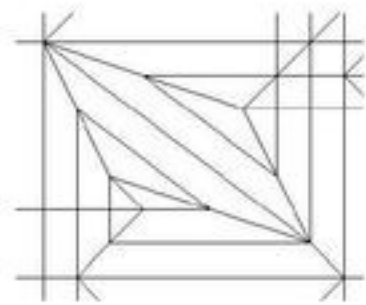


The part of the green segment that was originally inaccessible has transformed into a more robust pleated structure like the edge. This technique is often used on characters' vertical axis to strengthen details such as collars, clothes and skirts. Note that each use of this technique will use two units.

Seventh, special angles

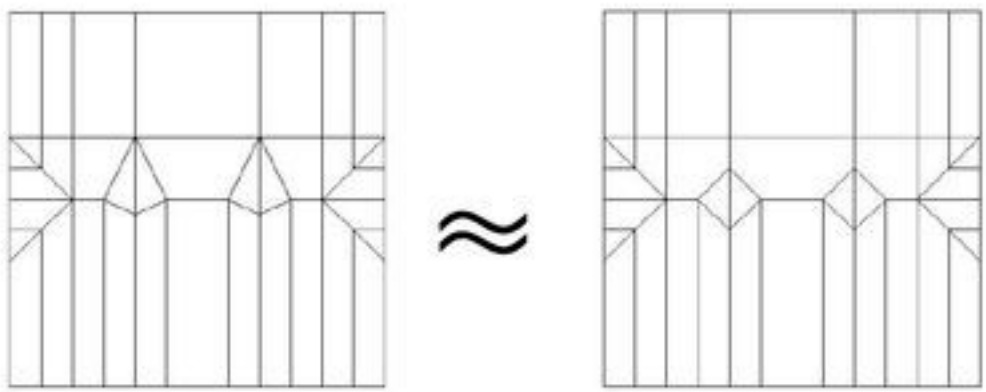
Sometimes you will encounter some angles other than 45 degrees, for example:





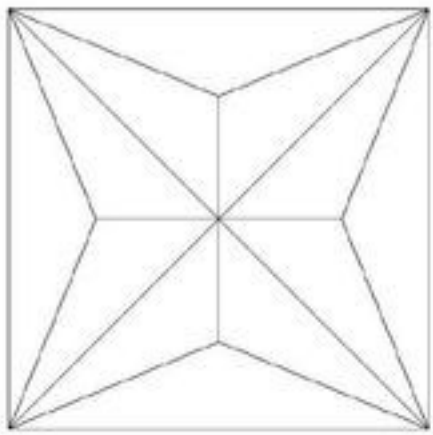
In general, there are two reasons for this situation:
(a) Branches coherently connecting 2 structures
(b) To form some compatibility of branches that cannot be achieved through horizontal, vertical and diagonal lines

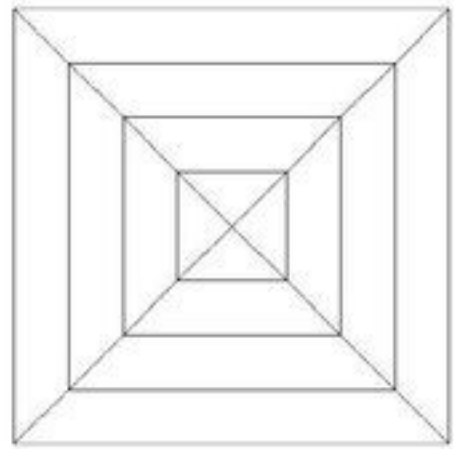
In the two examples above, the diagram on the left belongs to the first type, and the diagram on the right belongs to the second type.



Regarding its usage, you can only use these methods in specific circumstances.

Next, let's compare the "cross-shaped" structure with the "bird base" structure:





Both have four branches that are half the length of the side, but there is also a short branch in the middle of the "bird base" structure, and for structures that are only composed of horizontal lines, vertical lines, and diagonal lines, no matter how many equal parts are used, this cannot be achieved (when there are four branches with half the length of the side). This is probably a small limitation of the pure DP, but it has basically no effect on character origami design.

Simple Structures

First, an overview

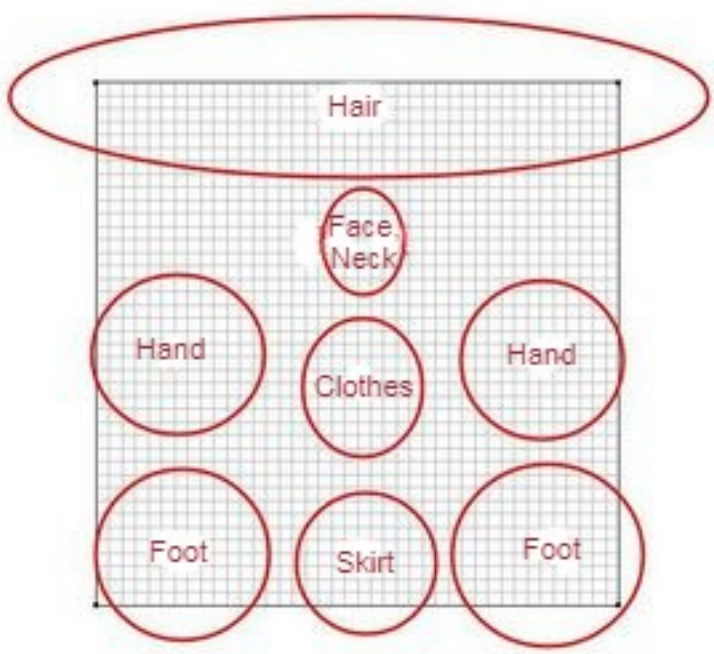
There are many structures of BP characters, and we can classify them according to the following criteria:

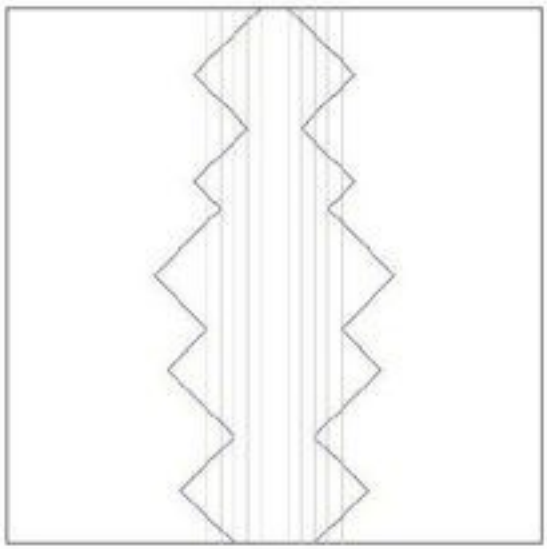
1. Single color / Color changed
2. Symmetrical / Asymmetrical
3. Simple / complex shape
4. Details on one side / completely detailed

If any of the former options is used, then the structure is very simple, just use the structure mentioned in "Basic Knowledge". Once one of the latter options is chosen, the structure becomes complicated. In this article, the design of the BP character is only briefly introduced, so only a few simpler structures are presented.

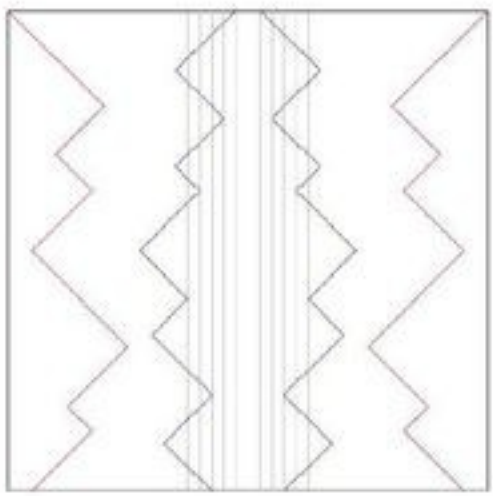
Second, symmetrical structures

That is, the structure in "Basic Knowledge" is suitable for characters with single colors, symmetry, and simple shapes





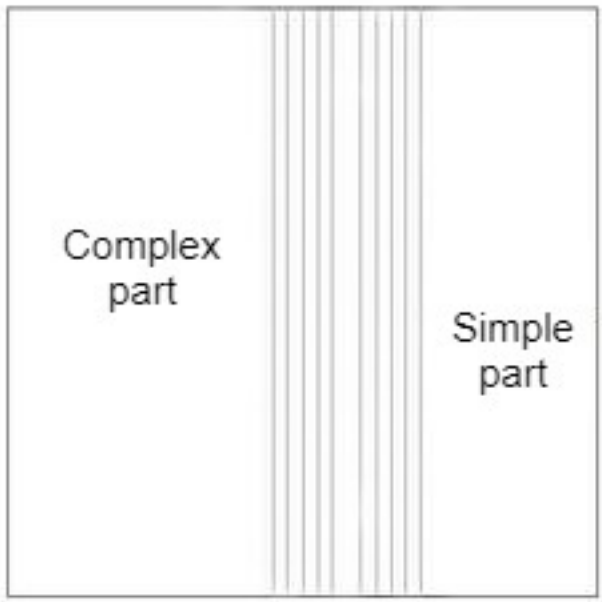
The design of the character starts with the vertical axis of the center, and the part that needs to be expressed on the vertical axis is considered first. For example, hair, bangs, face, collar, bow tie, dress hem, skirt, etc. from top to bottom.



Then design branches on the edge. After creating a rough draft, use various techniques to adjust, optimize, and finally shape it.

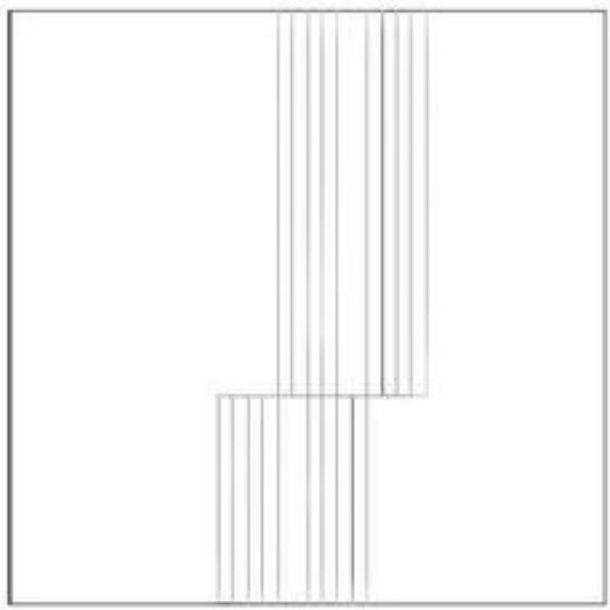
Most characters can be completed with this structure. But if you want to make your work eye-catching, you should consider advanced techniques such as color changes, 360-degree details, asymmetry, complex modeling, and multiple objects in one paper, not just one method.

Third, off-axis asymmetric structures



When we begin the design, we shift the position of the vertical axis slightly to one side, so that the two parts divided by the vertical axis have more and less paper, which can be used for complex parts and simple parts, respectively.

This method will be more effective and easier to use for characters that are obviously asymmetrical.



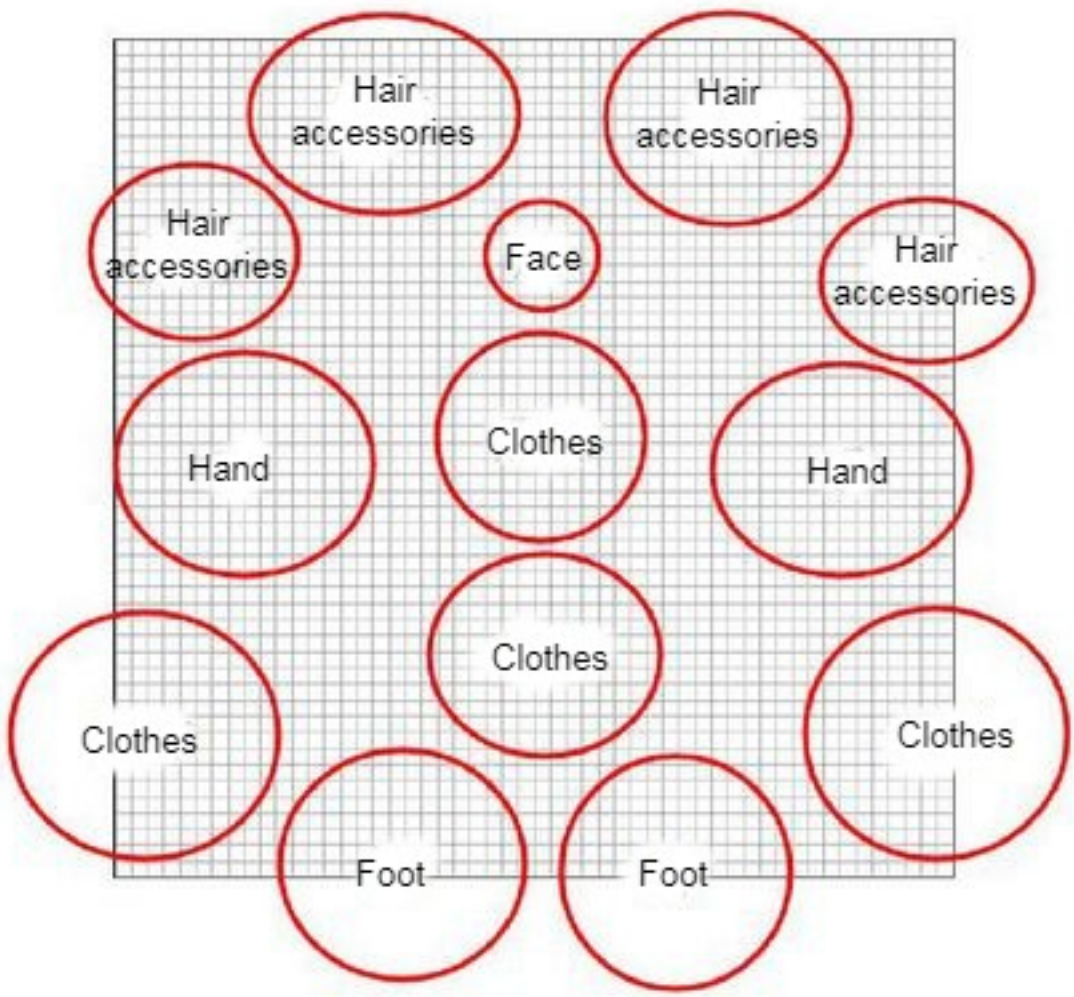
We can also translate the axis twice to form a "variable axis structure".

The rest of the design is similar to the "axisymmetric structure".

Fourth, compact structure

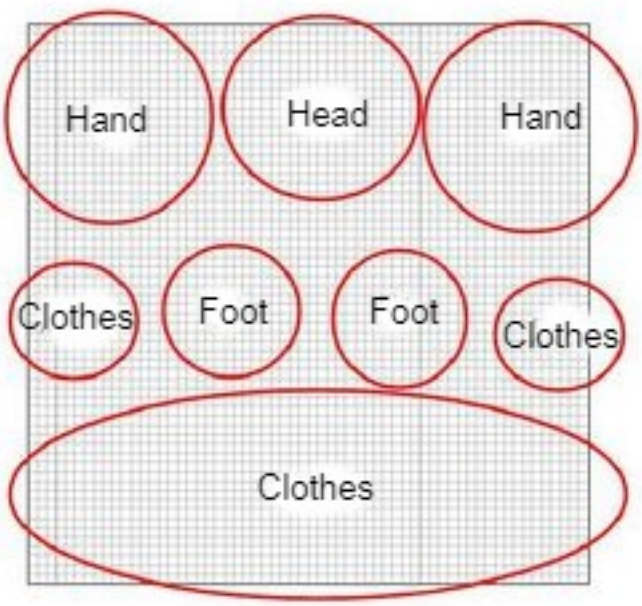
This is has small changes from "axis-symmetric structure" and it is more complicated, so as to obtain more available branches. Due to the large number of branches, the branch length must be short, and the whole is more compact, and the requirements for modifications will increase.

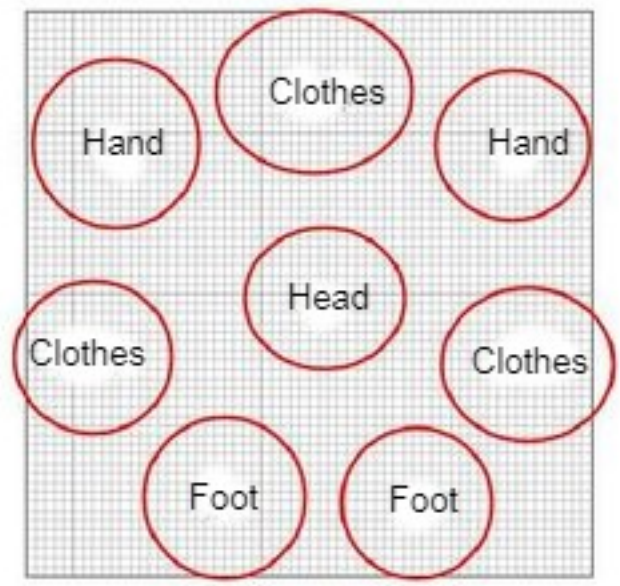
We can carry out various small changes to basic mechanisms, and the following is just one example:



5. Enclosed structure

The branches in the previous structure are basically imitating the human body, arranged in order from top to bottom. We can also change the order and put the feet or head inside the paper, so that the design will start from the center of the paper, and the remaining branches are surrounded from the outside, so it is called "enclosed structure", and generally you cannot use this method with small grids. You use this method to obtain many branches and also have 360-degree details.





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