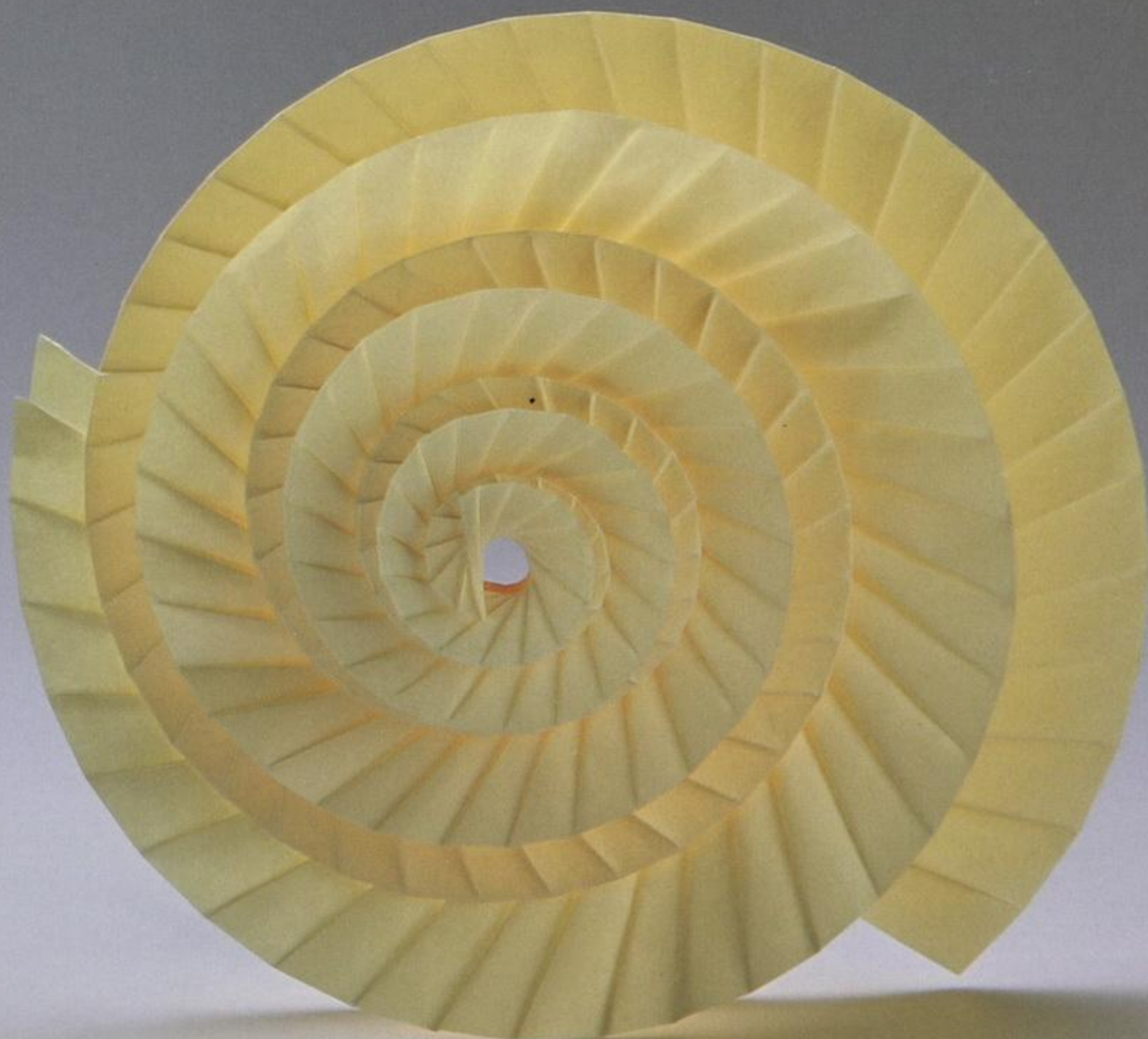


布施知子

TOMOKO FUSE

SPIRAL

ORIGAMI | ART | DESIGN



This is a book about folding ideas. A world full of magic curves, paper figures hard to imagine, are represented here.

A SPIRAL is a fascinating and complex form. A theme Tomoko Fuse has occupied herself with for many years.

In this book you measure, you cut, you assemble and you create. How to show the dynamic, the beauty and the poetic in these spirals? How to explain the path, the proper way to get to these forms? How to present three-dimensionality and the energy of those models created by Tomoko Fuse on the flat pages of a book?

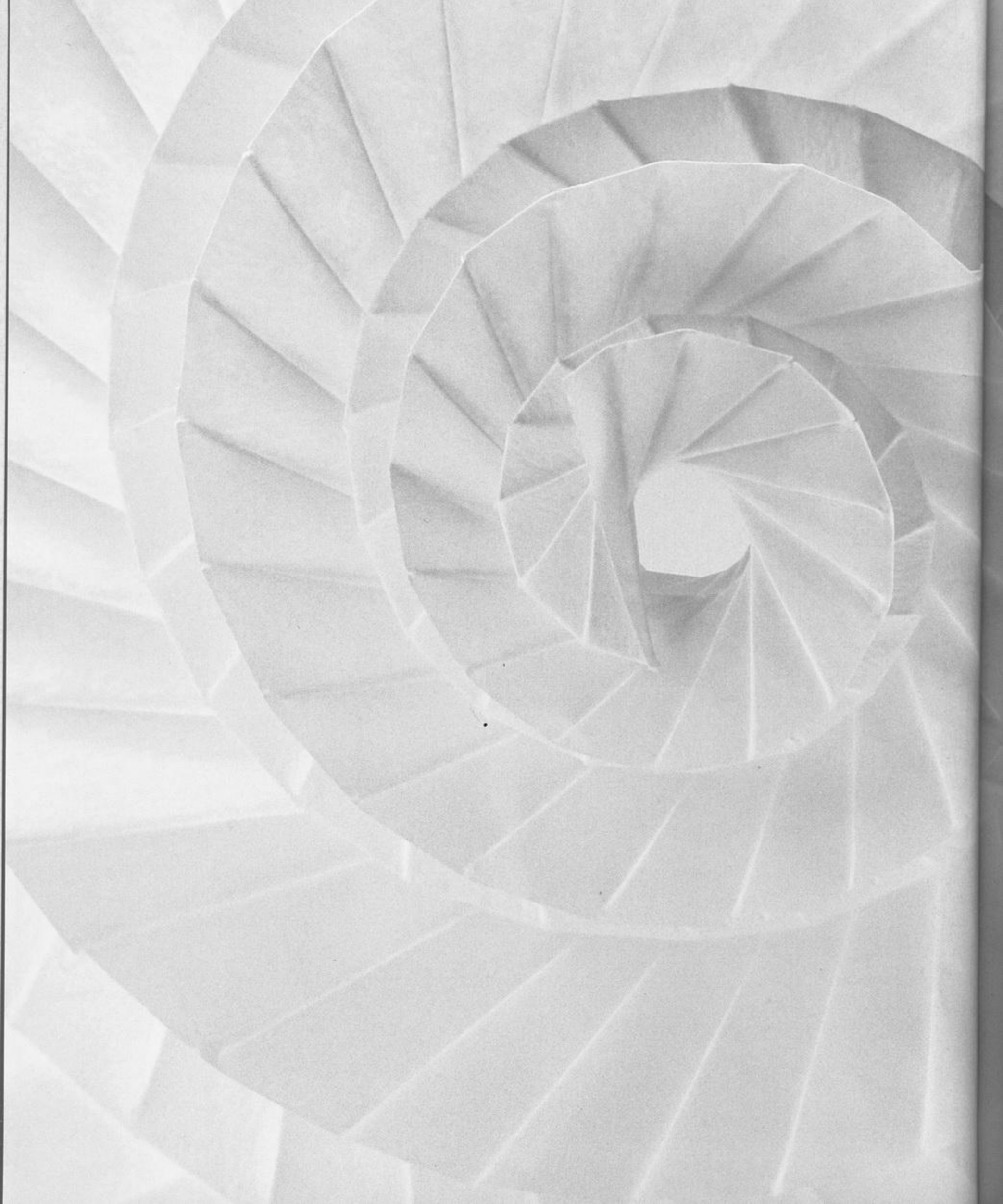
To assemble all this examined and highly-developed material of Tomoko Fuse and present it within such a book turned into a challenge for me and all who have been directly involved in this project.

Are we discovering Origami or is Origami discovering us? With the realization of this project, the first book of the VIERECK VERLAG, we would like to facilitate this discovery.

Many times we think: we fold the paper – but the paper is folding us.

Paulo Mulatinho

Publisher VIERECK VERLAG





布施知子

TOMOKO FUSE

SPIRAL

ORIGAMI | ART | DESIGN



VIERECK VERLAG

FUSE, Tomoko

SPIRAL – ORIGAMI | ART | DESIGN

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The Spiral is a spectacular form, dynamic and full of energy. This book shows the results of my informal spontaneous experiments of folding spirals and is not really a document of detailed scientific research.

The results that I have obtained are the outcome of folding, and not from attempts to imitate nature. Often I exclaimed »wow!« out loud when the paper formed unexpected shapes, even after random folding: this was a surprise gift from origami.

I hope that this book conveys my enjoyment in these forms, and reveals new paths to explore in origami.

Tomoko Fuse

PREFACE

At first, I wondered what this book is about. When I opened the pages, the coherent and multifold beauty of the images caught my eyes, and, reading on and on, these images infinitely expanded their own worlds. I do understand that it is an origami book, but it is much more.

The term *origami model* often reminds us of a kind of paper sculpture enclosed in a finite space. This is also true of the models in this book. However, once we pay attention to the essence of any model here, we can find ourselves either released into an infinite space, or alternatively swallowed into an infinitesimal space.

Why? Let me point out the fact that, even though spirals are based on a circle, they can expand out of the circular space by altering the mode of curving little by little. Ms Fuse magically handles delicately pleated layers in such a way that she is *spinning* paper with them. Only a little change in her manipulations with the paper can result in various styles of spirals, energetically running through space. The curves there often seem beyond any possible shapes of origami.

Once Ms Fuse talked to me about her way of folding: »First I imagine, at random, what shape I would like to fold. While folding the paper, the image of the final shape gradually materializes. In other words, I am creating the model guided by natural property of origami.«

I am certain that, in the woods in the mountain of Shinano, Japan, many beautiful spirals are created that we would otherwise never have seen.

Professor Koryo Miura

Professor Emeritus, University of Tokyo

Professor Emeritus, Inst. Space & Astronautical Science, JAXA



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MORE HELICES AND SPIRALS

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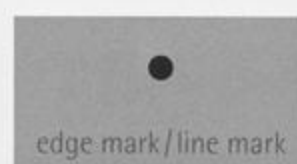
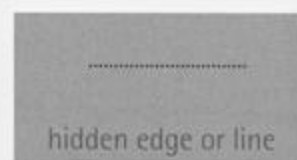
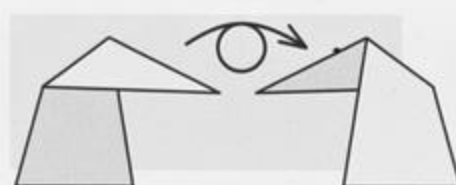
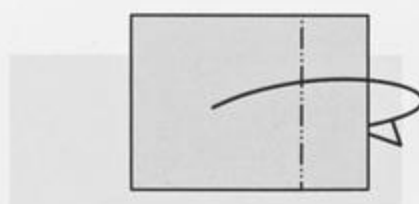
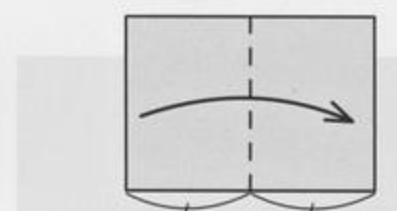
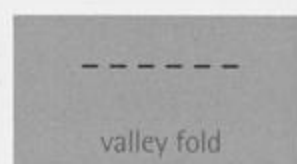
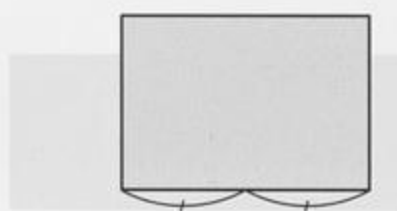
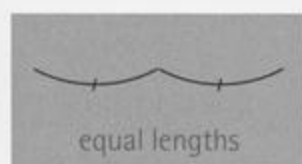
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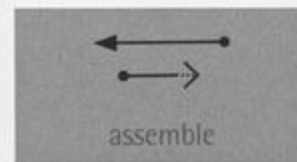
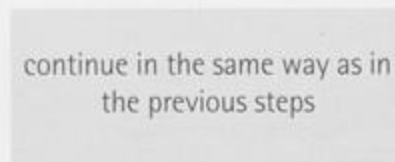
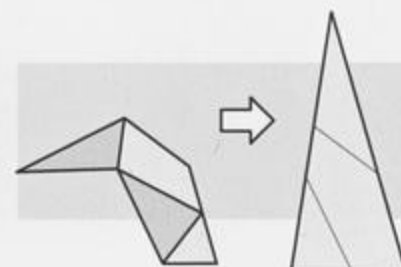
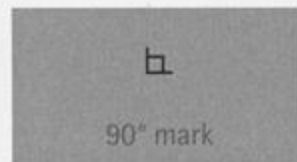
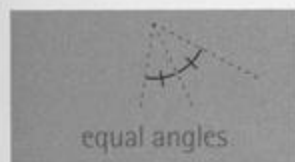
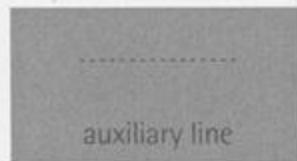
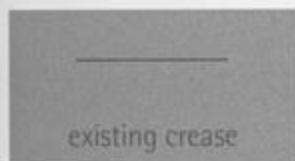
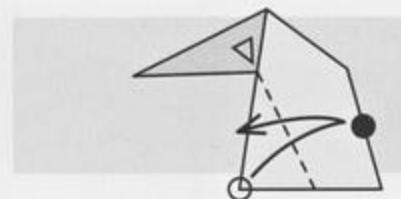
ABOUT TOMOKO FUSE

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A portrait by Florian Aicher

SYMBOL LEGEND







Spirals and Helices are geometric structures that occur in the smallest and largest bodies within the universe. Their shape occurs in the infinite cosmic clouds of the Milky Way, as well as in the tiniest bio-molecules. The beauty of this infinite geometry evokes marvel and tranquillity in the eye of the beholder, as he senses that there are entities in life that possess neither beginning nor end.

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HELICES AND SPIRALS

In both the natural world and the man-made world, there are many convoluted objects. The curling tendrils of climbing plants, shells, rams' horns, spiders' webs or DNA are some examples of such things that can be found in nature. Corkscrews, mainsprings, coil springs or soft serve ice cream cones are cases of man-made objects.

For convenience I classify them in two groups: *Helices* are three-dimensional curves that wind around an axis often at a constant distance while moving parallel to the axis. *Spirals* are mostly two-dimensional curves that wind around a fixed centre point at a continuously increasing distance.

Using a narrow strip of paper you can easily create both: a spiral by winding it into a coil, and a helix by twisting it at both ends. In origami, however, we use straight folds only.



1
2
3
4

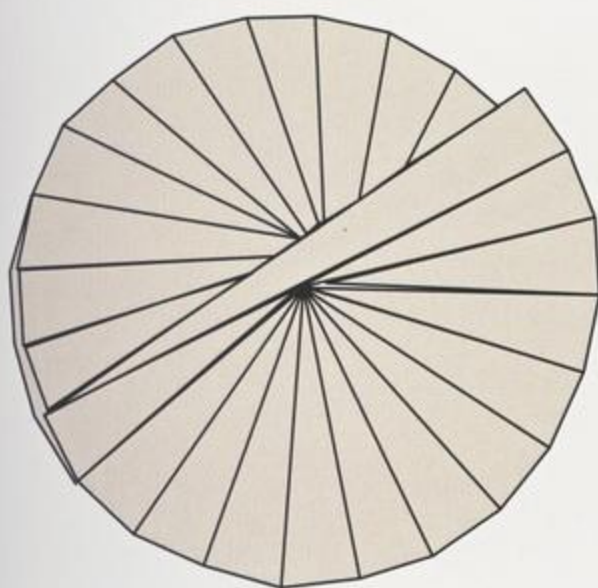
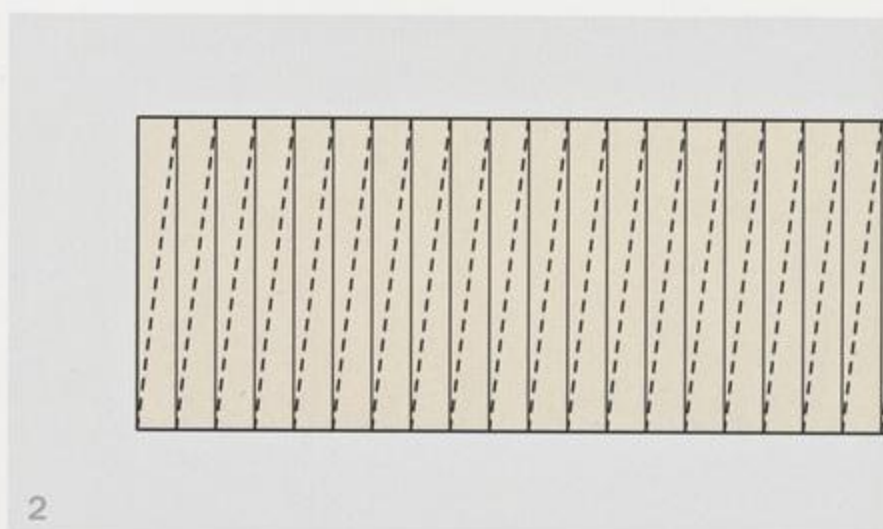
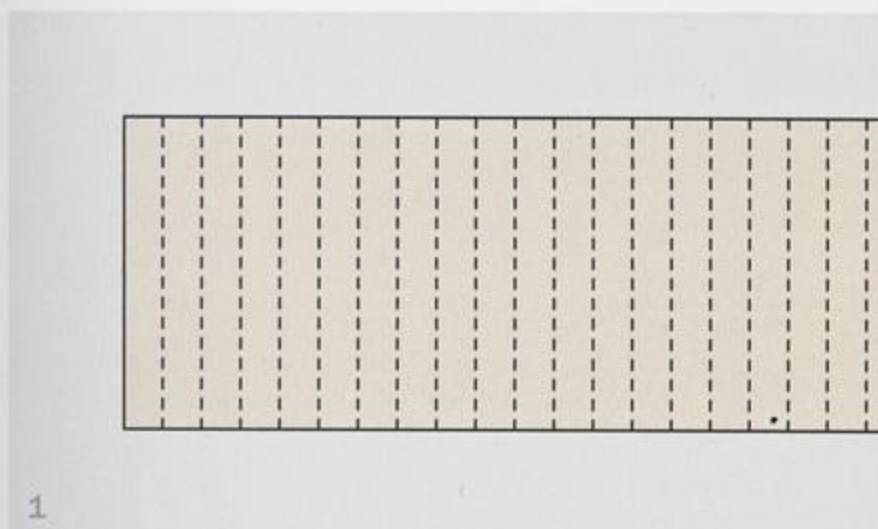
HELICES AND SPIRALS

簡単なつる巻き

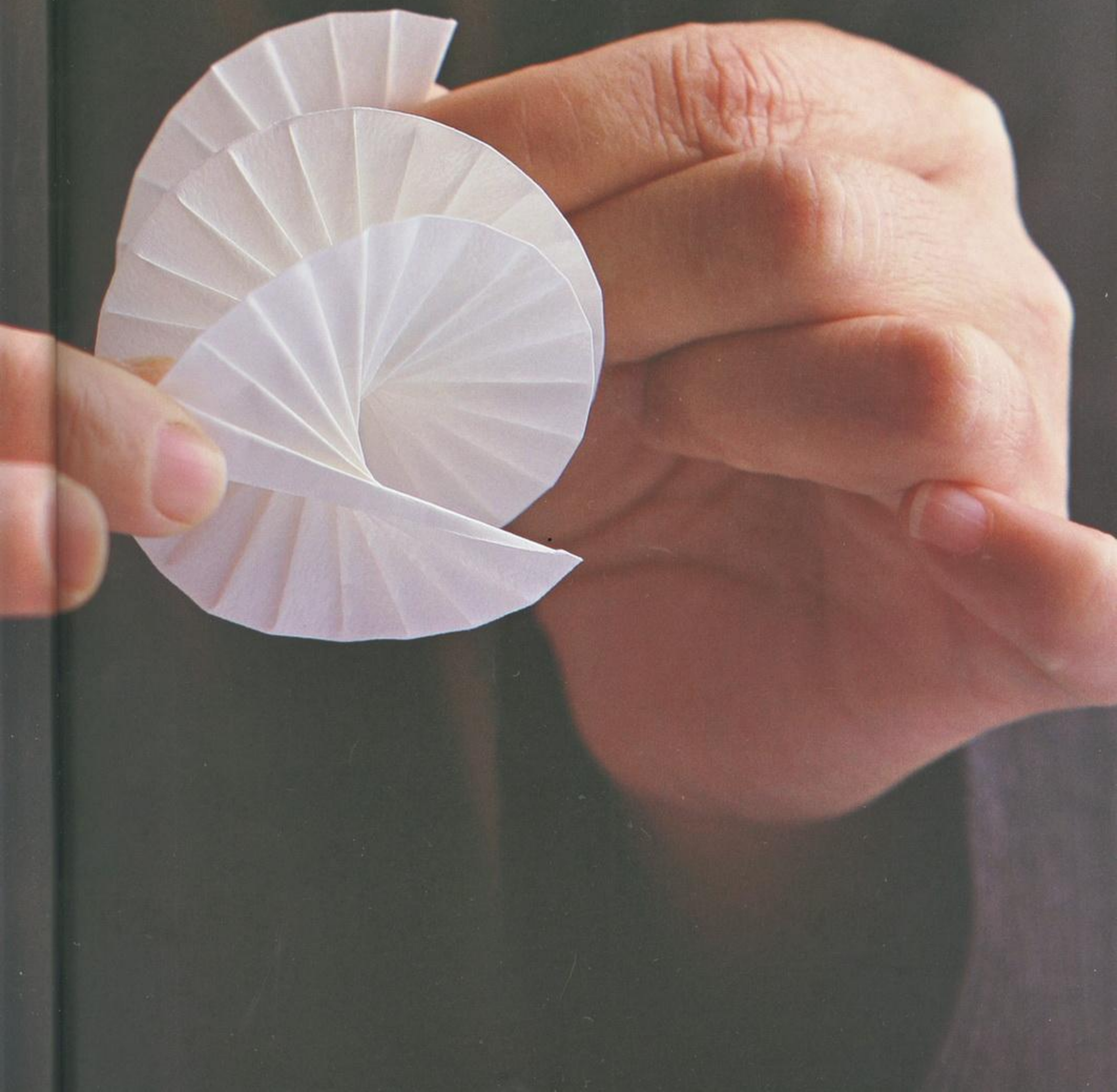


SIMPLE HELIX

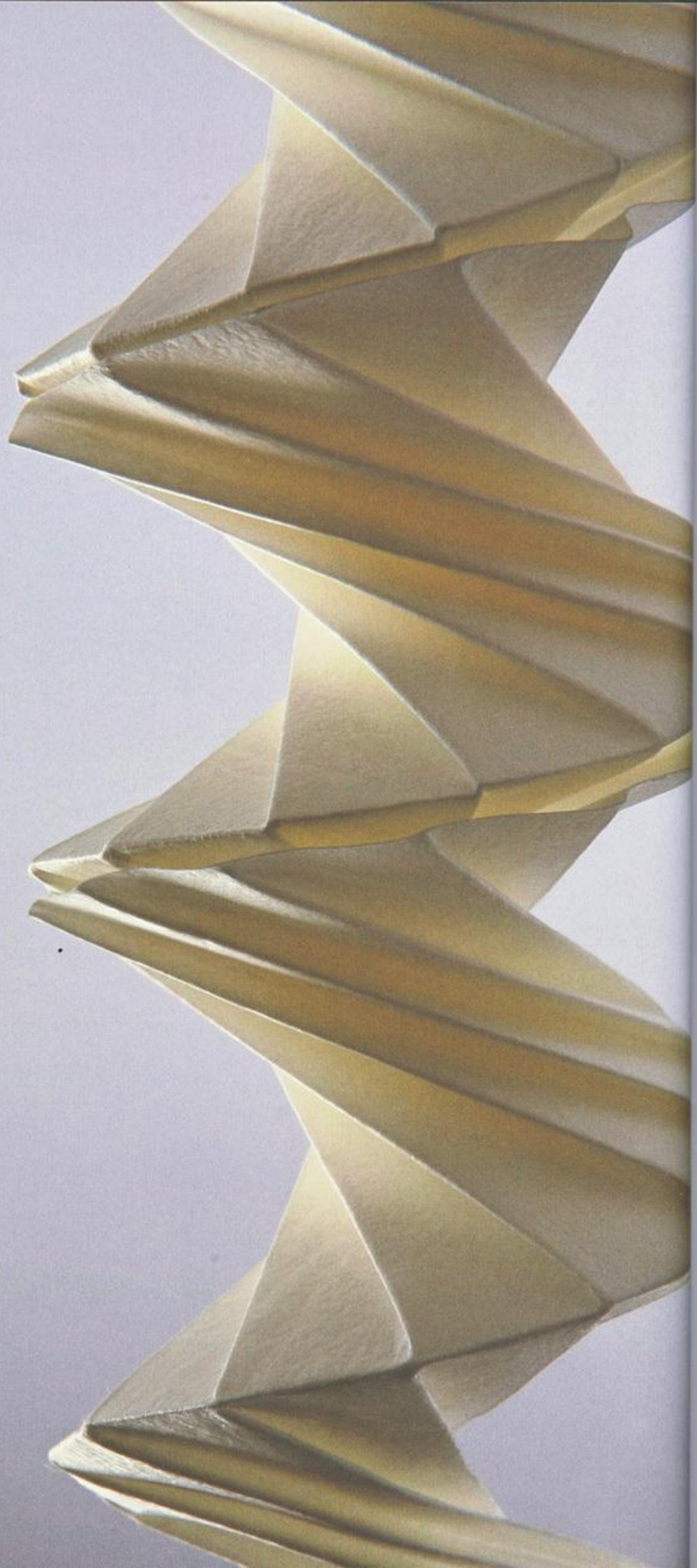
Start with an A4 format cut in half as shown and fold equidistant valley creases. Turn over and make the diagonal creases. After making all mountain and valley folds, the model becomes circular. Pull gently at both ends to expand the helix.







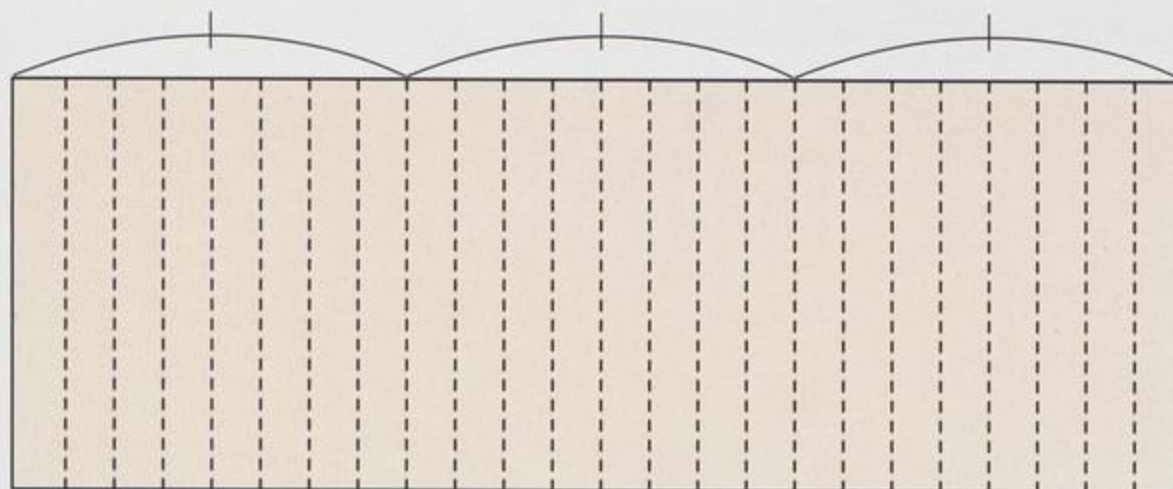
つる巻き二枚重ね



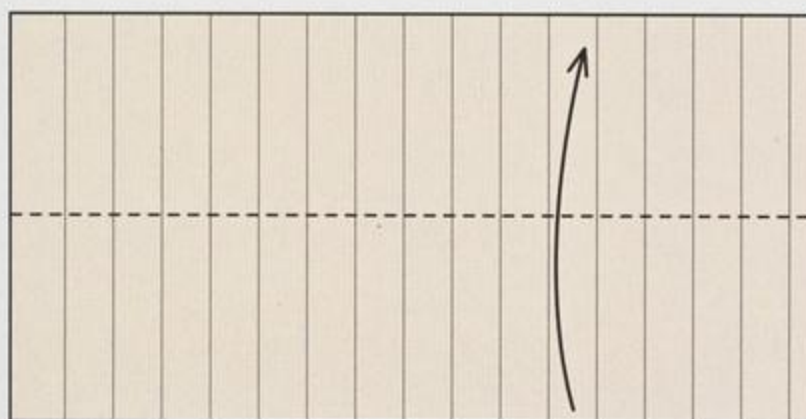
TWO-LAYERED HELIX

Later we will work with four layered rectangles and trapezoidally shaped paper folded into two layers. More and more impressive results are obtained as we progress to the next starting shape.

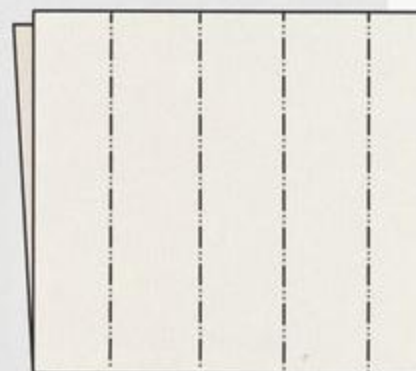
But for practice, begin with an A4 format cut into halves lengthwise. You will get a more interesting model when you use longer paper. The creases are equidistant but the distance is arbitrary.



1

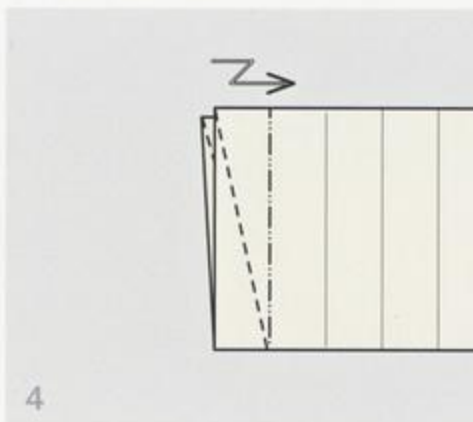


2

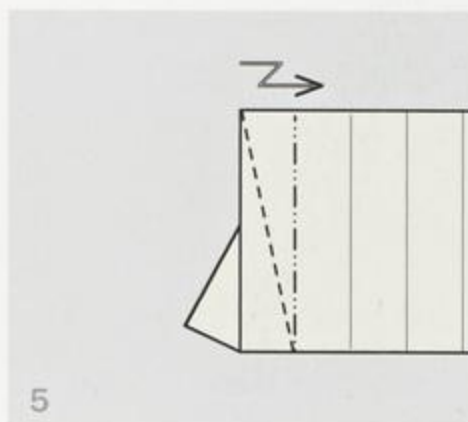


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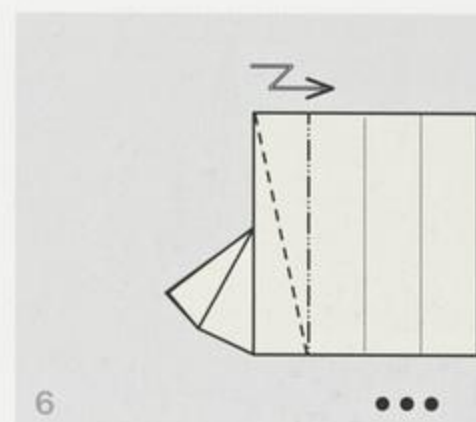
Mountain crease both layers together.



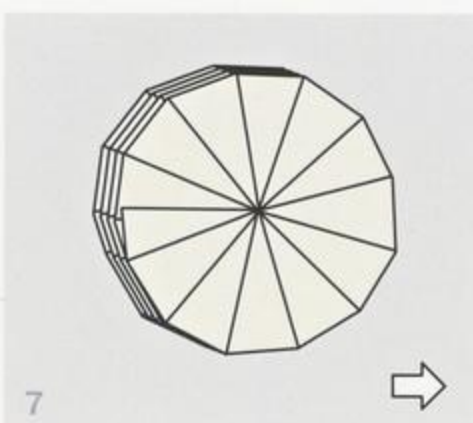
4
Fold both layers together.



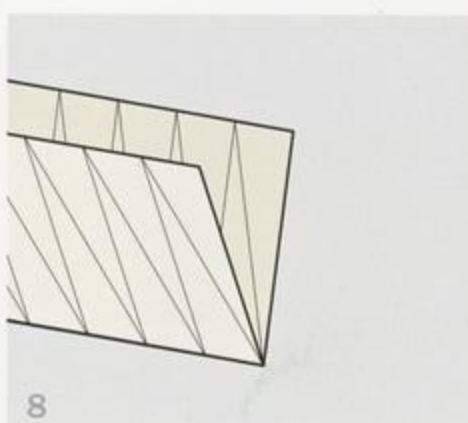
5



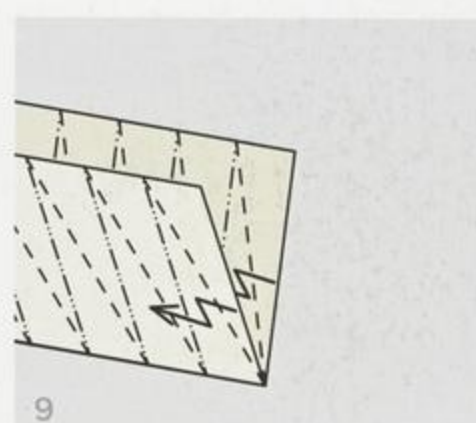
6



7

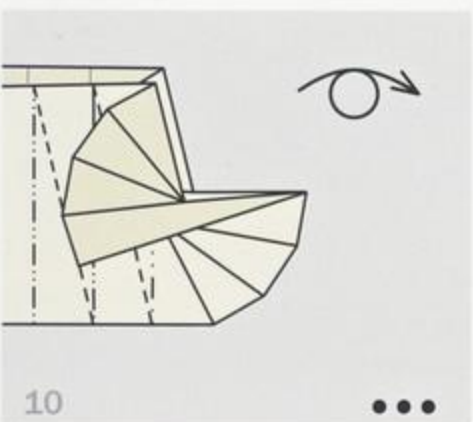


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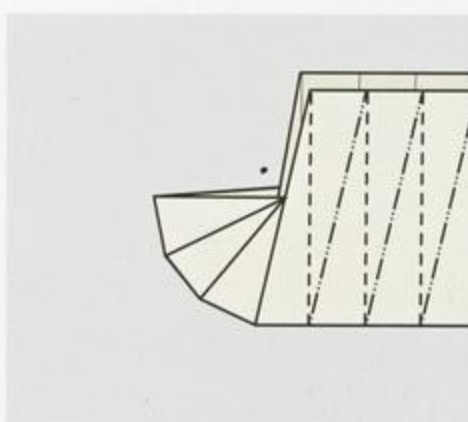
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Continue at this end.

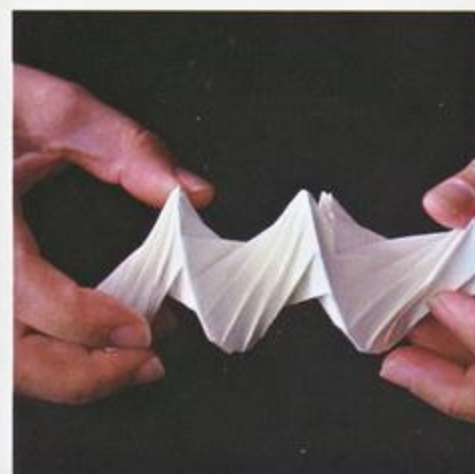


10

Move the two layers slightly apart and fold each layer separately using only the existing creases without changing their orientation.



View of reverse side.



The photos show the folding method starting with step 7

つる巻き二枚重ねー孔があく場合

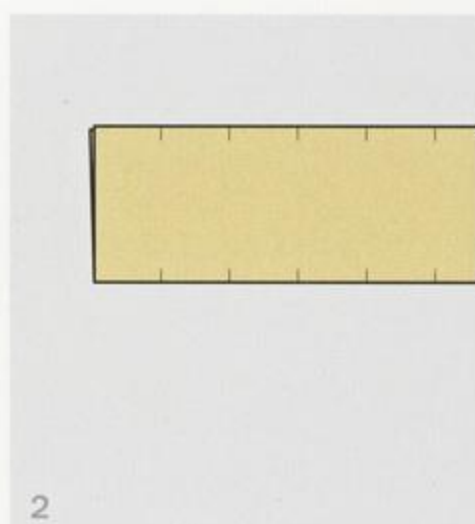
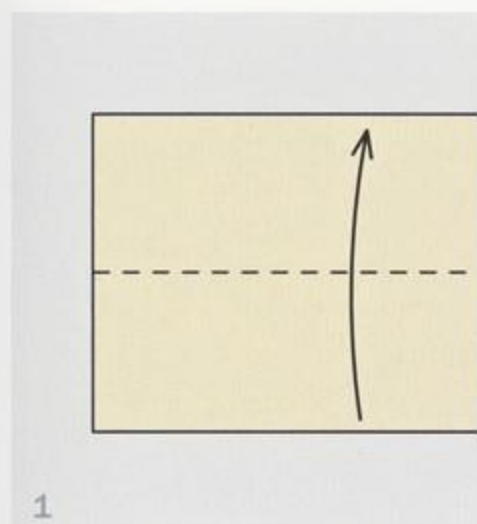
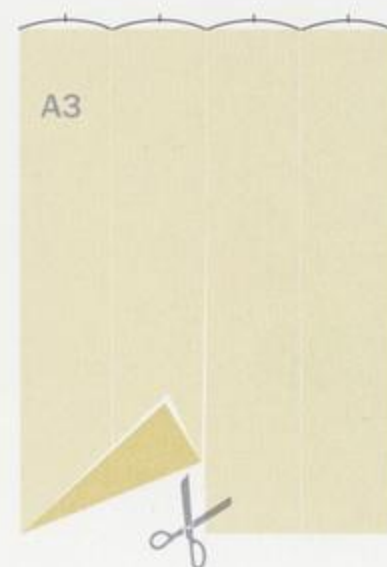


TWO-LAYERED HELIX WITH HOLE

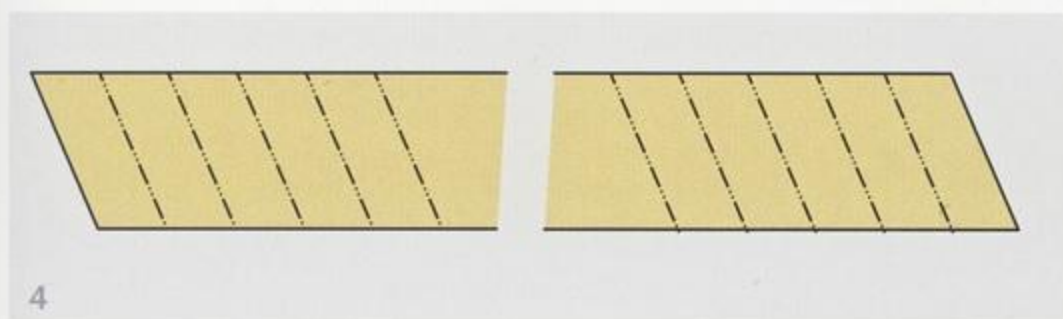
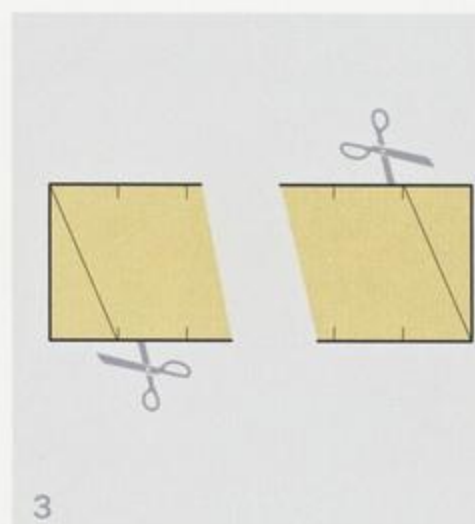
You will get a helix with a hollow axis if you incline the pairs of mountain and valley folds as shown below.

A greater inclination will result in a bigger hole.

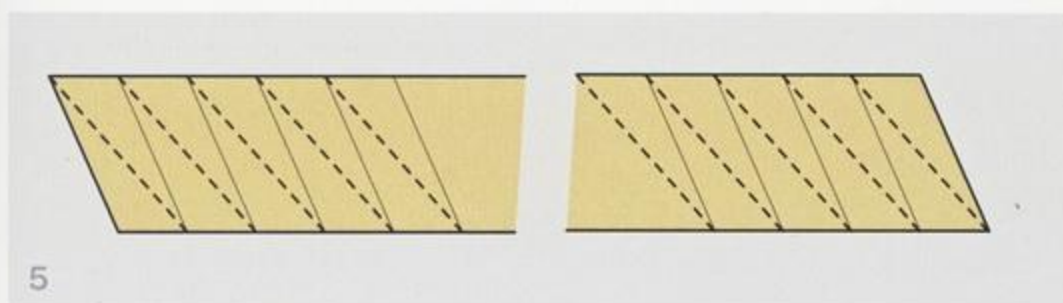
The method of folding is exactly as with the Two-layered Helix shown on the previous pages.



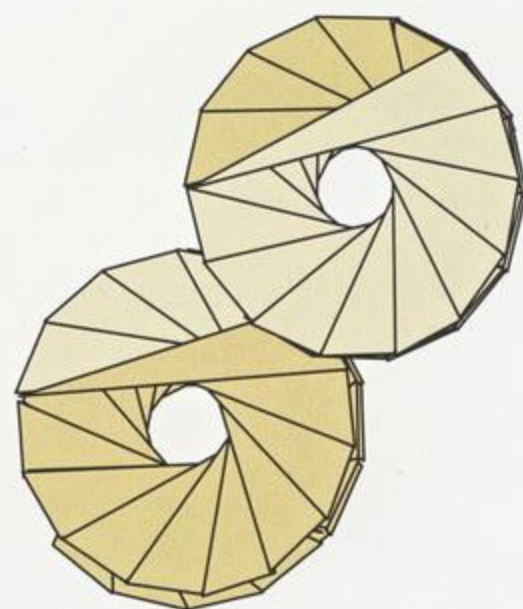
Mark at distances approx. 1 cm apart.

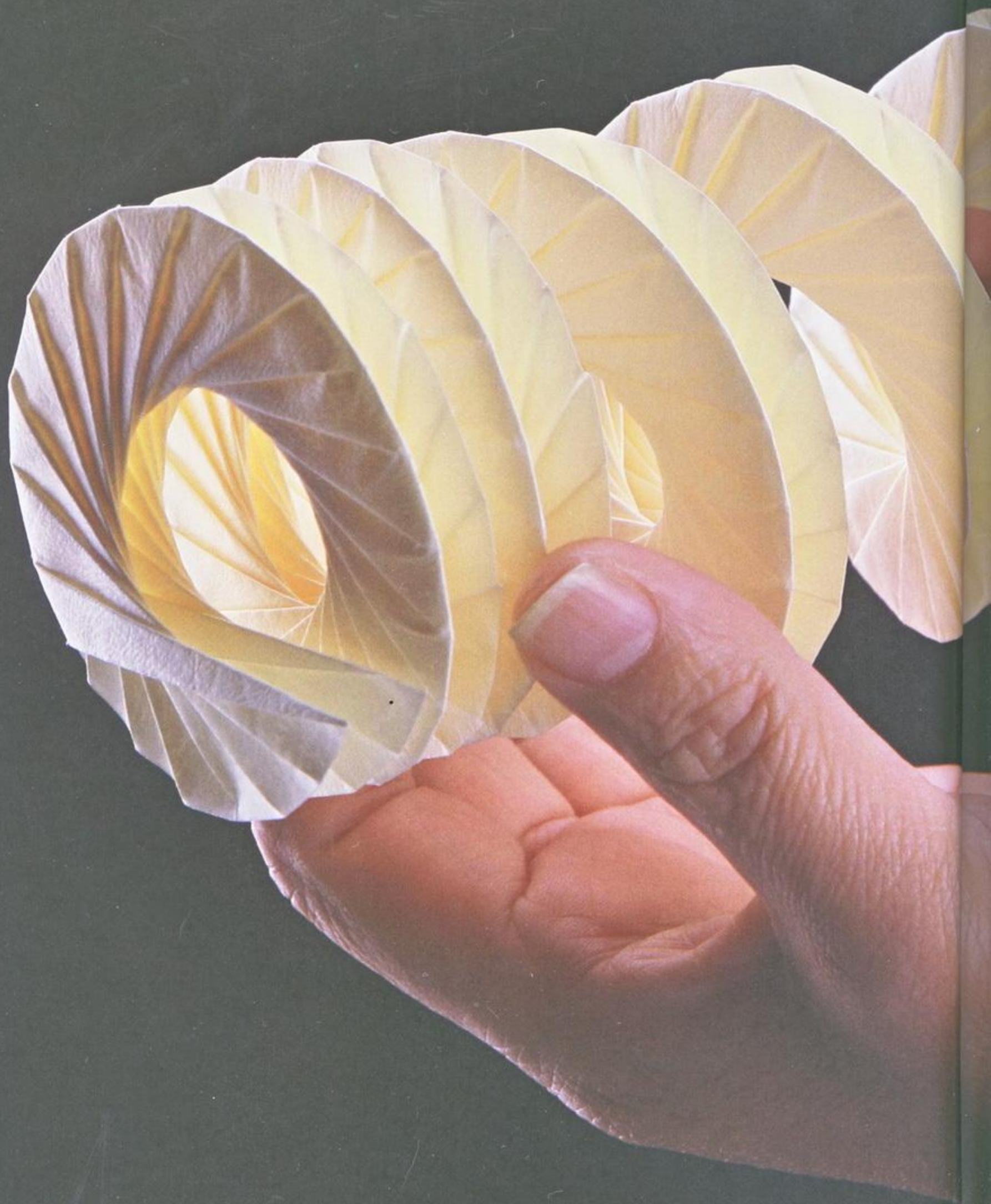


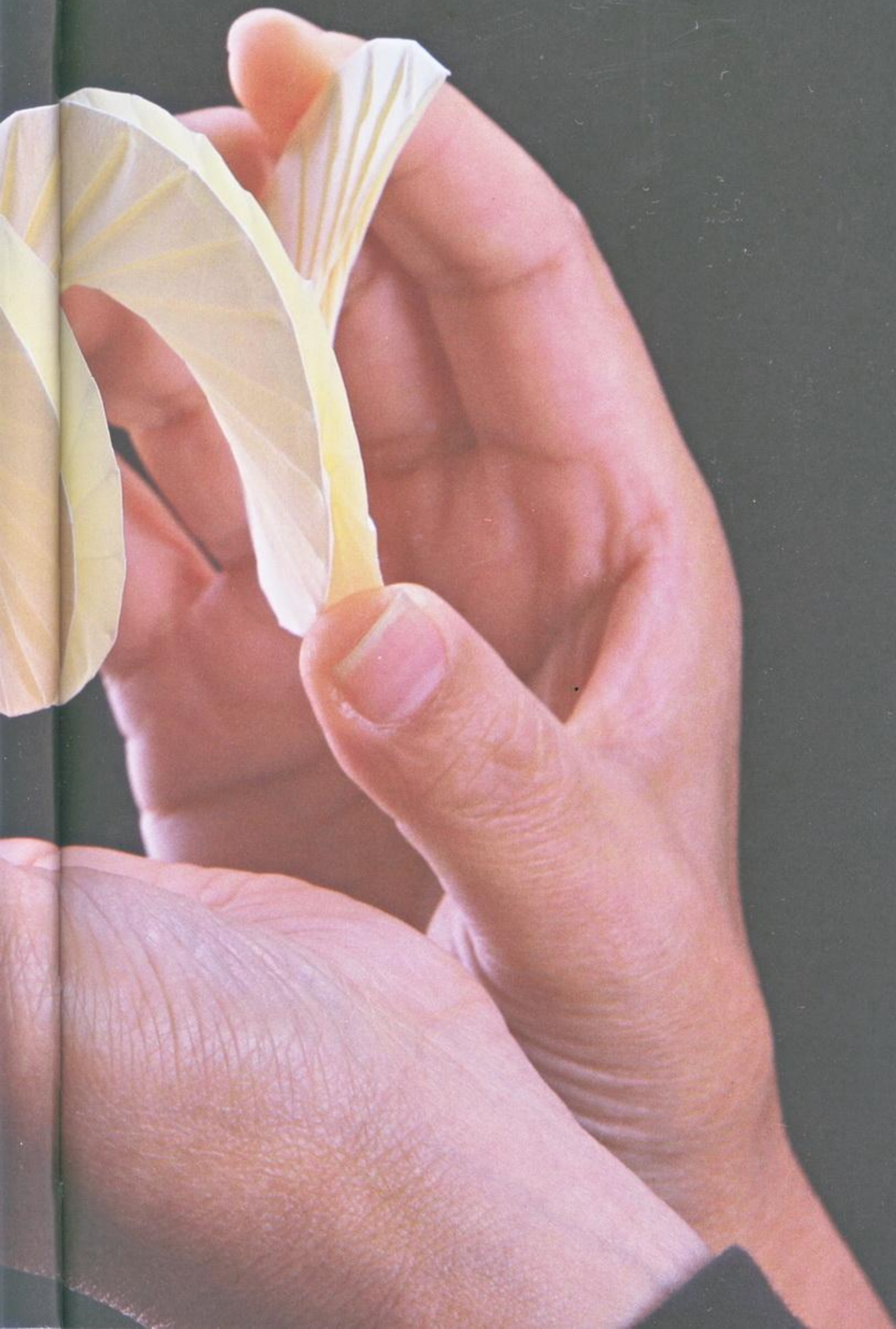
Crease both layers together.



Crease both layers together. Continue as in »Two-layered Helix« from step 8 on page 26.





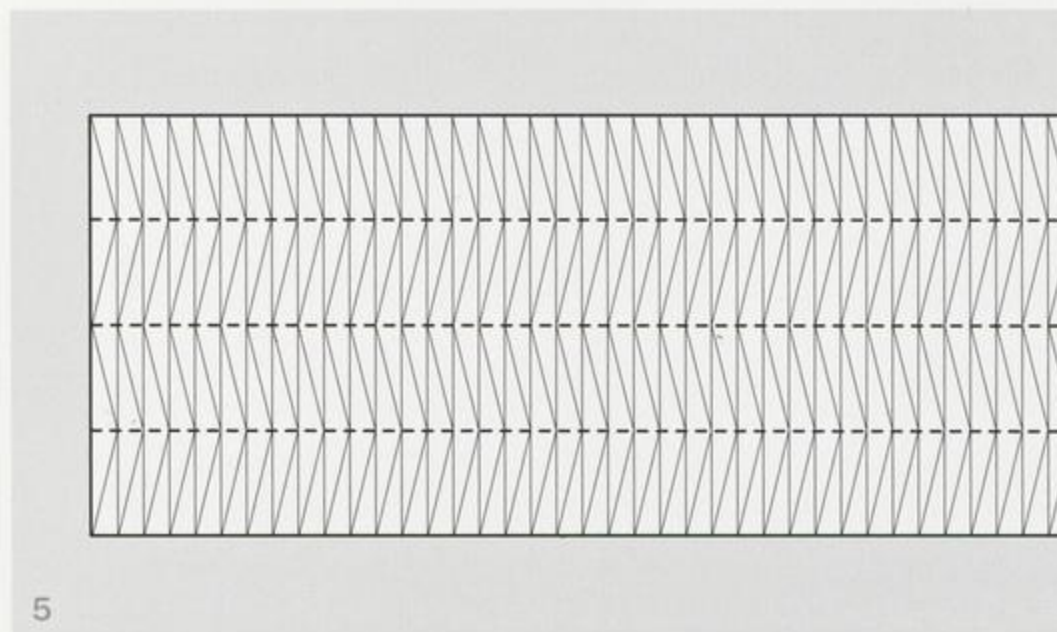
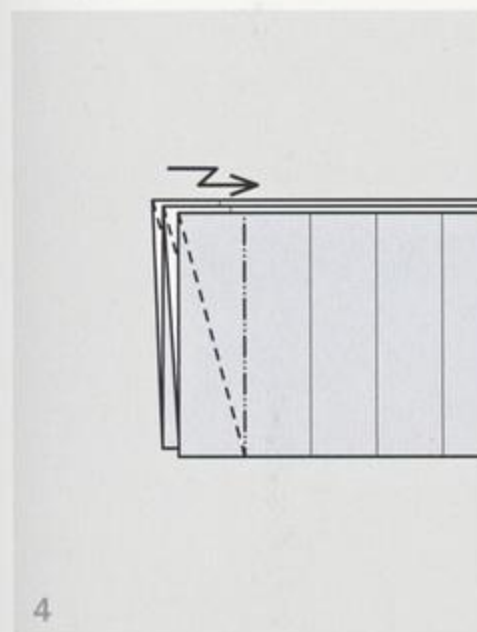
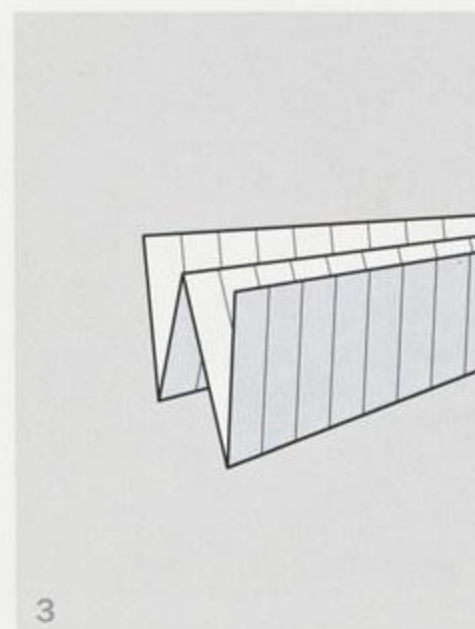
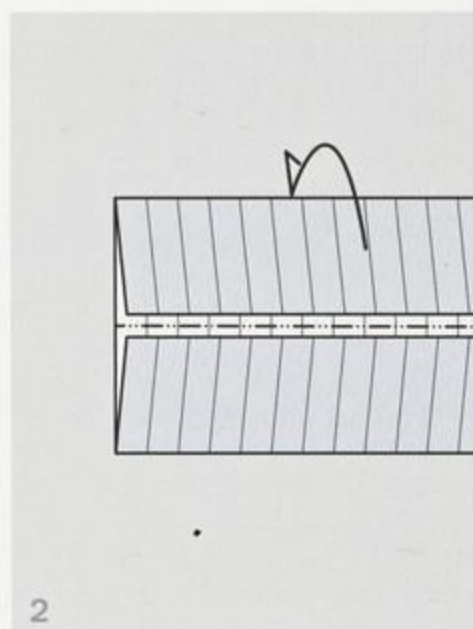
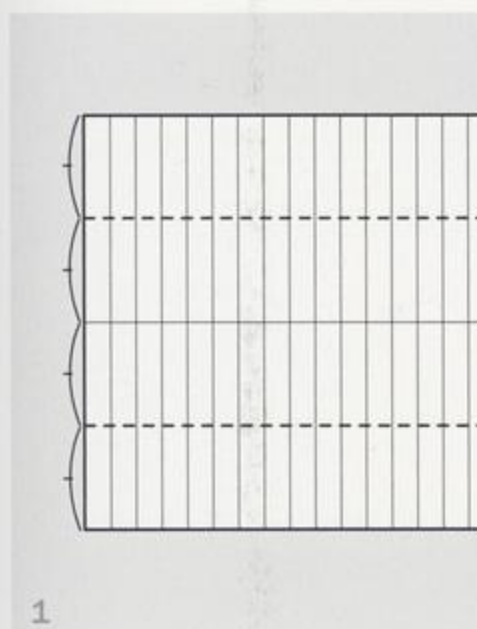
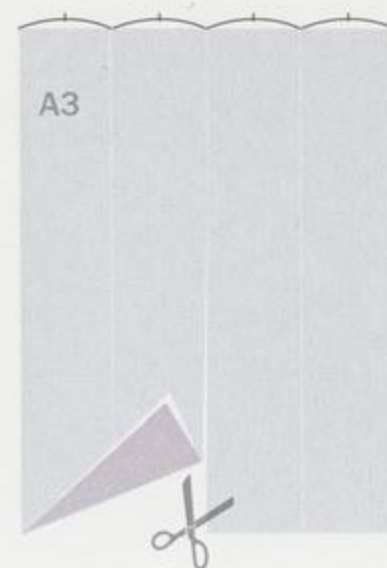


つる巻き四枚重ね



FOUR-LAYERED HELIX

We continue applying the same folding technique to a four-layered rectangle. Fold 4 layers together in the same way as in steps 4 to 7 of »Two-layered Helix« on page 26 and open again.



Change centre line to a valley fold, make helix according to the precreases.





台形から折るつる巻き

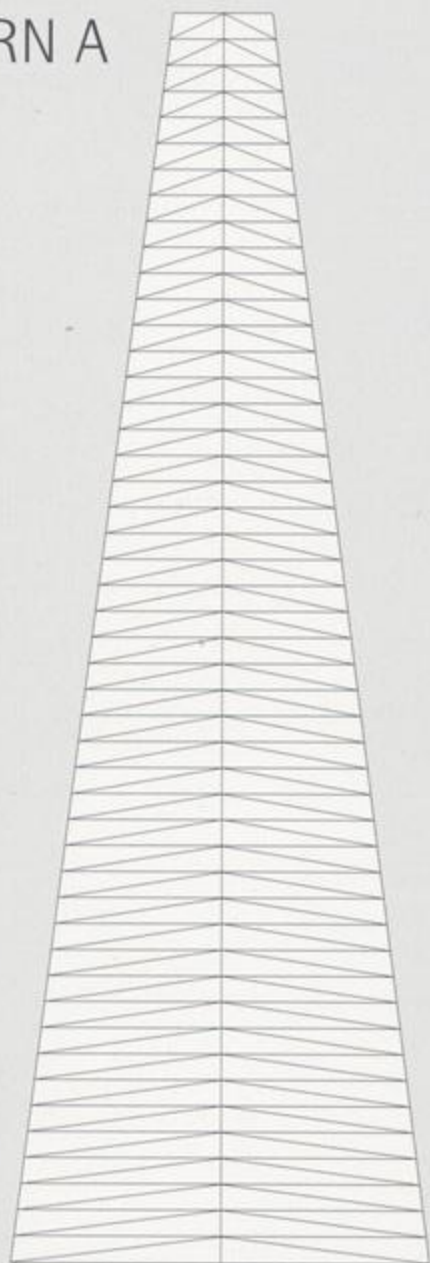


HELICES FROM TRAPEZIUM

Use trapezium-shaped paper for making helices in the same way as before. Crease patterns A and B give you some hints. For the models shown in the photos I used paper considerably longer than that shown in the crease patterns. Also the distances of the creases may vary.

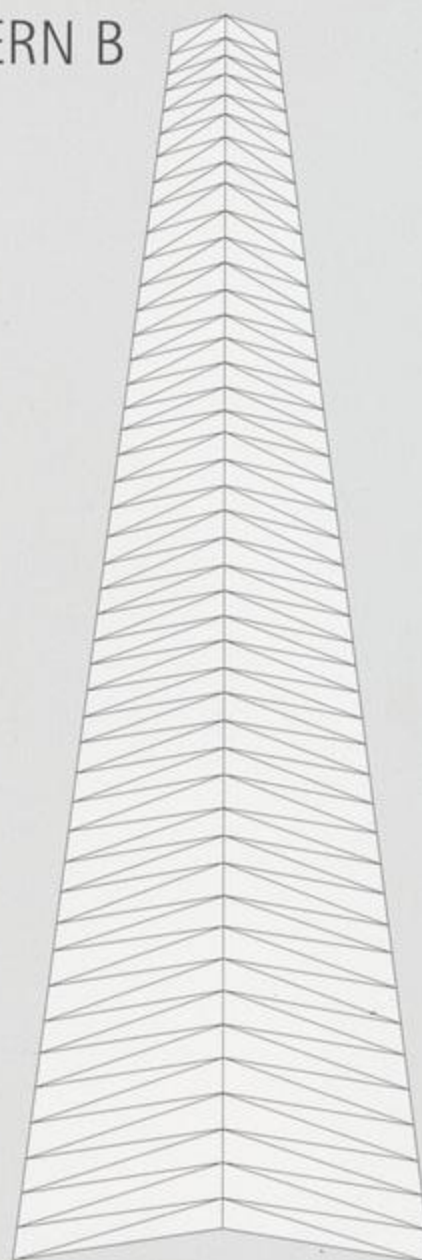
Hint: It might be easier to collapse the helix (step 8 of «Two-layered Helix» on page 26) starting with the narrow end of the trapezium.

PATTERN A



Crease pattern A is the simplest one for trapezium-shaped paper. The horizontal creases are equidistant and the diagonal creases accordingly aligned. The folding method is the same as for the «Two-layered Helix» on page 25.

PATTERN B



Crease pattern B shows several variations: The distances and inclinations of the 'horizontal' creases vary slightly in a more or less arbitrary way from bottom to top of the trapezium. You can invent your own rules for the distances and inclinations of one set of the creases. The second set will always result from aligning it with the first set.

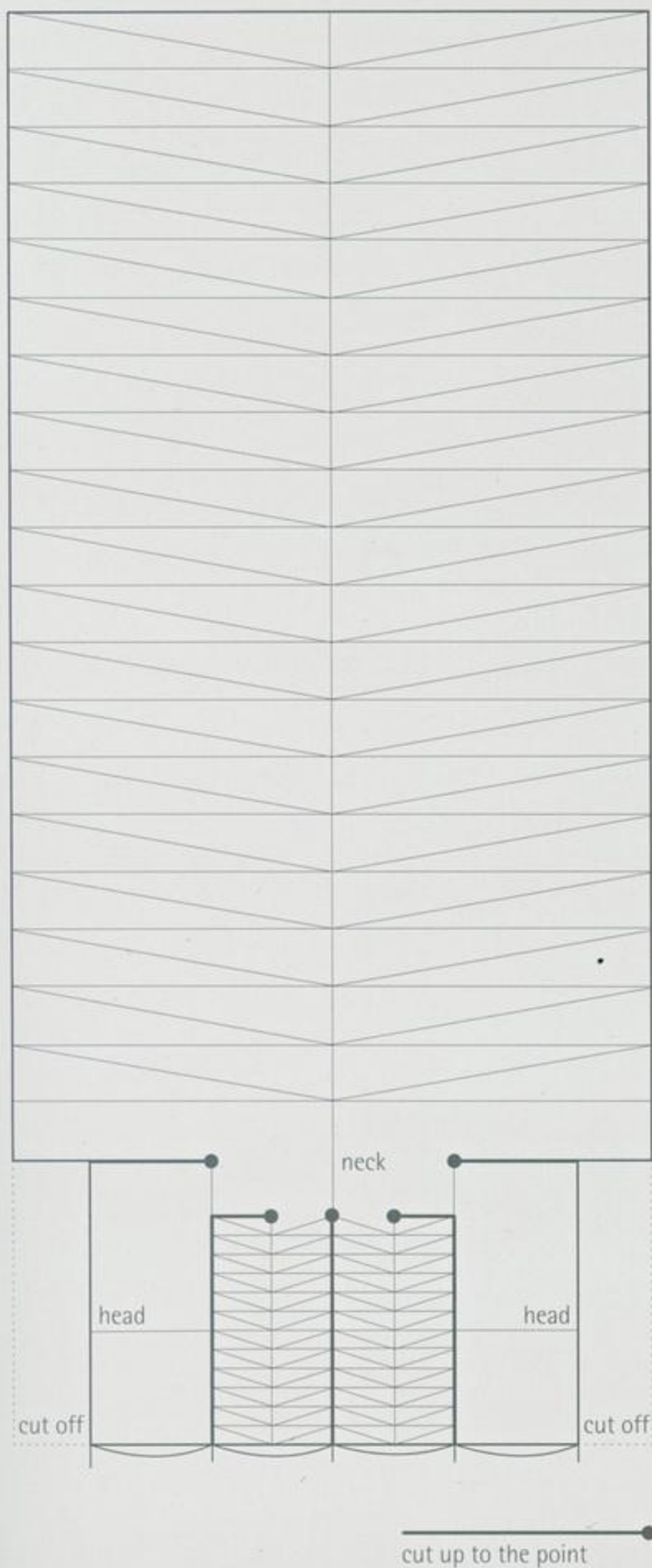
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FLYING BULL

In 2005, the widely publicised exhibition *Masters of Origami* took place in Hangar-7 at Salzburg airport in Austria.

I was proud to be one of the exhibitors, along with many influential origami artists. This stylised Flying Bull was one result of my research in the universe of spiral folds. The motif of the Flying Bull was also used on the poster and the catalogue for the exhibition.



Hangar-7 *Masters of Origami* 2005

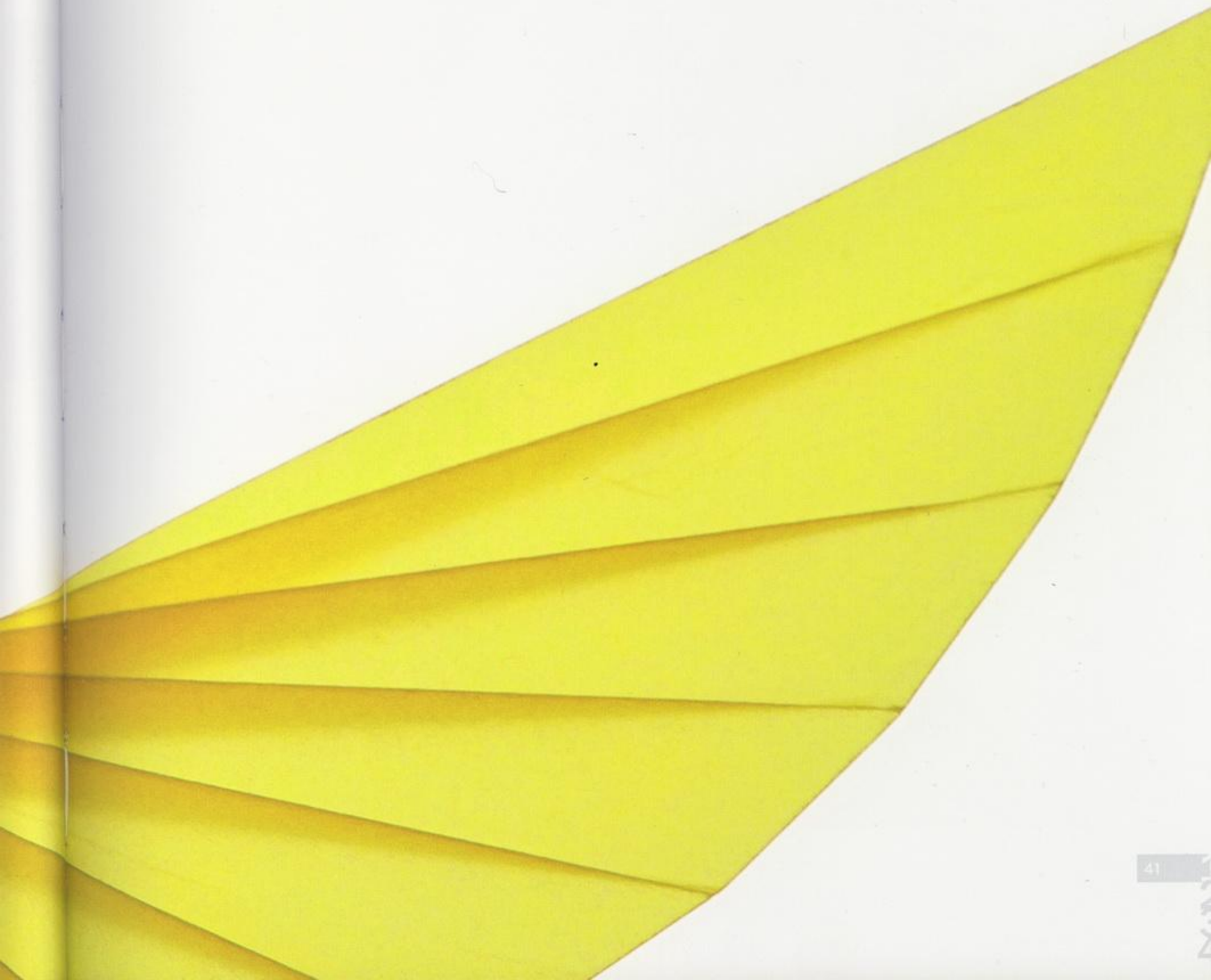
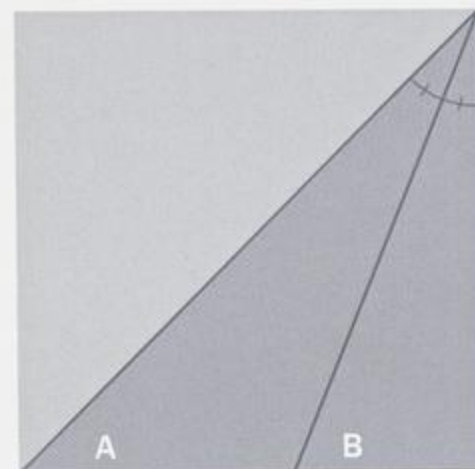
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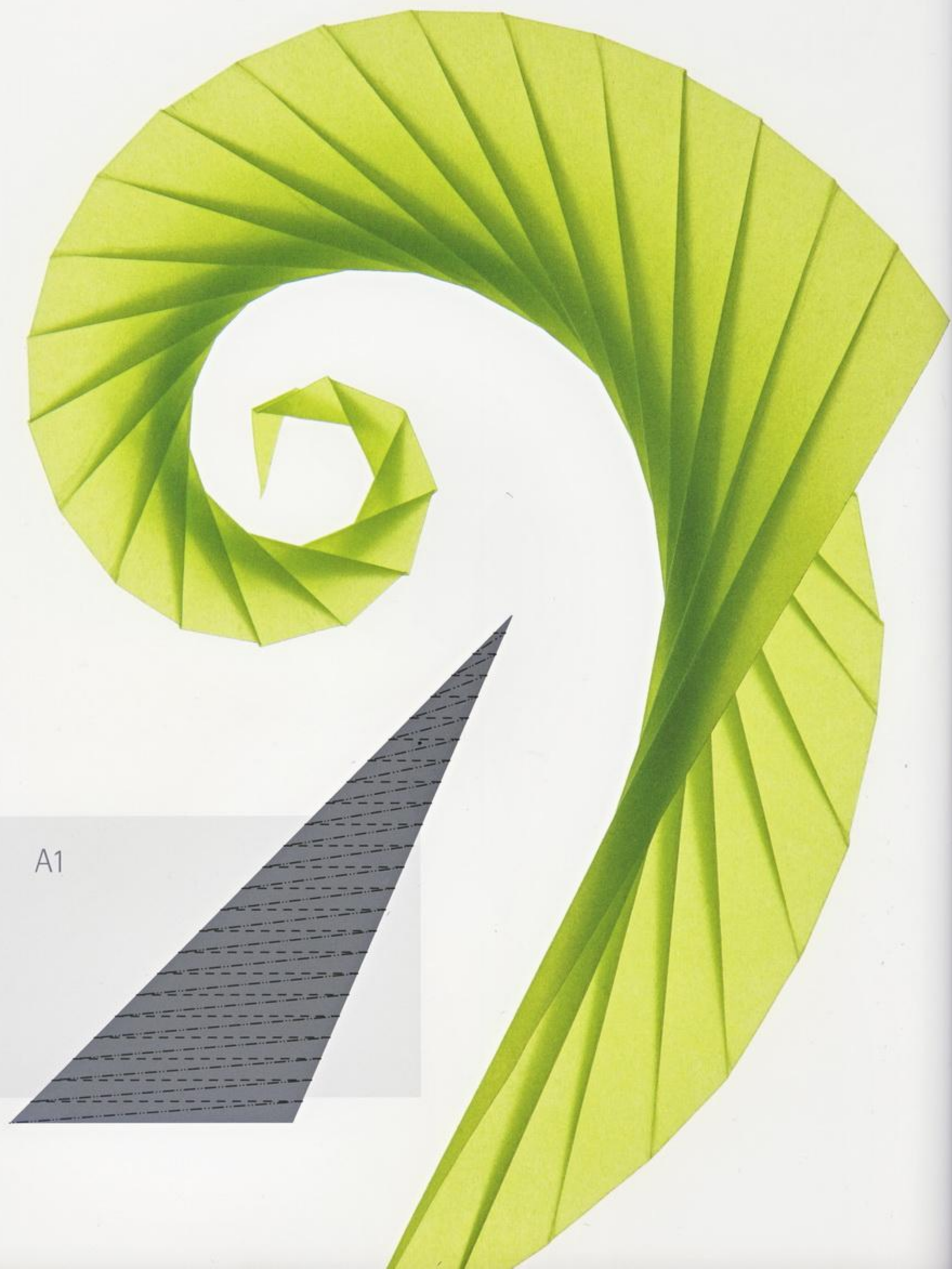


SPIRALS

You can obtain different spiral objects by using different paper shapes (compare A and B) or by changing the orientation of the diagonal creases (compare A1 with A2 and B1 with B2 on the following pages).

The gathering of regular straight lines results in beautiful curves.

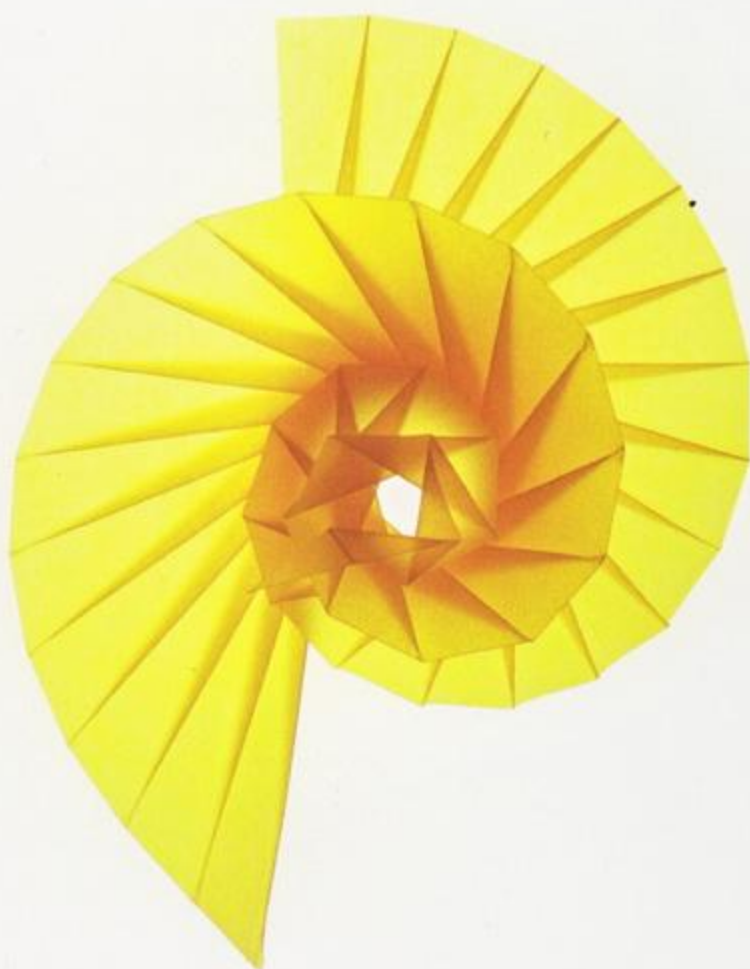
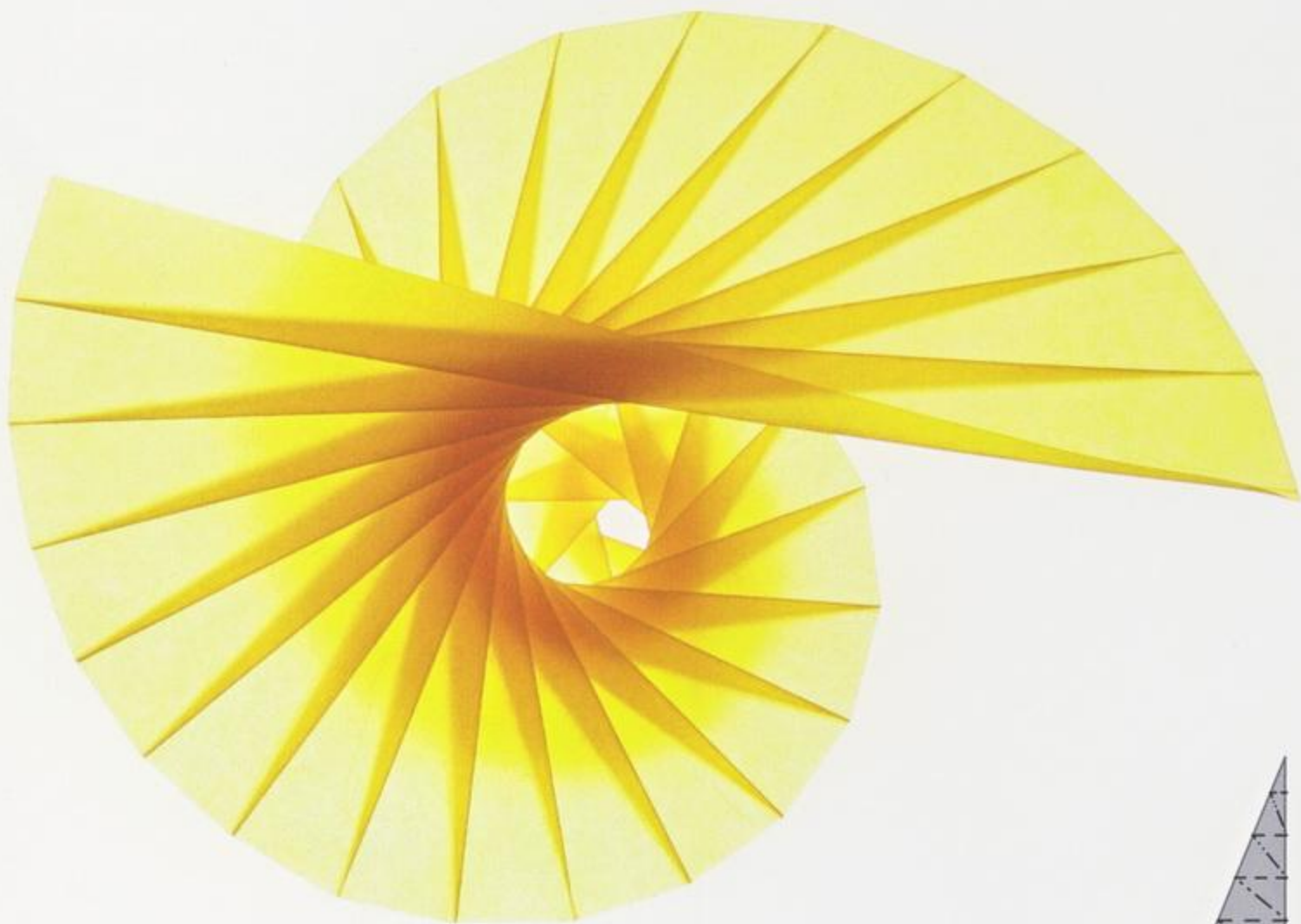




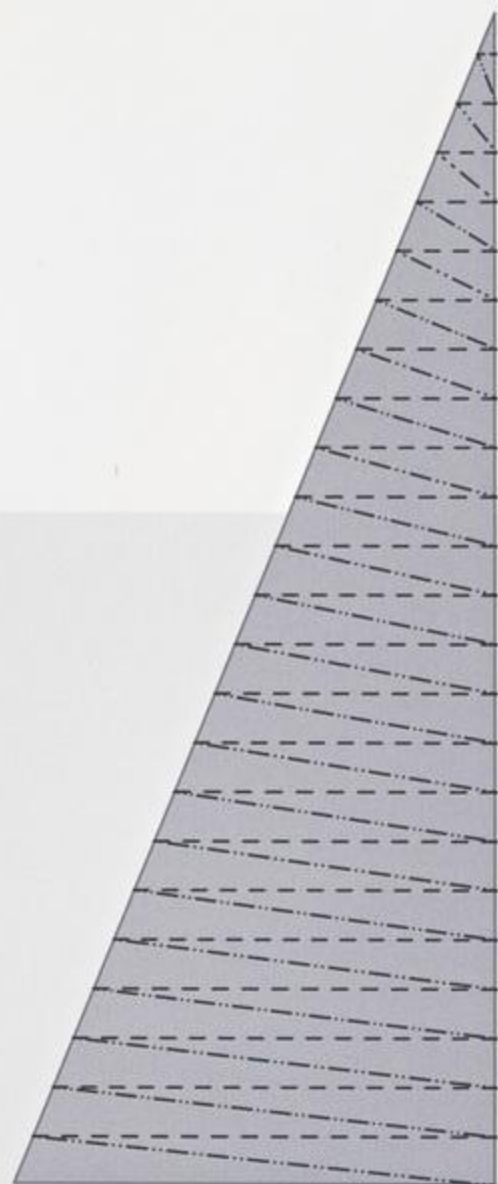
A1

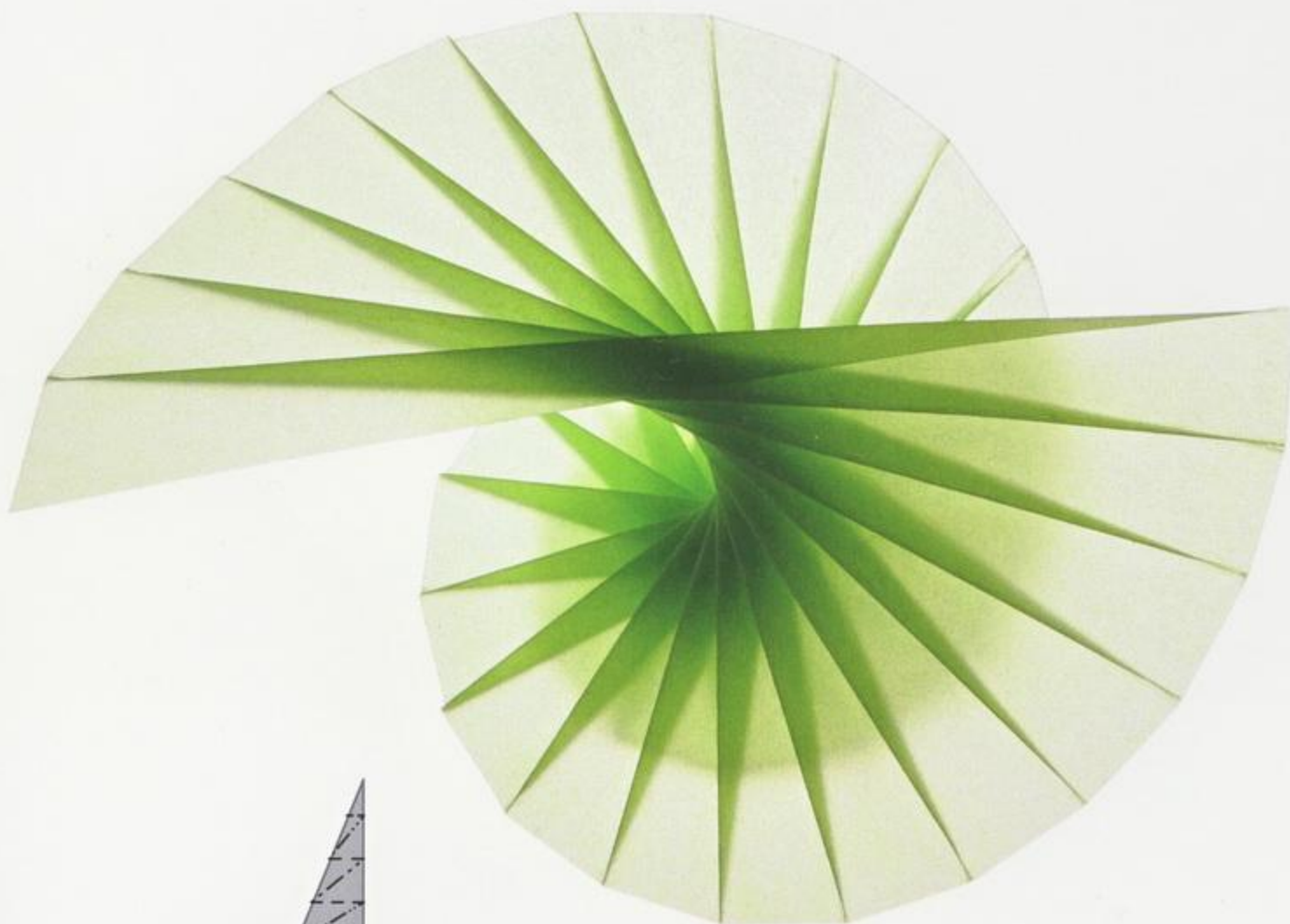


A2

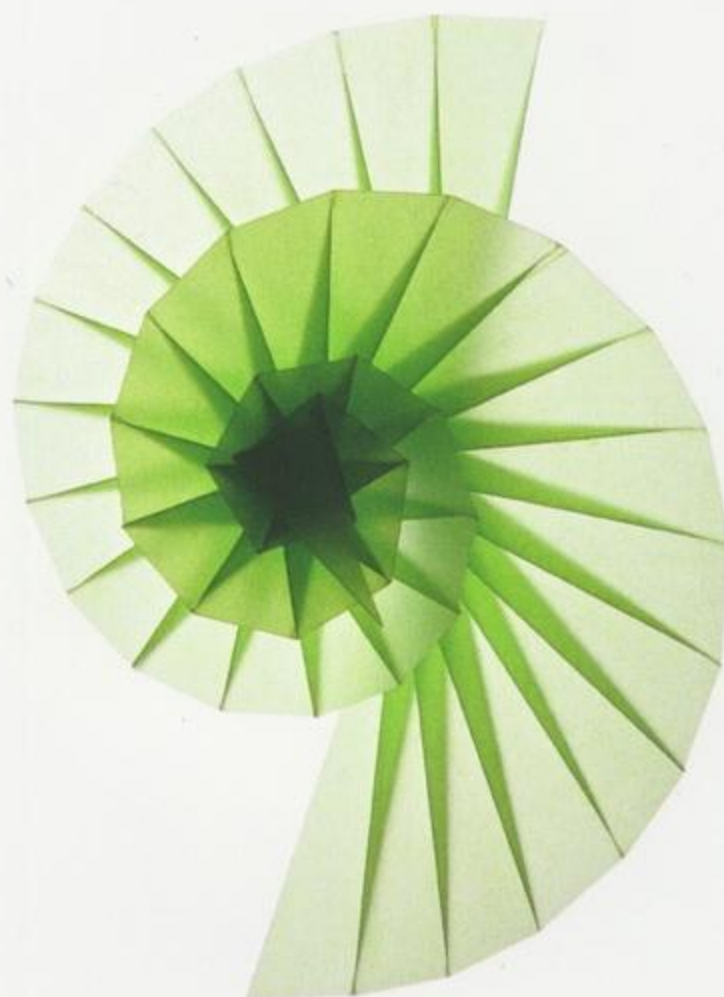


B1



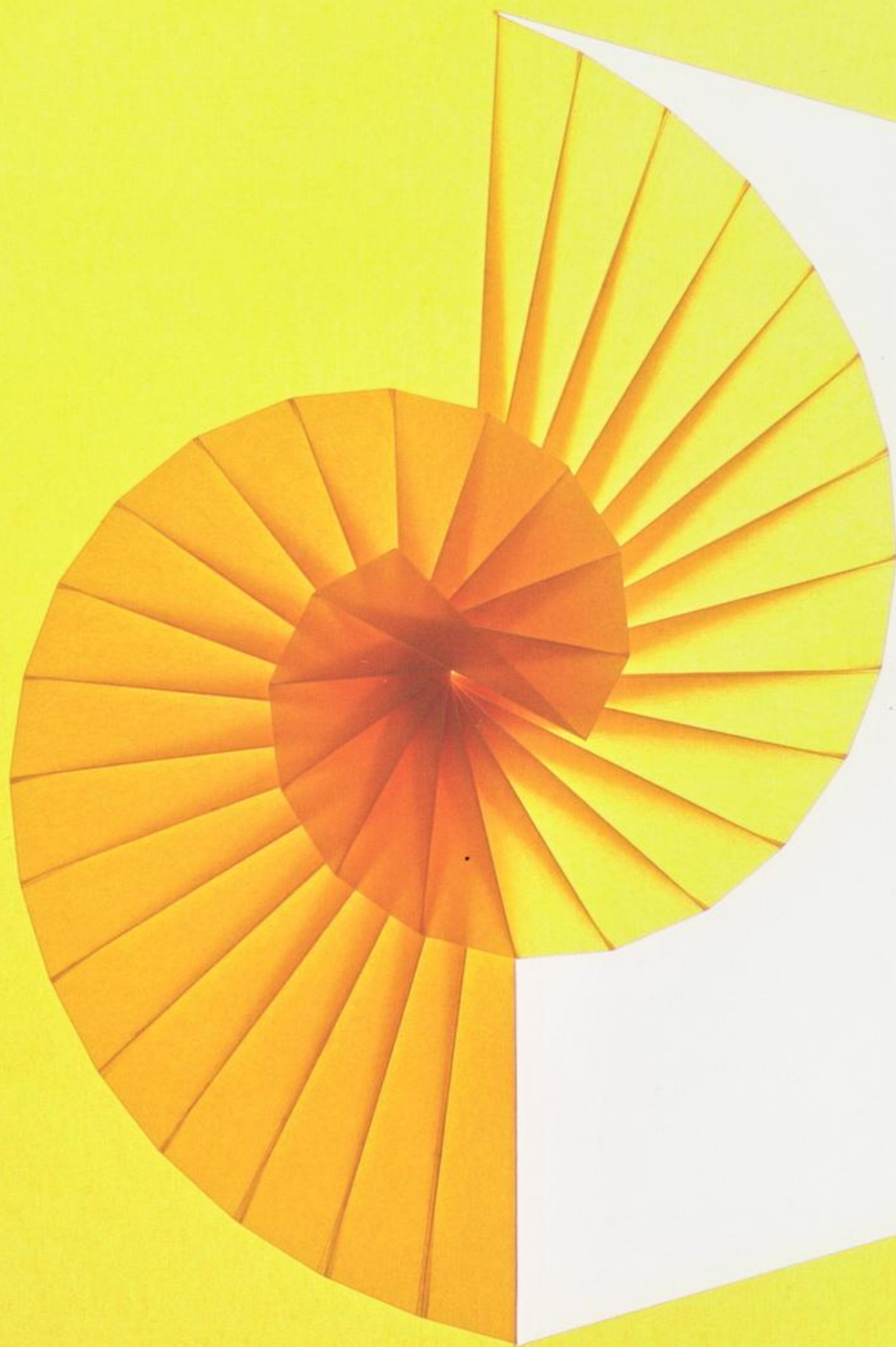


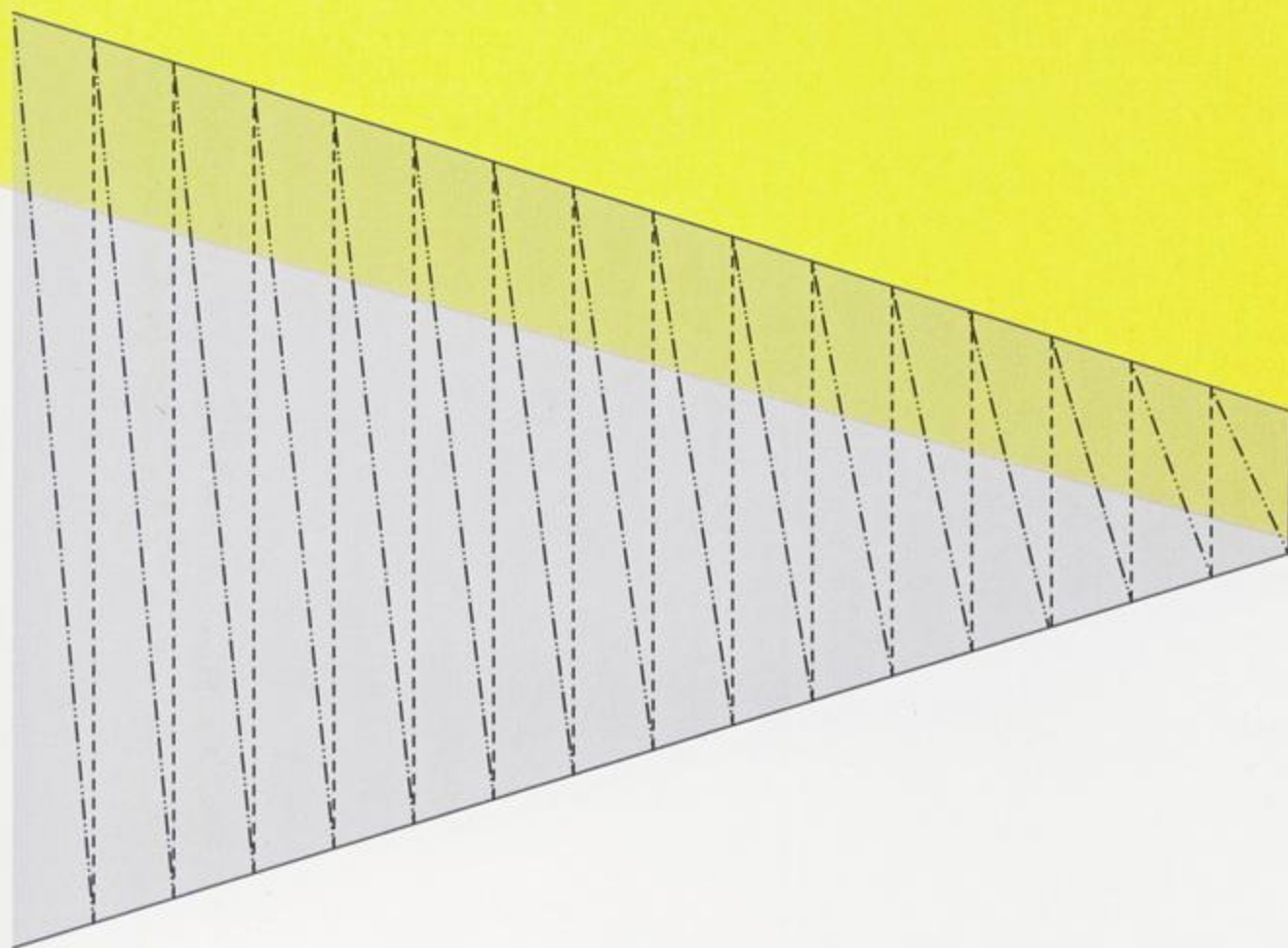
B2



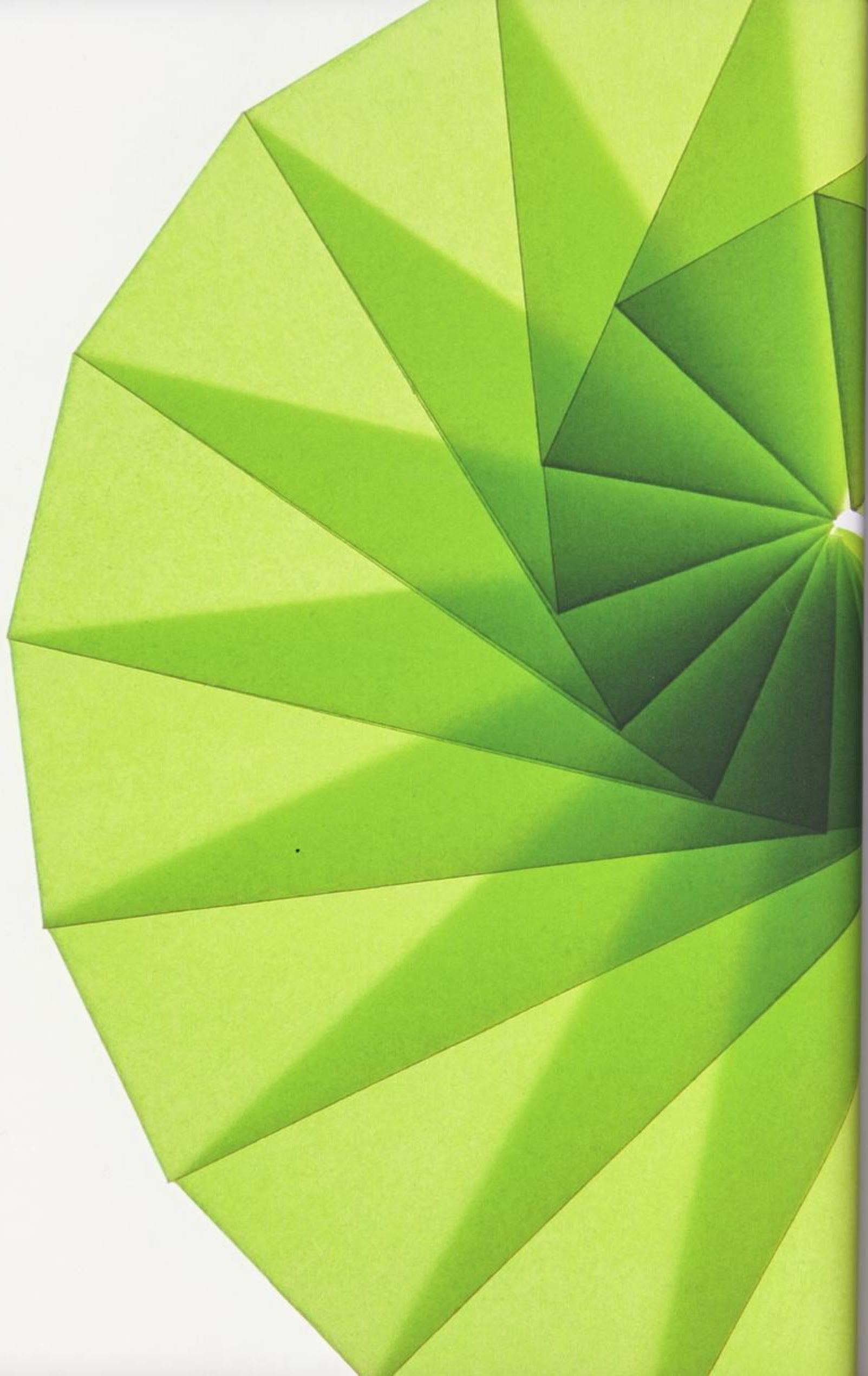






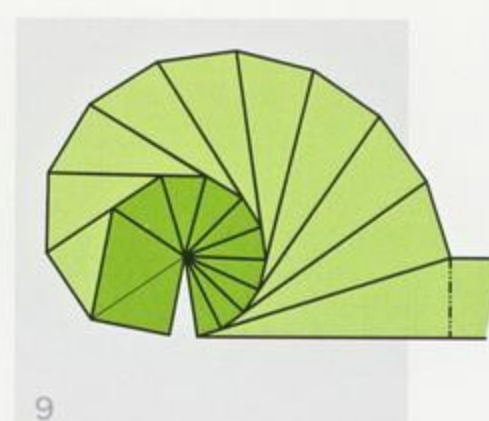
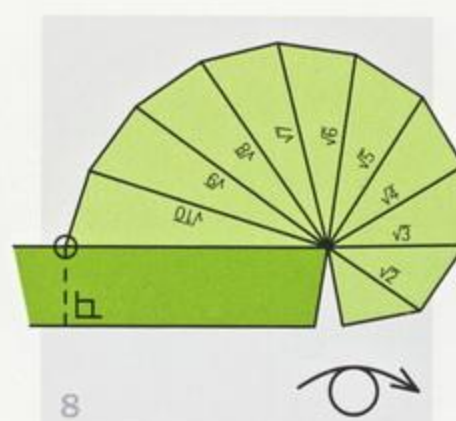
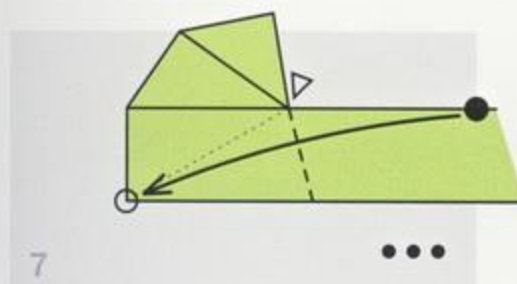
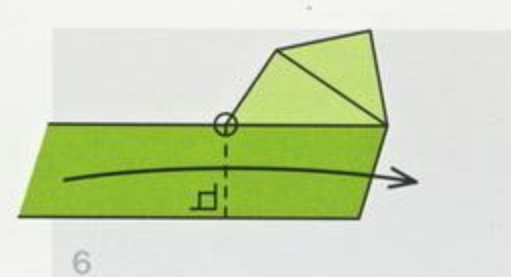
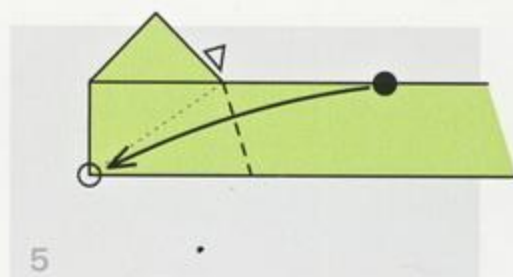
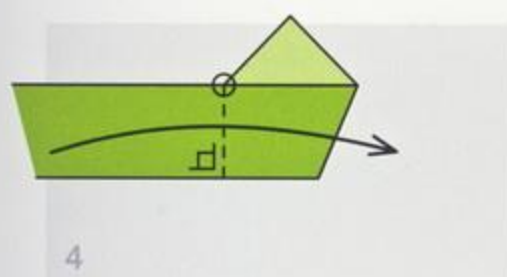
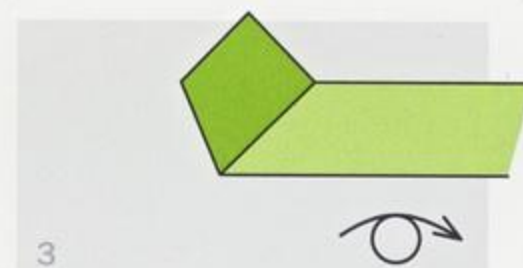
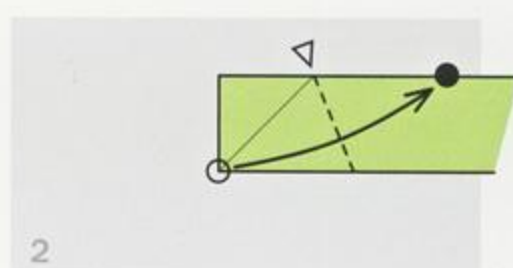


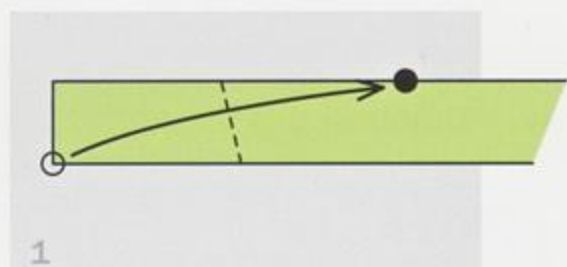
テープから折るらせん



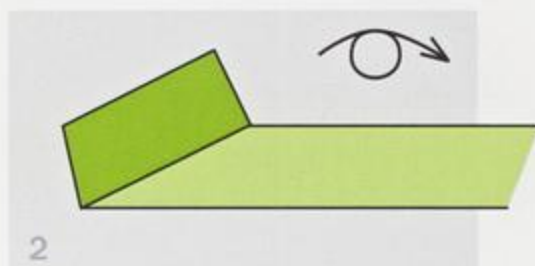
SPIRAL FROM TAPE

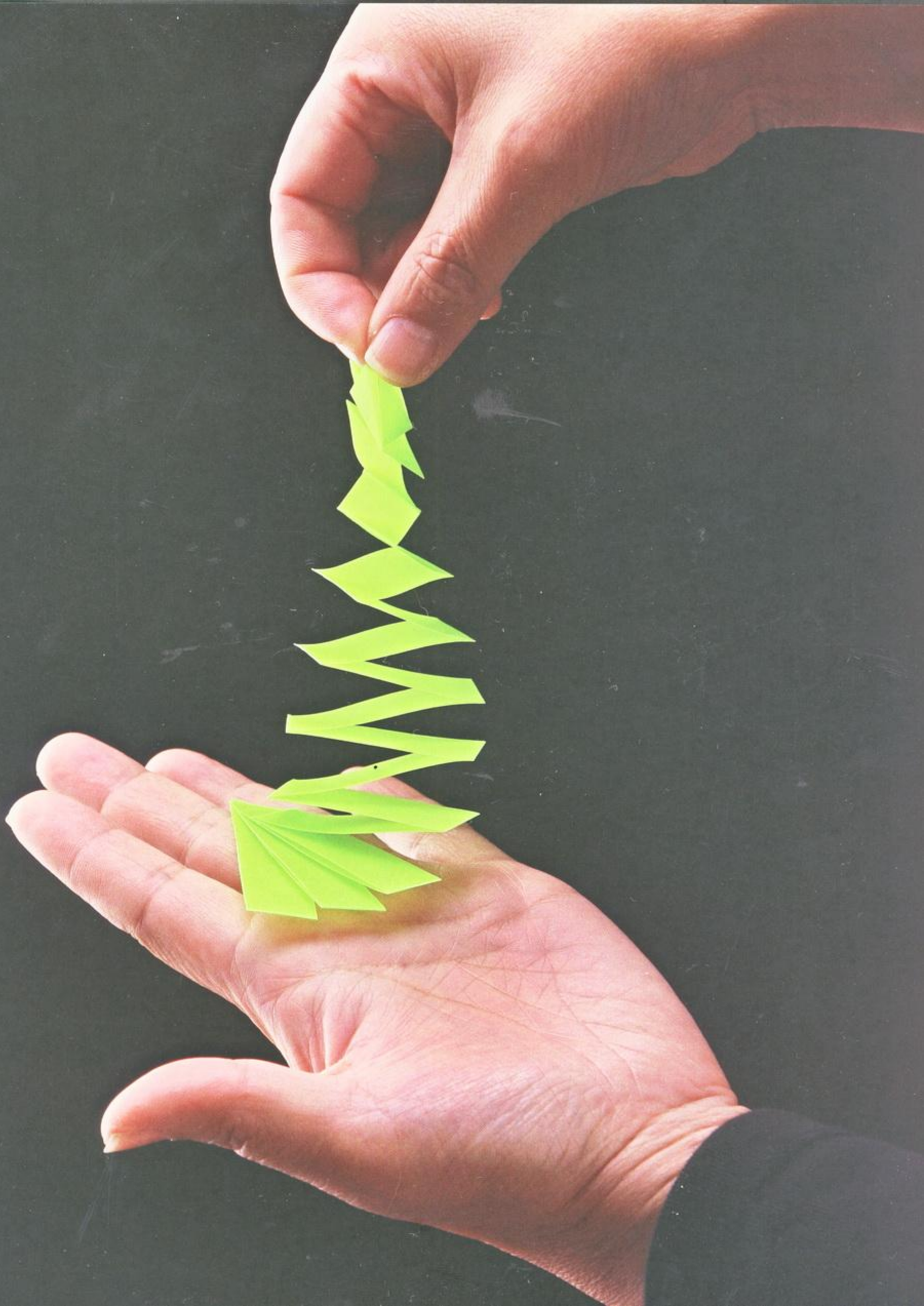
You can easily fold a tape into a *Spiral of Theodorus*, also called *Einstein Spiral* or *Pythagorean Spiral*. It is built by contiguous right angled triangles. The hypotenuses of the triangles are the radii of the spiral. Their lengths are the succession of the square roots of the natural numbers, if the width of the tape is 1. See diagram of step 8.





You can also start with an arbitrary crease as shown here.





三角らせん

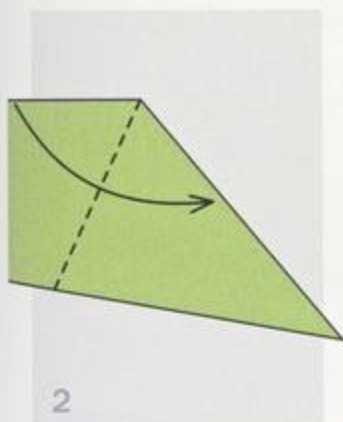


TRIANGLE SPIRAL

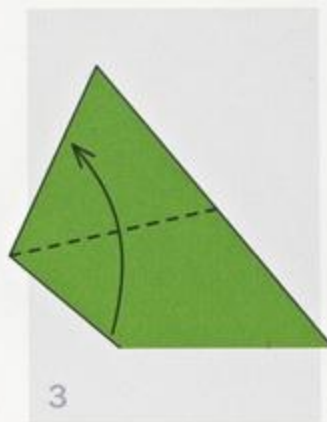
Begin with an arbitrary elongated triangle. Different acute angles α result in different shapes. Except for the initial crease, always fold a raw edge to the folded edge created in the previous step.



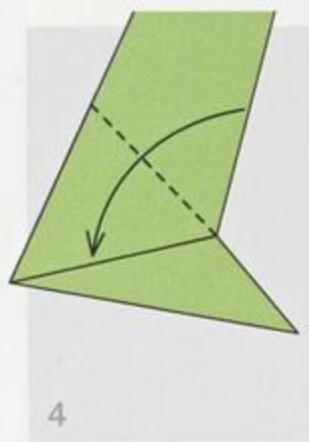
1



2



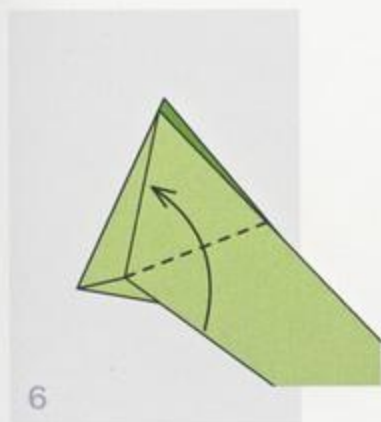
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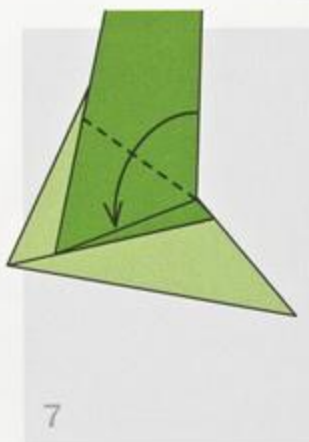
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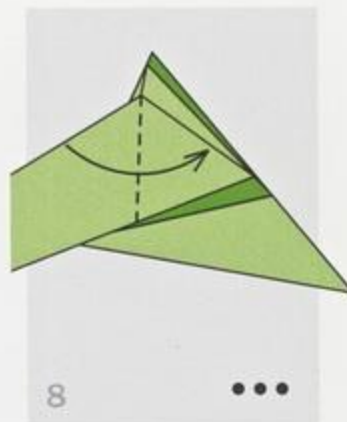
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6



7



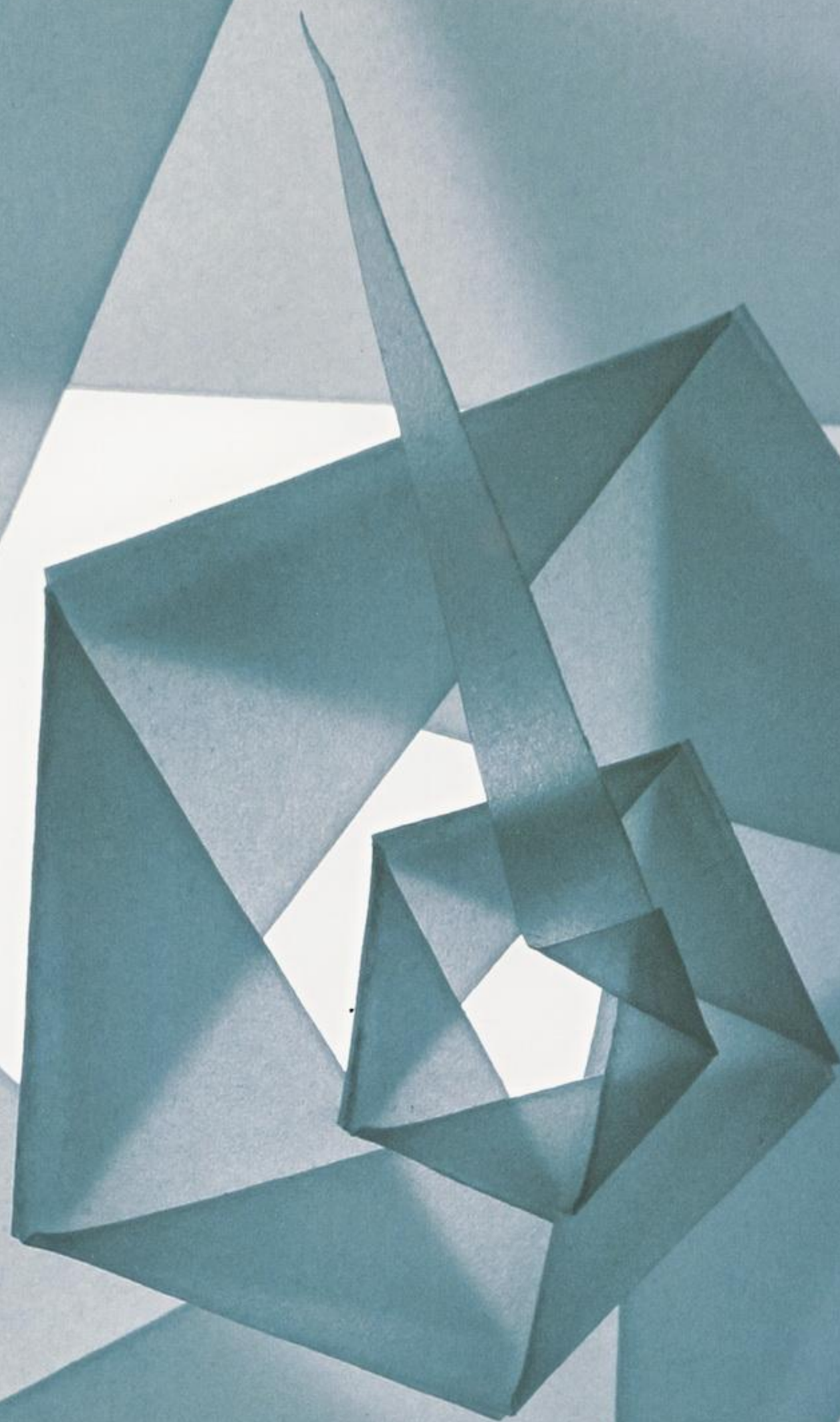
8 ...







五角ぜんまい巻き



PENTAGON SPIRAL

The basic triangle is cut from an A4 format. The smaller the angle α is, the more coils will result in the spiral.

The marks in Fig. 1 correspond with the marks in the diagrams, as you will see as the folding progresses.

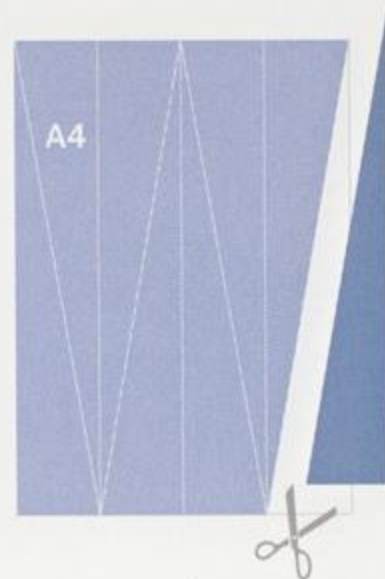
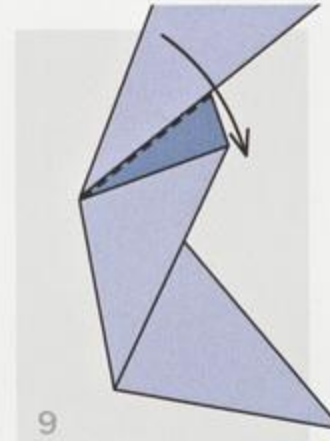
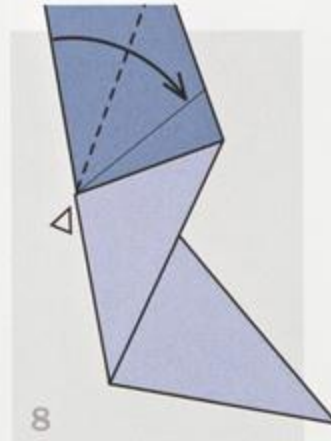
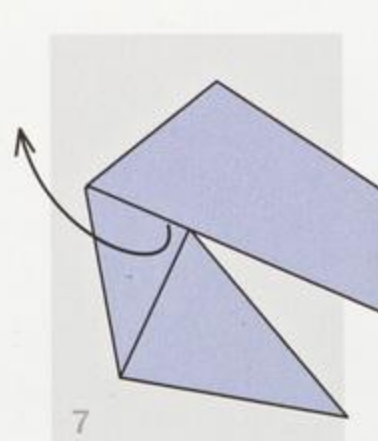
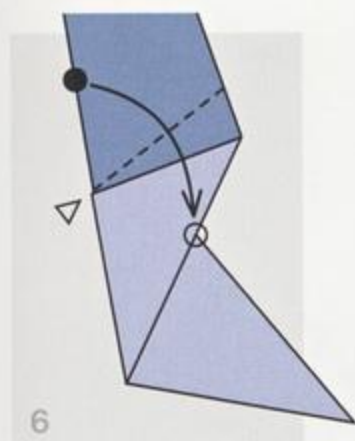
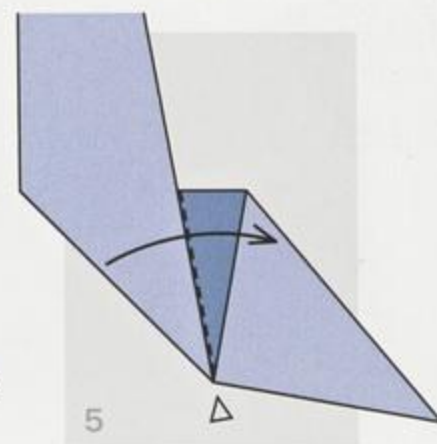
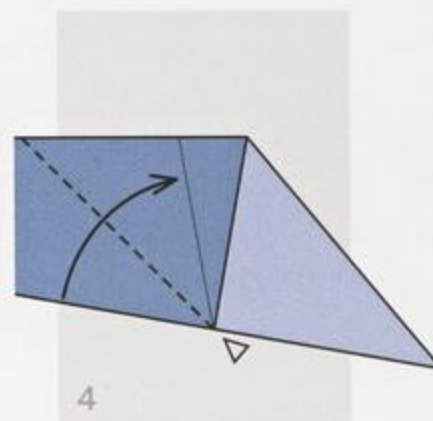
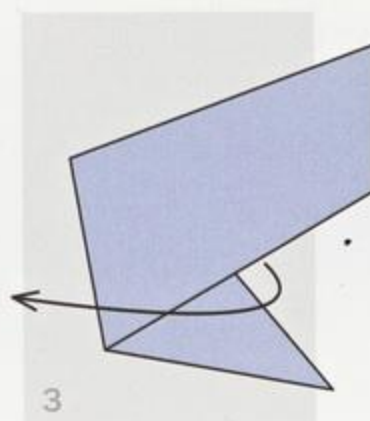
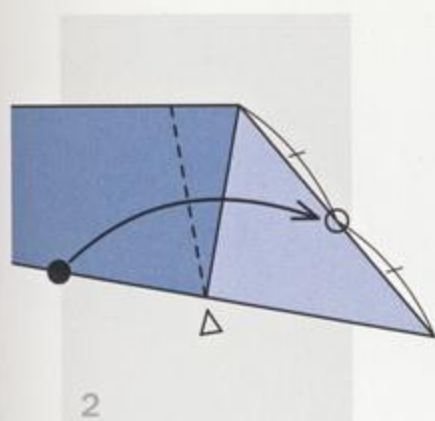
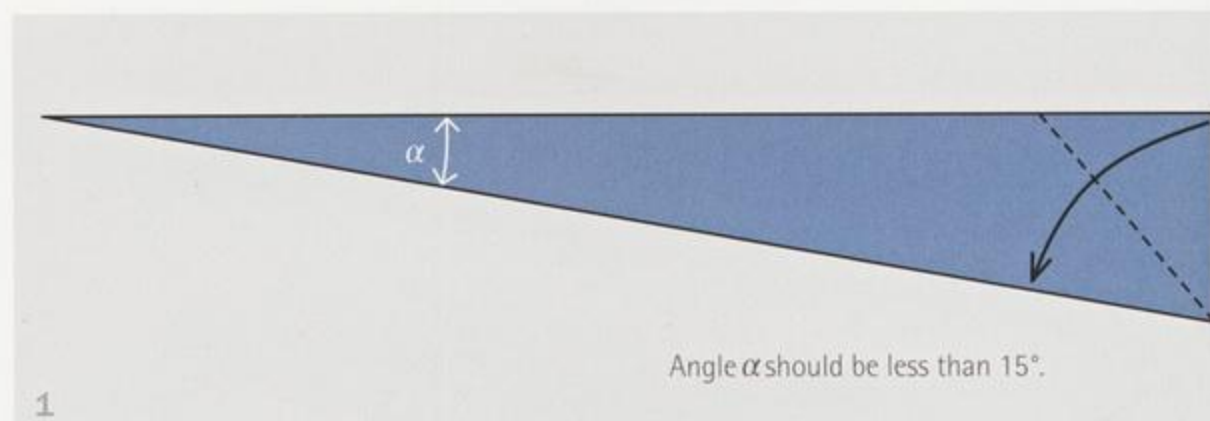
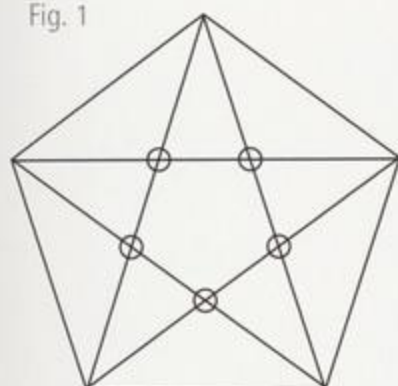
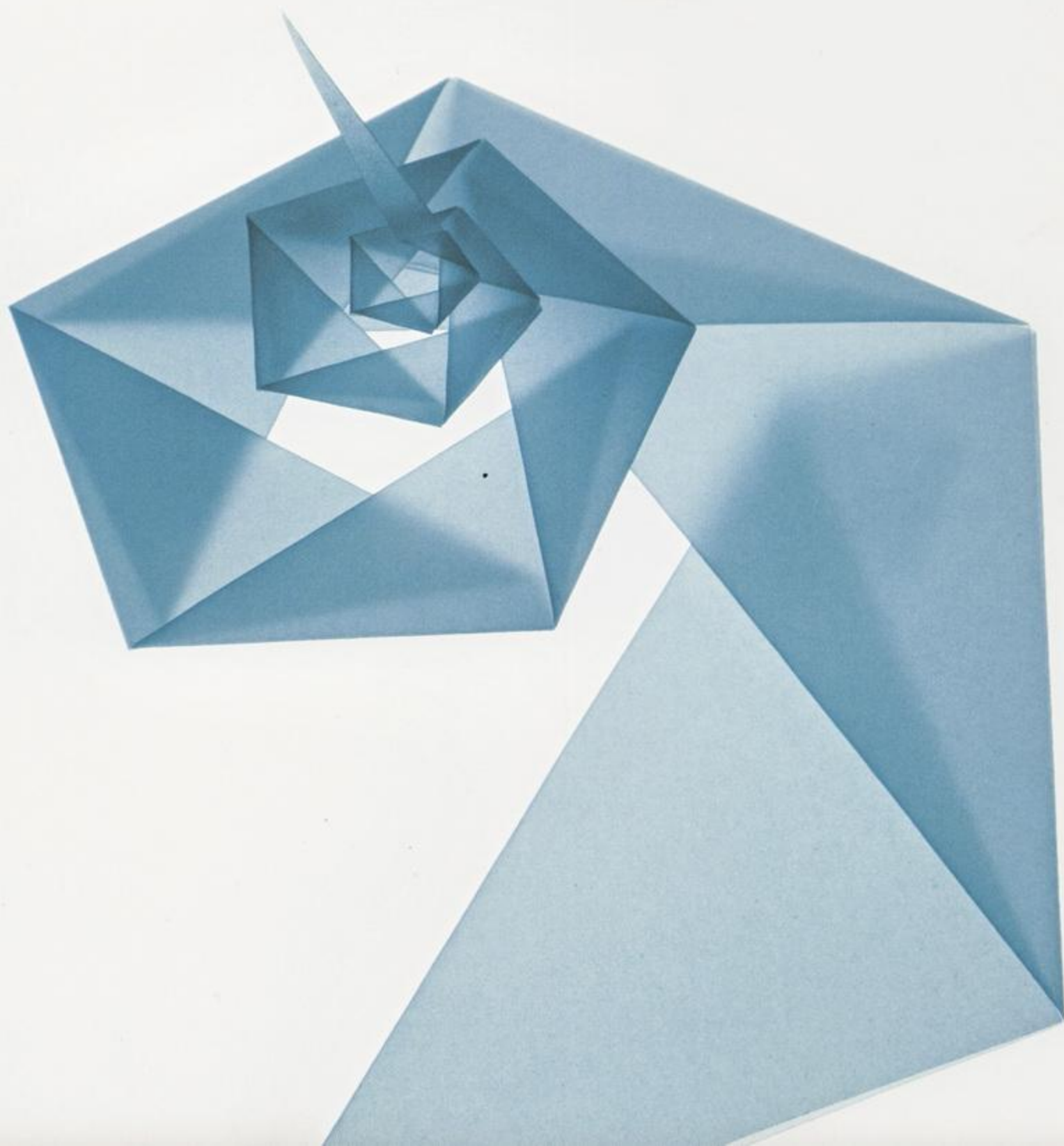
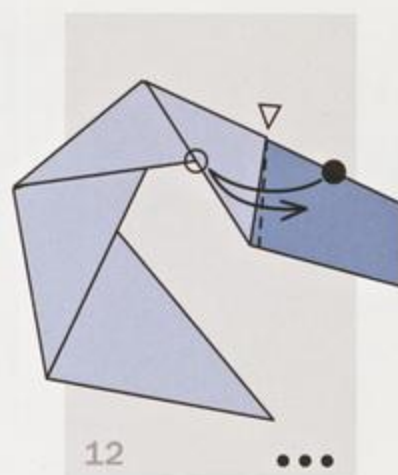
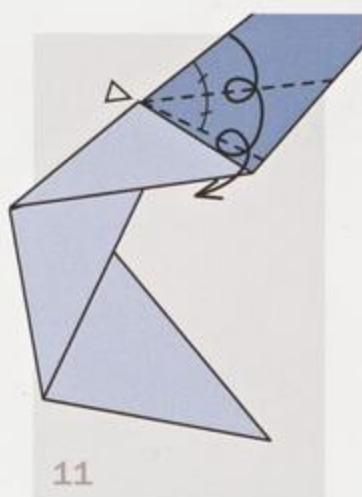
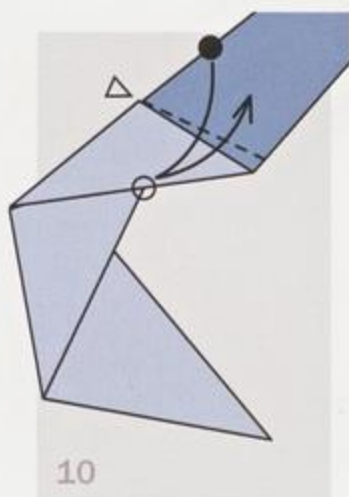
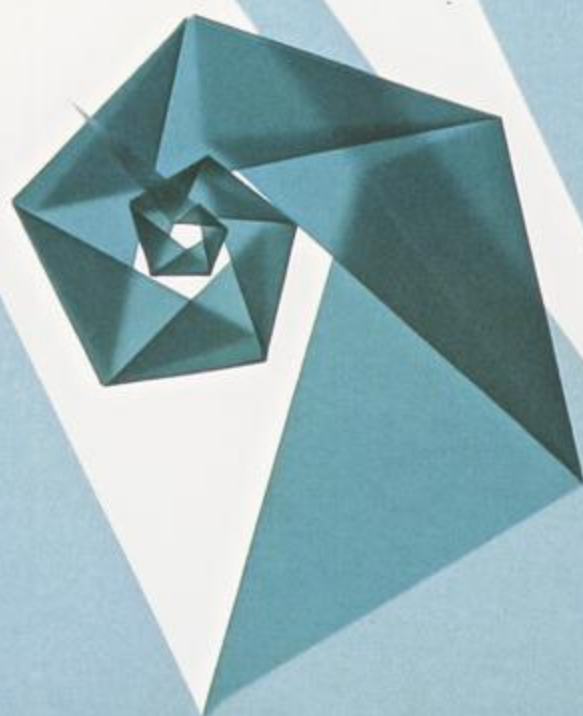


Fig. 1







六角ぜんまい巻き



HEXAGON SPIRAL

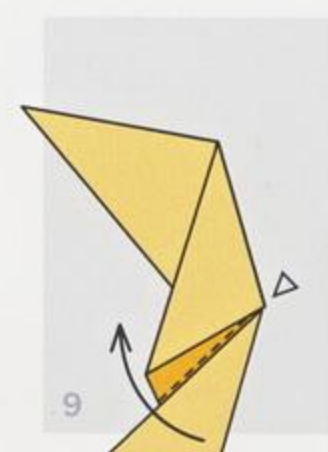
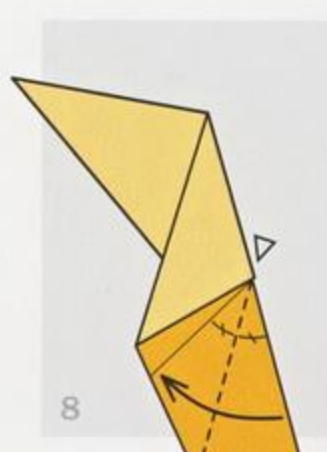
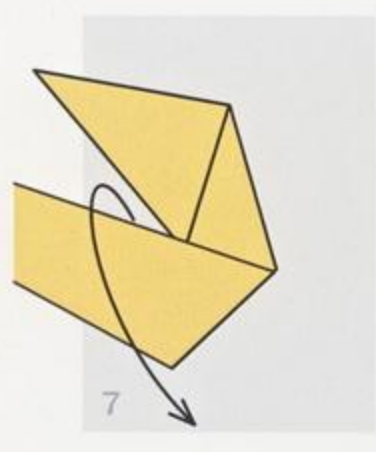
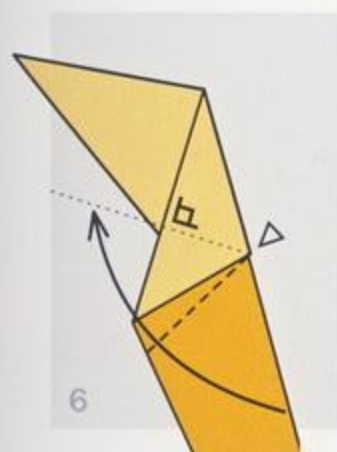
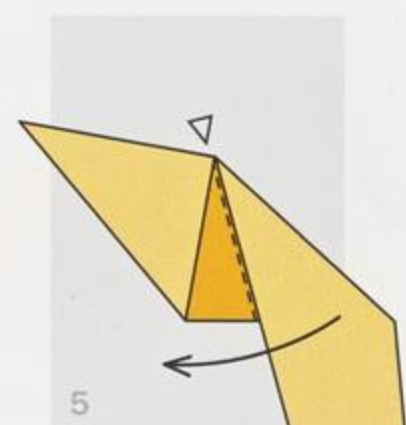
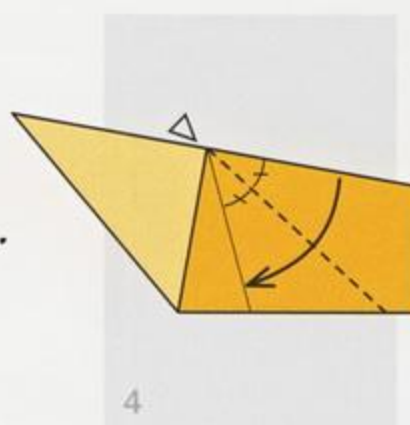
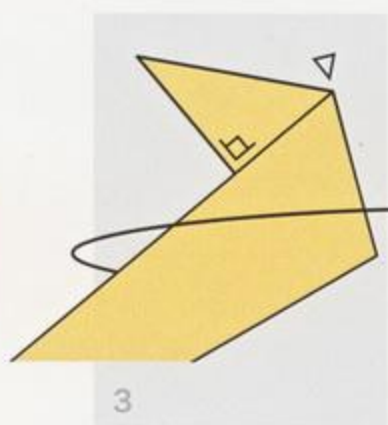
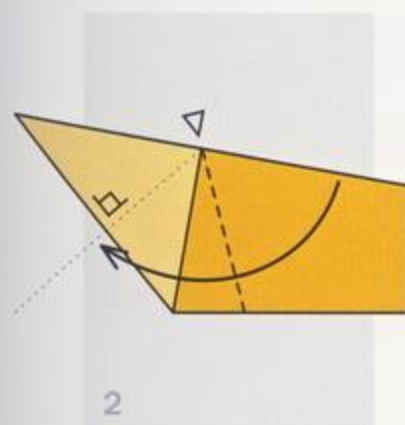
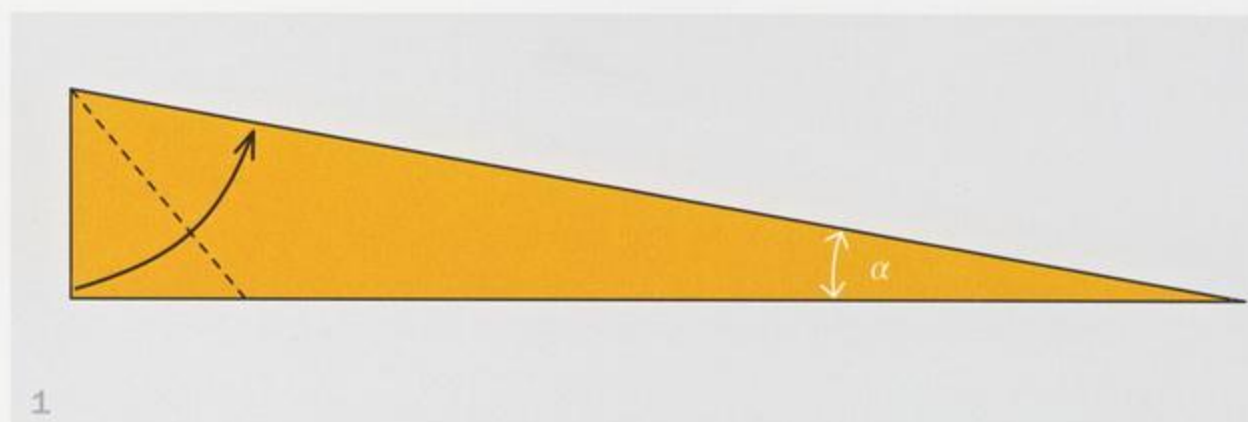
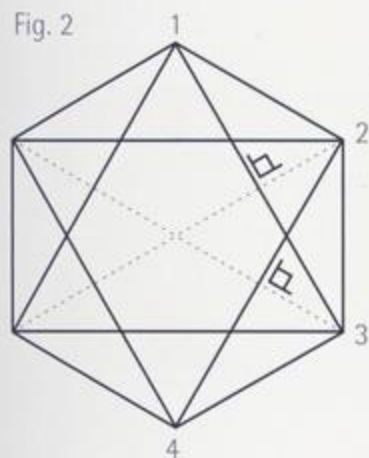
The initial shape is a triangle cut from an A4 format.

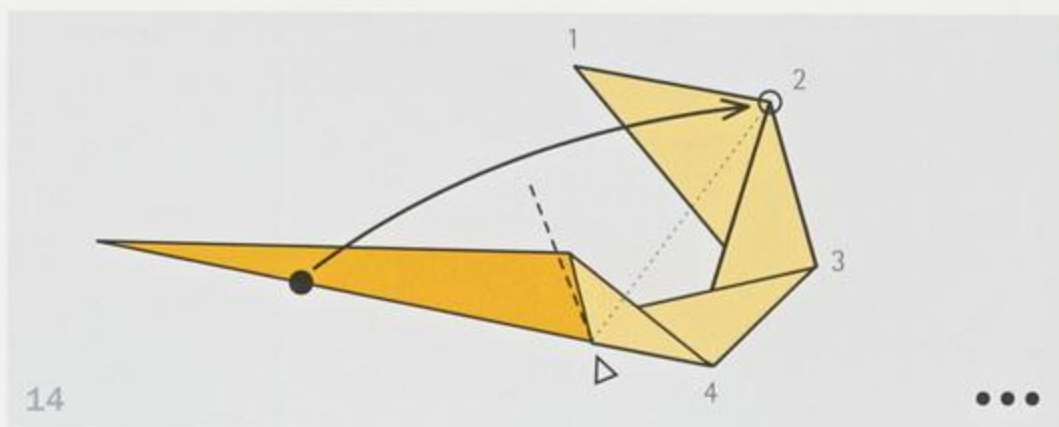
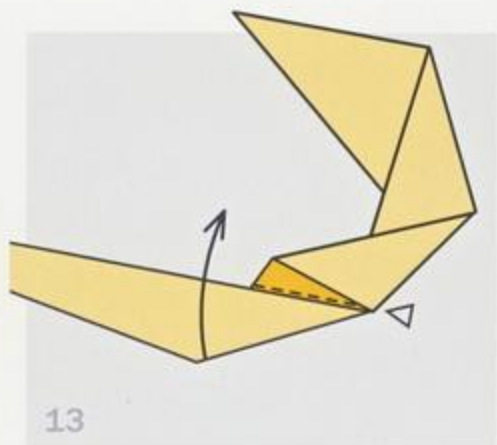
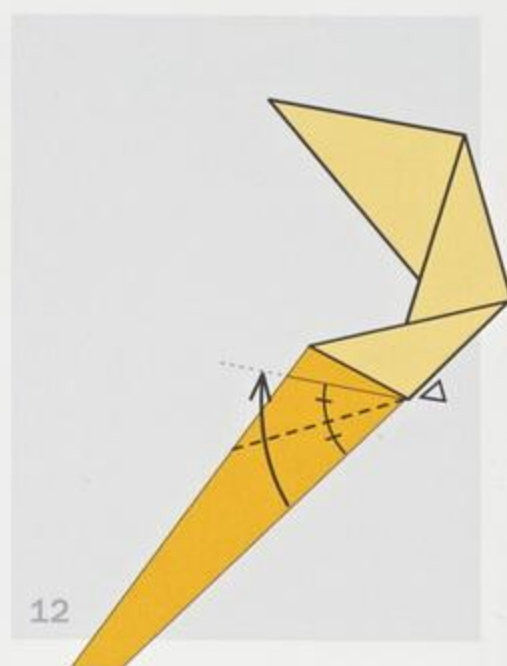
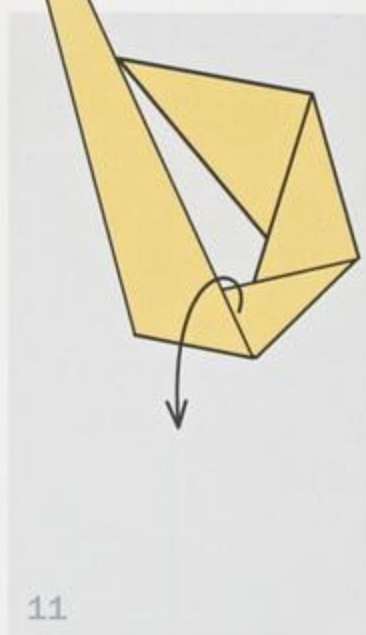
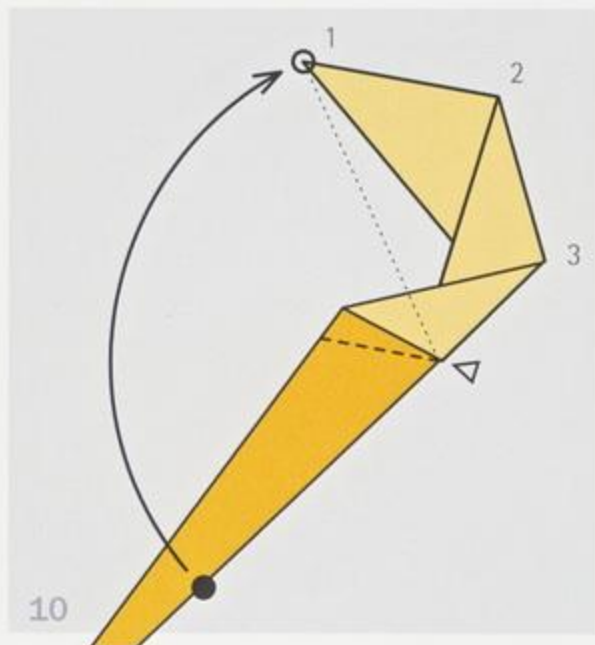
The 90° marks in Fig. 2 correlate with the marks in the diagrams, as you will see as the folding progresses.

The acute angle α should be less than 15°. Different angles α result in different spirals. When you use the same folding method with a tape with parallel sides you will get a regular hexagon instead of a spiral.



Fig. 2





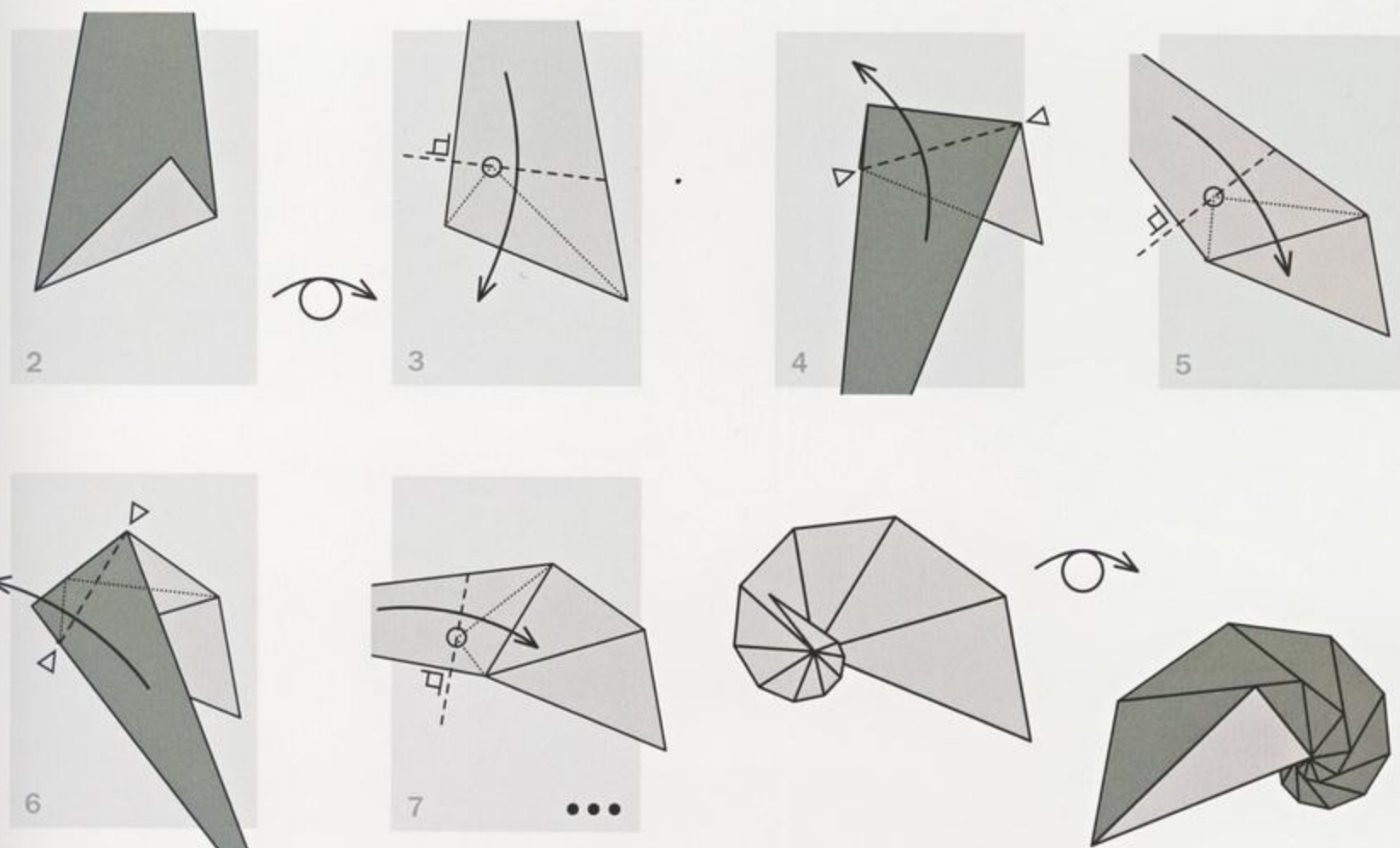
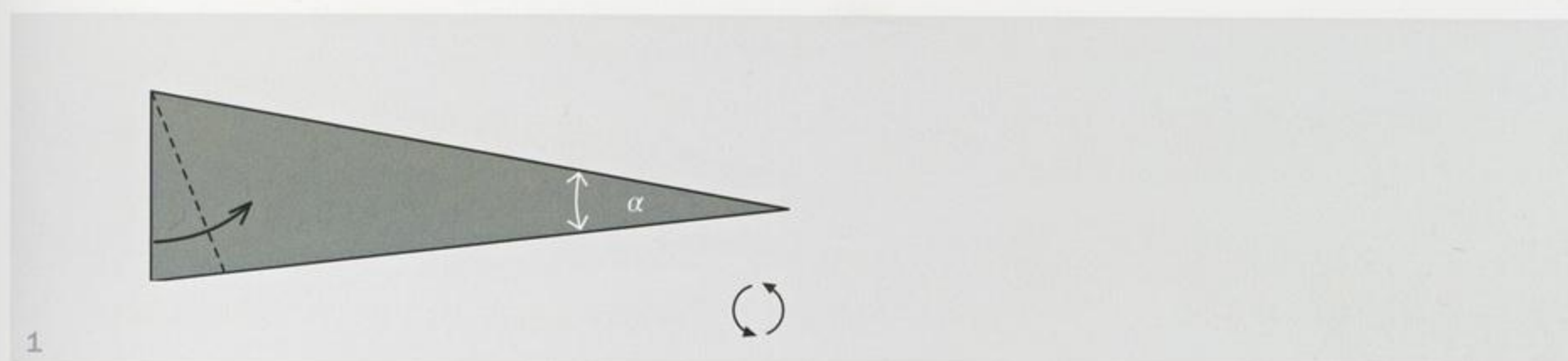


オウム貝



NAUTILUS

Begin with an arbitrary elongated triangle and an arbitrary first crease. When the model is folded with a two-layered initial triangle, the model will become more realistic. Different acute angles α result in different shapes.



卷貝

SPIRAL SHELLS

Spiral shells are the main theme of this chapter. To make you familiar with the rules of spiral folding I begin with flat spiral shells varying in the number of segments and the segment angles, all folded from a square.

Although it is not my intention to imitate nature you will realize that nature follows the same or similar rules in forming the shapes of its own creations. Various shells of snails and cephalopods, some of them already extinct and today existing as fossils only, will illustrate this point.

In the final part of the chapter I shall present modular spiral folds and show how to fold some shells with this technique. Using this method folding is much easier and you can use papers of different colours.

2

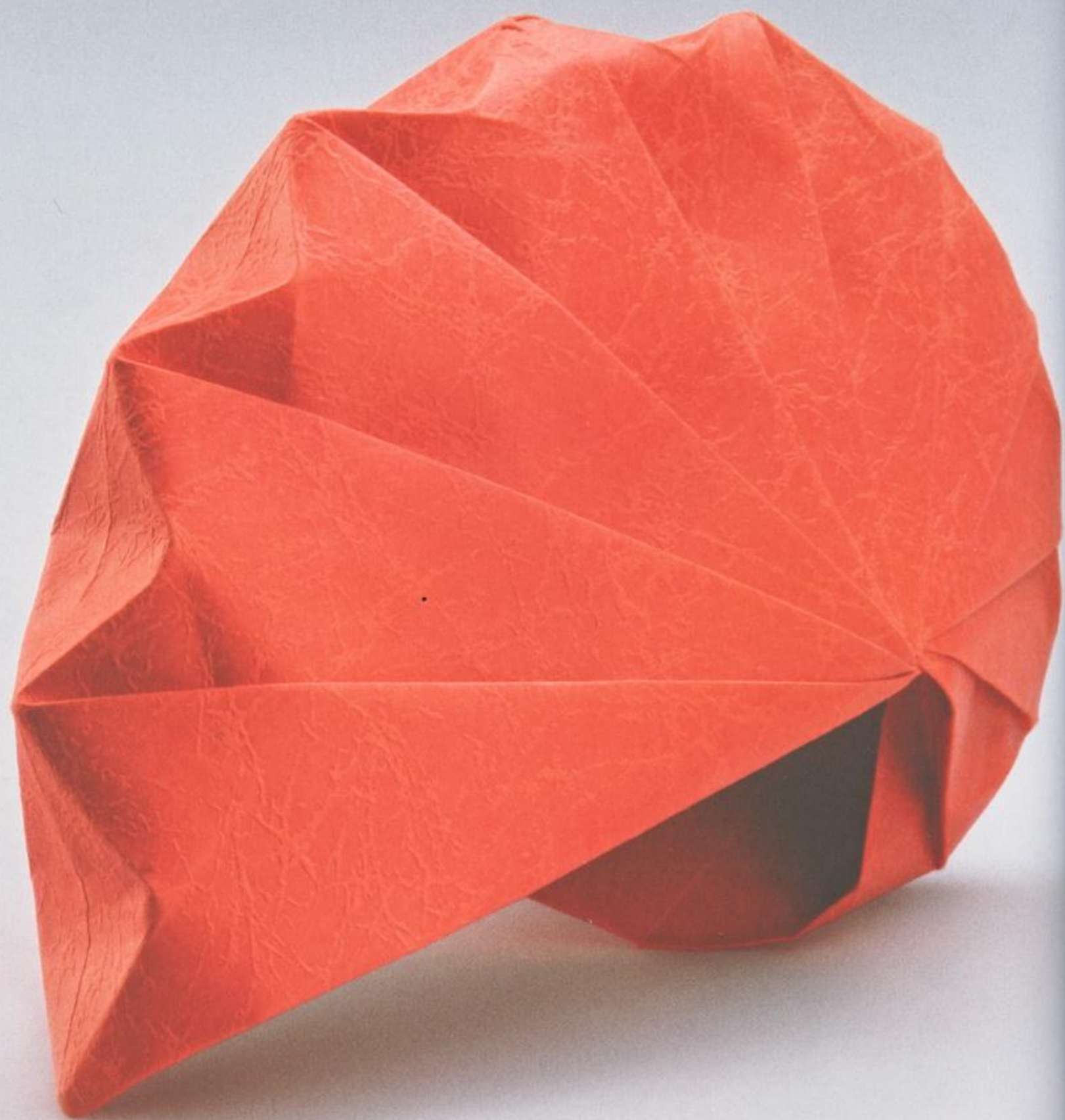
A sea-shell is a rough, hard object. Yet it encloses the most precious thing the ocean bestows on us: the pearl. As they lie in your hand, Tomoko Fuse's paper shells feel mysterious and secretive. If you held them up to your ear, no doubt you could hear the silent sounds of the waves, whispering stories about planetary motion and the secrets of life.

SPIRAL SHELLS

4321



平らな貝二十二、五度



FLAT SHELL 22.5° SEGMENTS

Look at Fig. 1. The lines of the spiral named A to F cross the radii at right angles. These lines are referred to in the diagrams by these letters. The number of segments (10, 11 or 12) we will get in the finished model depends on up to which line (D, E or F) we are folding.

FLAT SHELL WITH 10 SEGMENTS

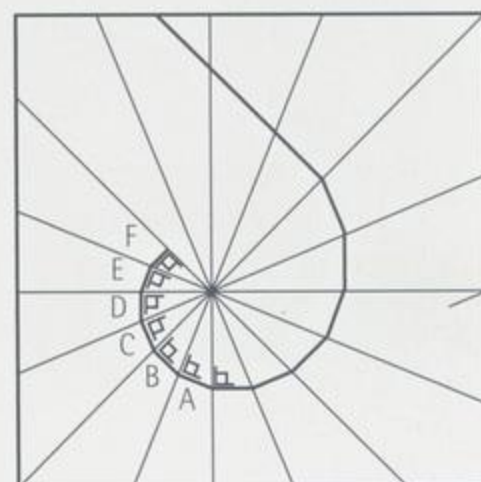
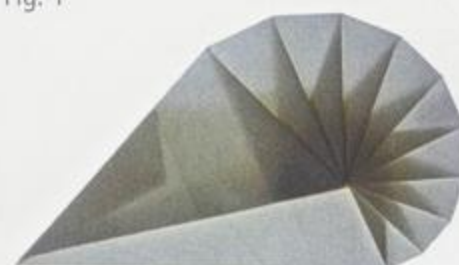
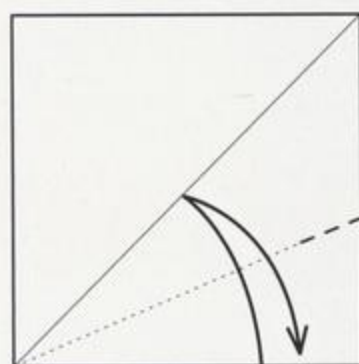


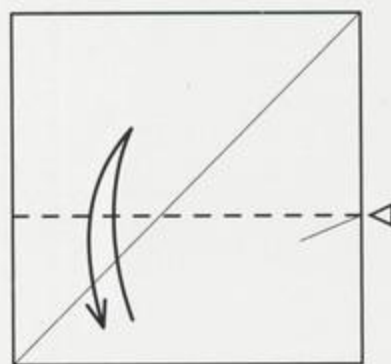
Fig. 1



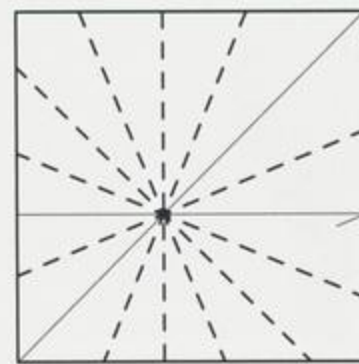
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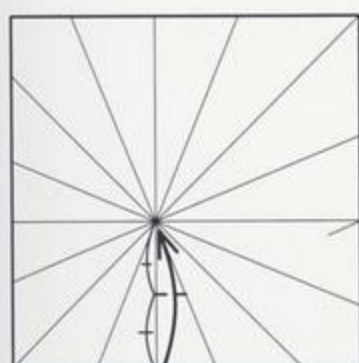
2 Pinch near the raw edge only.



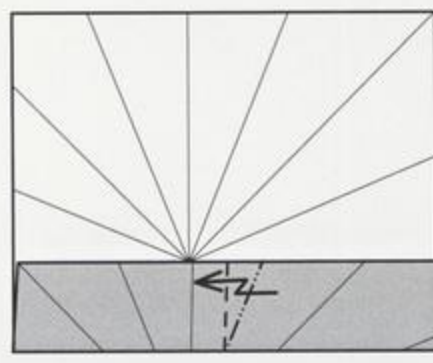
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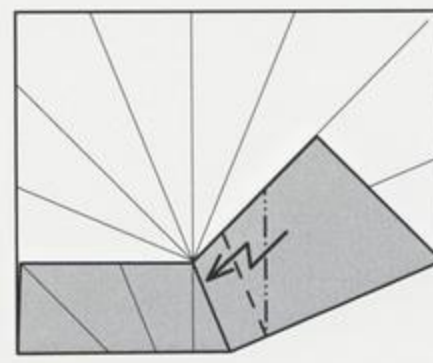
4 Divide 360° into 16 equal parts.



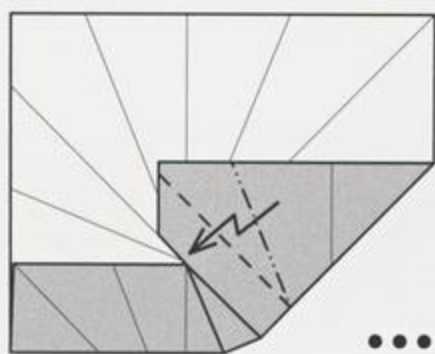
5



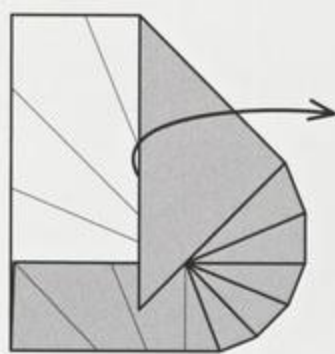
6 Mountain pleat to the centre.



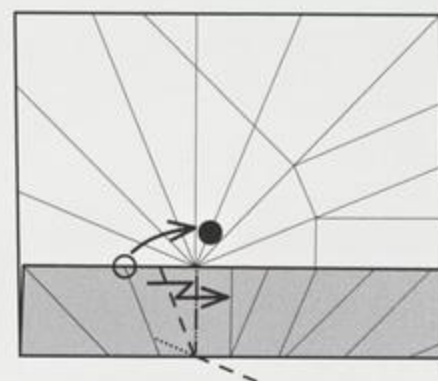
7 Mountain pleat to the centre.



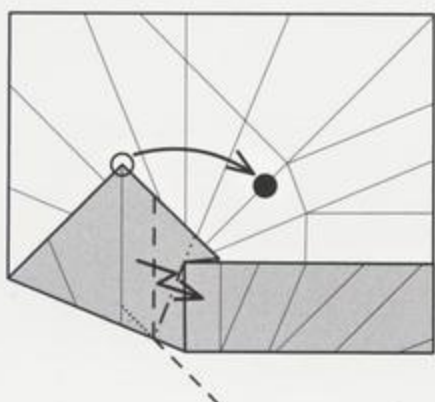
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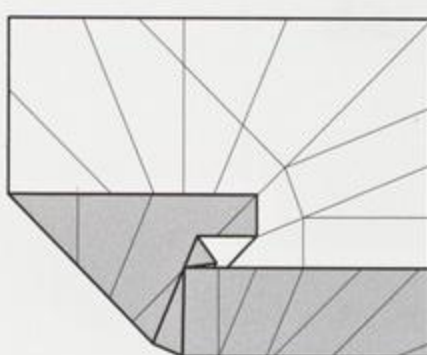
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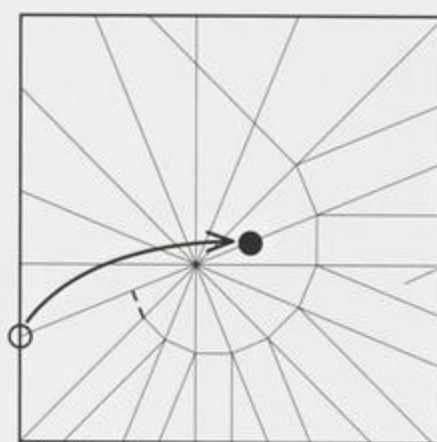
10 Fold line A.



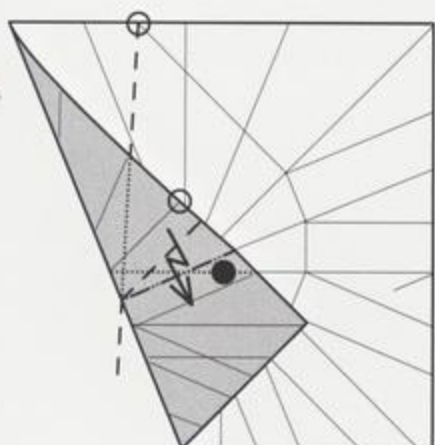
11 Fold line B.



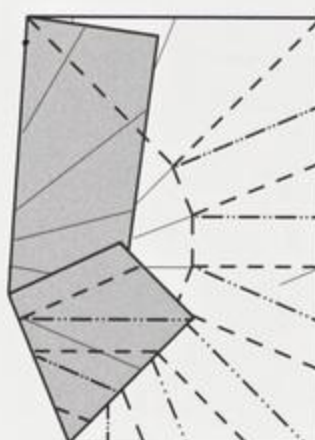
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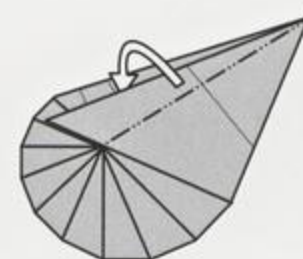
13 Fold line C.



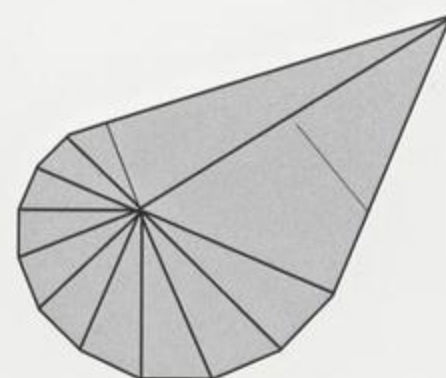
14



15 Pleat counterclockwise using the precreases made in steps 6 to 12.



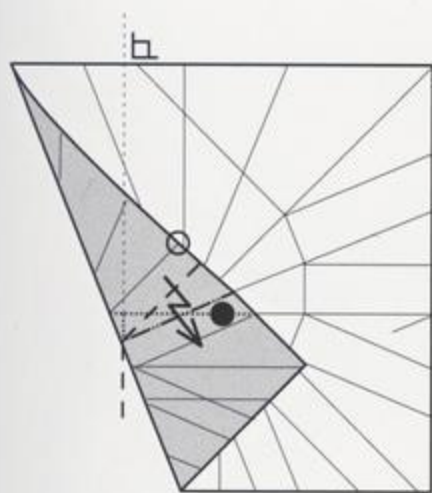
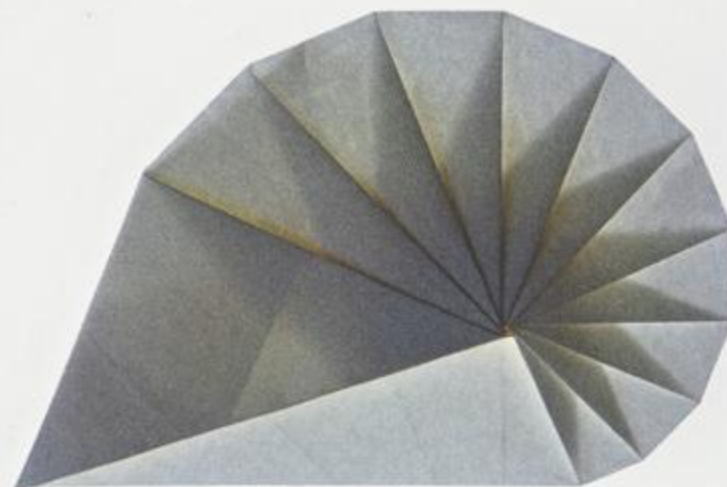
16 Fold inside.



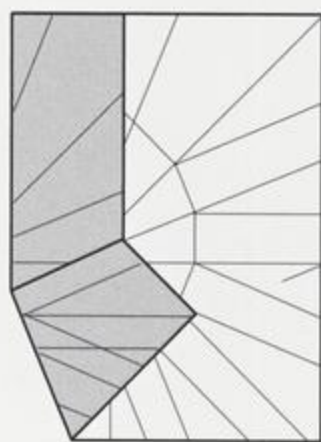
FLAT SHELL

WITH 11 SEGMENTS

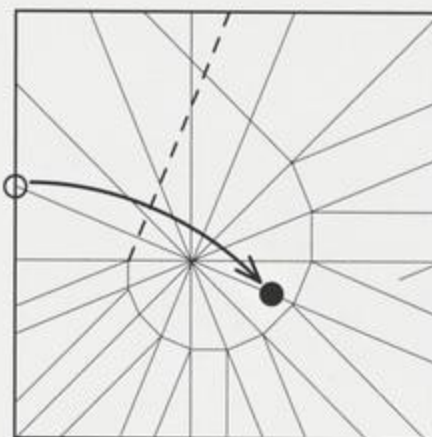
Continue with step 14 of previous model.



14 Fold line D.



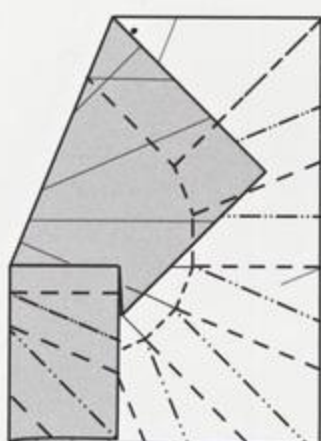
15



16 Fold line E.



17 Mountain pleat using existing creases.

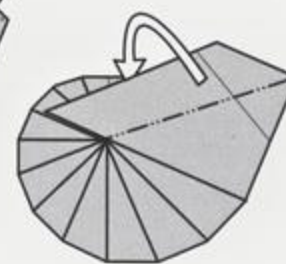


18

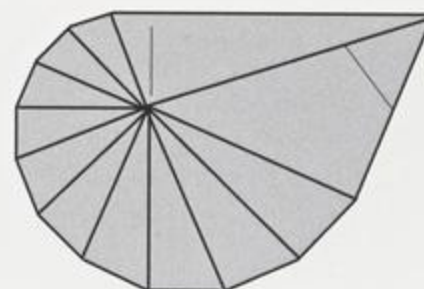
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19



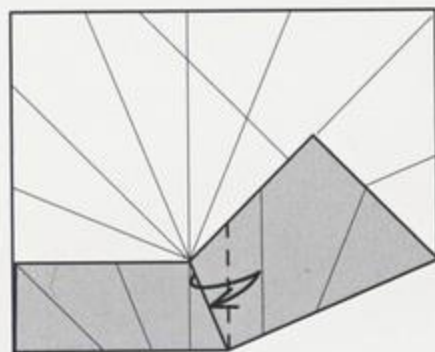
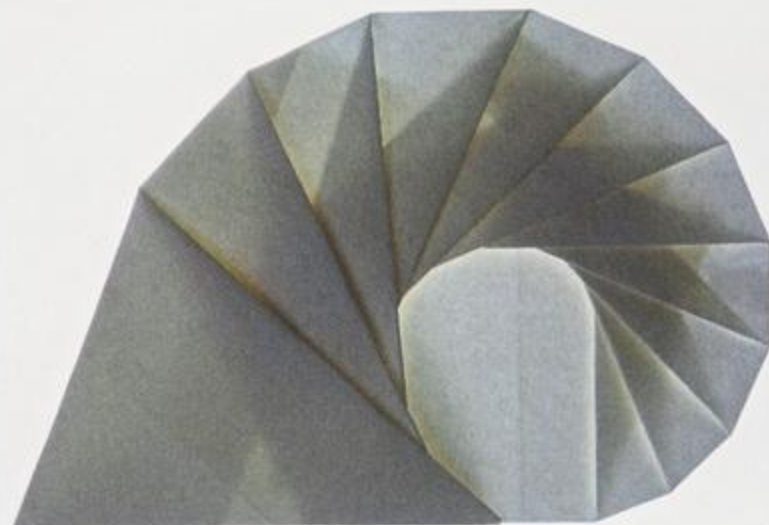
20 Fold inside.



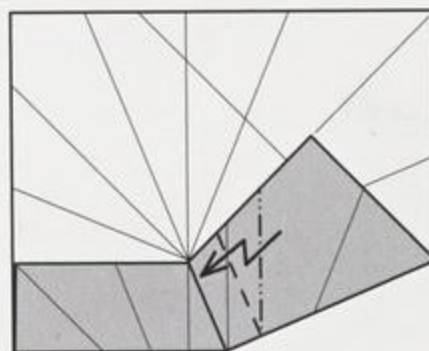
FLAT SHELL

VARIATION WITH 11 SEGMENTS

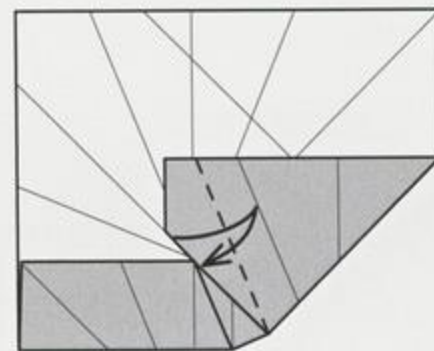
In this variation an additional crease is added after each pleat. Steps 1 to 6 are the same as in »Flat Shell with 10 Segments« on page 71.



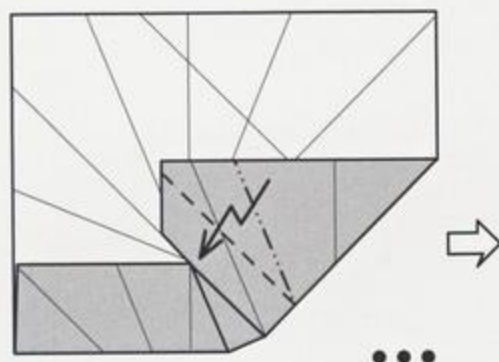
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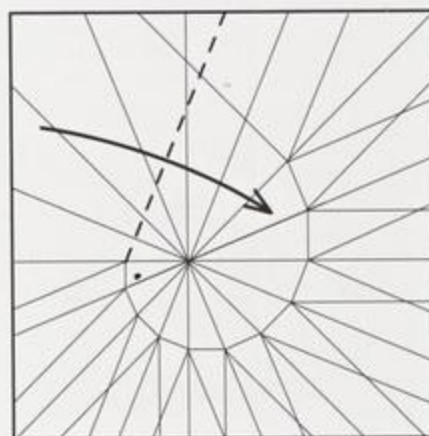
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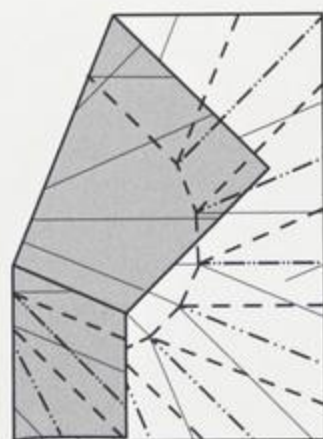
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11

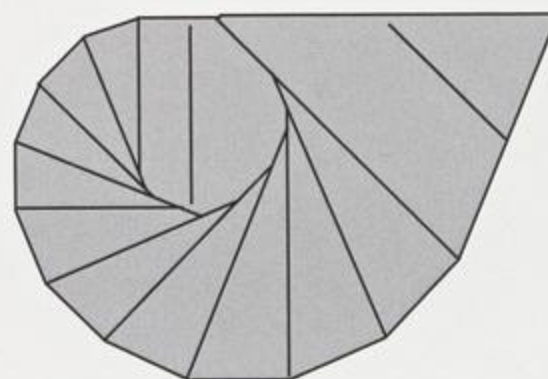


12



13

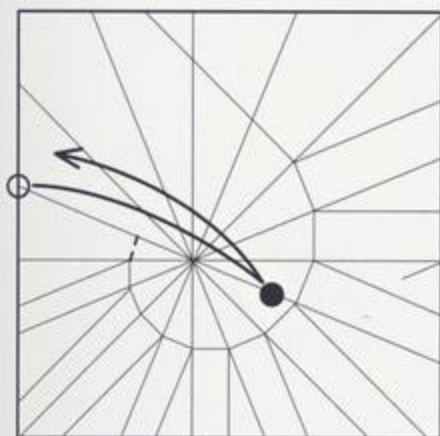
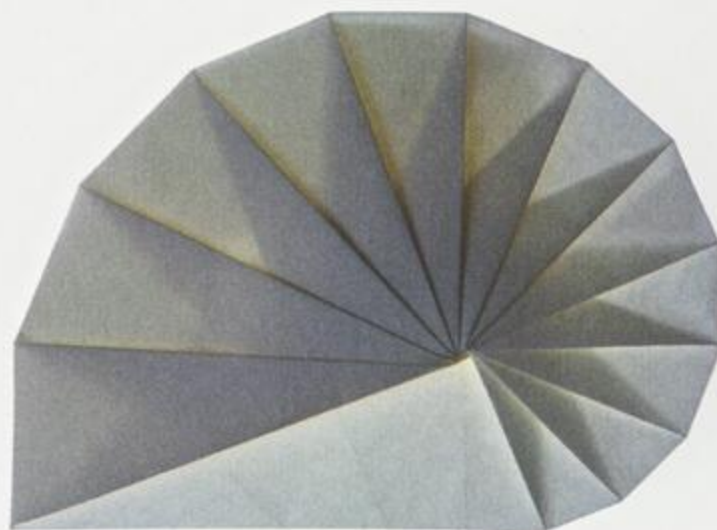
Precrease as indicated thereby changing mountains to valleys and vice versa. Then close the pleats according to the precreases.



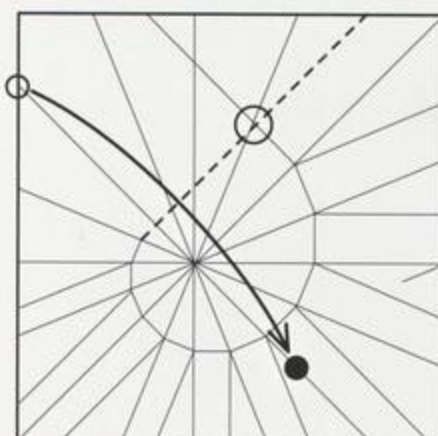
FLAT SHELL

WITH 12 SEGMENTS

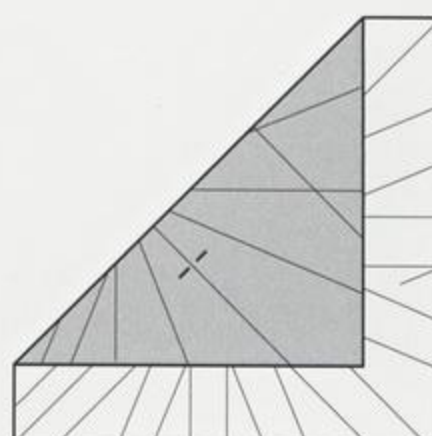
Continue with step 16 of »Flat Shell with 11 Segments« on page 73.



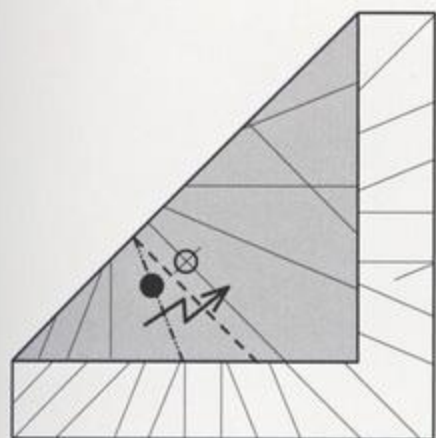
16 Fold line E.



17 Fold line F. New crease does not meet marked intersection.



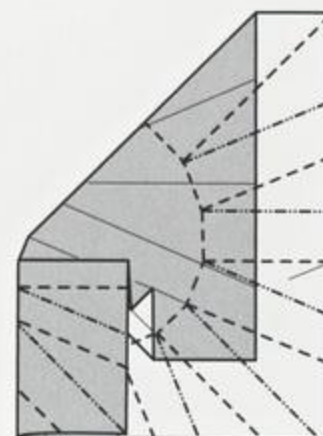
18 Mark centre of lower layer on upper layer.



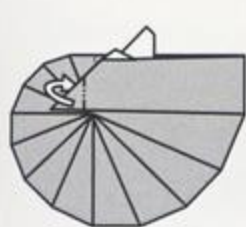
19



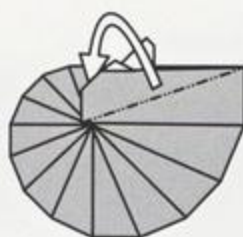
20



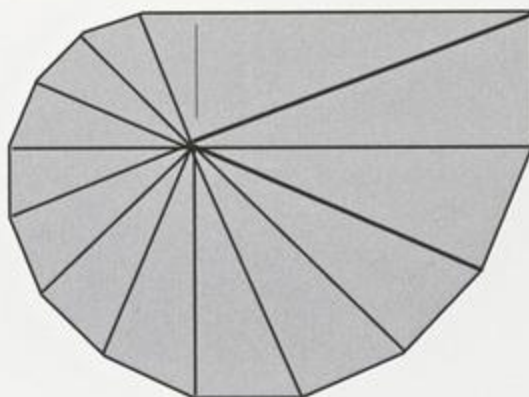
21 Continue mountain pleating using existing creases only.



22 Fold inside.

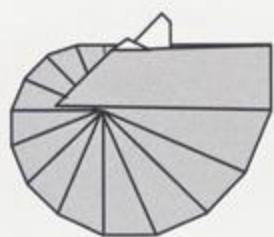


23 Fold inside.

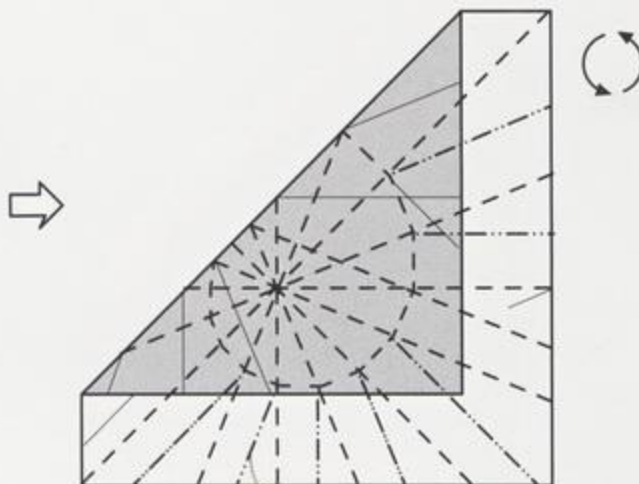


SOLID SHELL

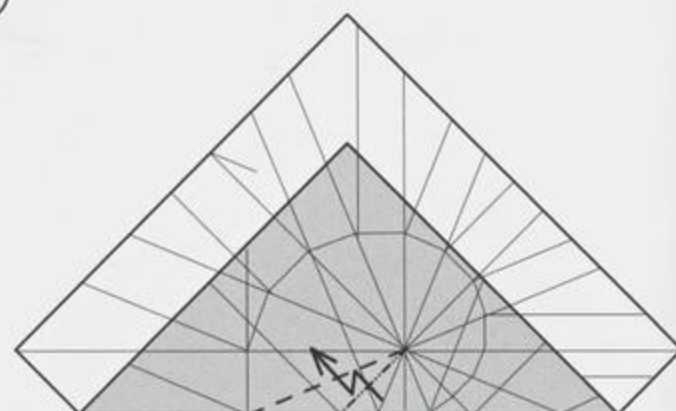
WITH 12 SEGMENTS



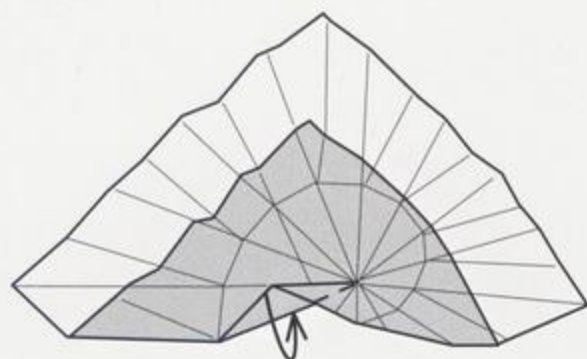
22 Unfold step 22 of «Flat Shell with 12 Segments» on page 75.



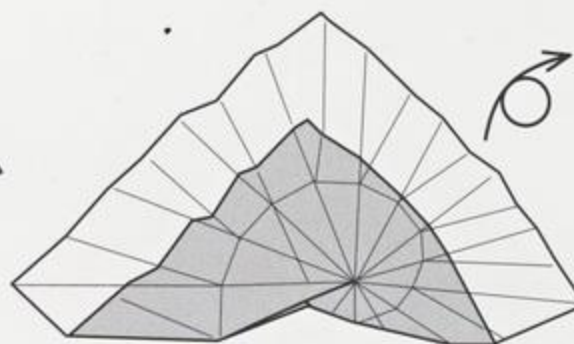
23 Precrease both layers together.



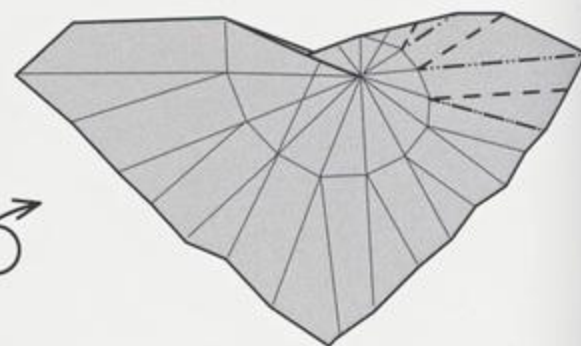
24 Precrease pleat...



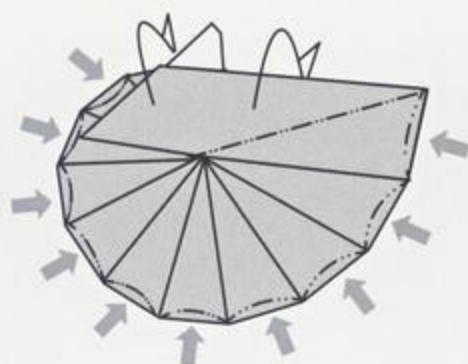
25 ... and reverse inside.



26



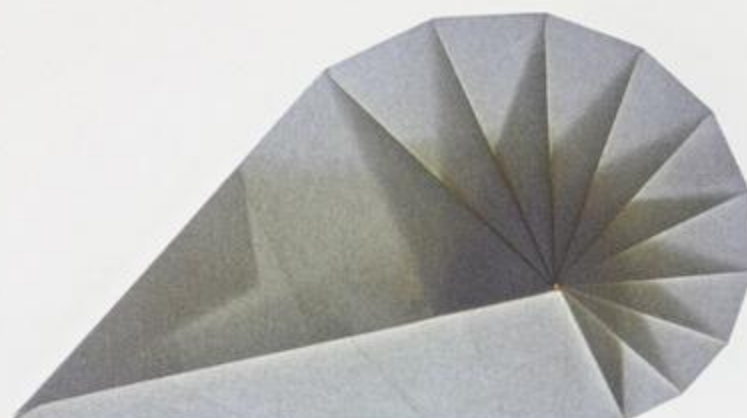
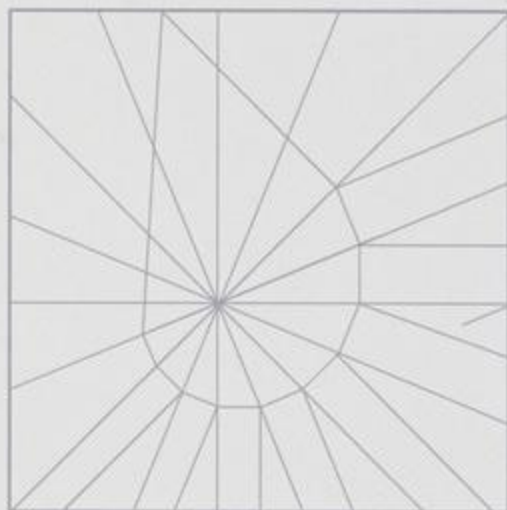
27 Close the shell again using the existing creases.



Fold flap inside and push the edges round.

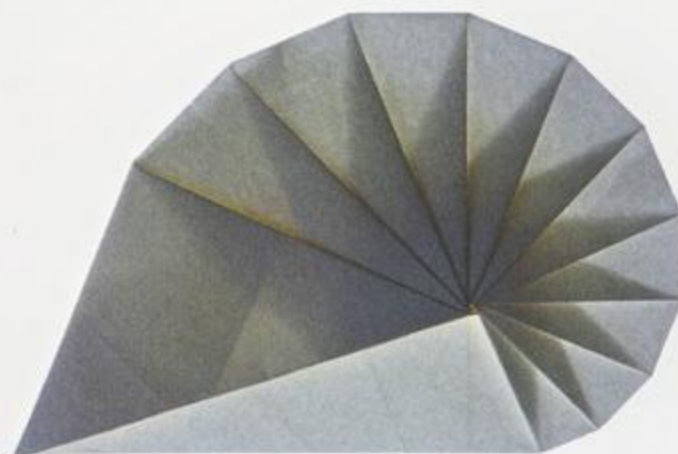
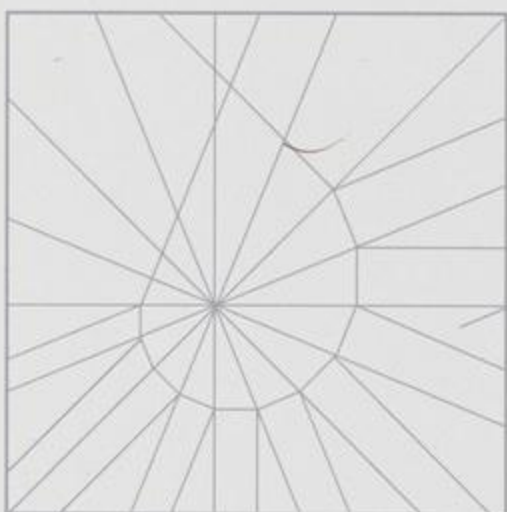
22.5°

10 segments



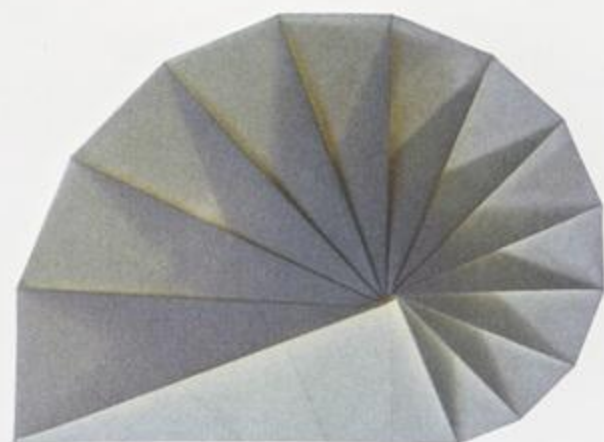
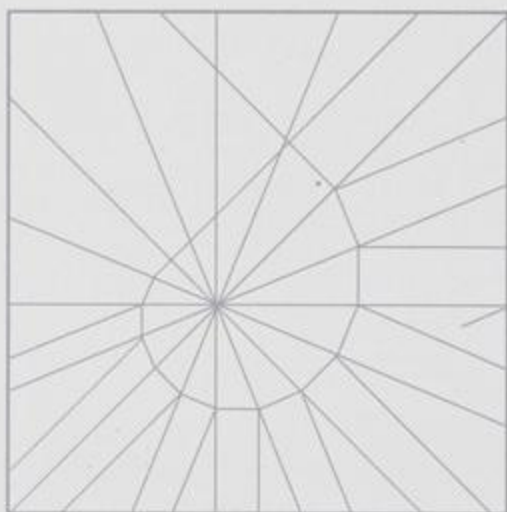
22.5°

11 segments



22.5°

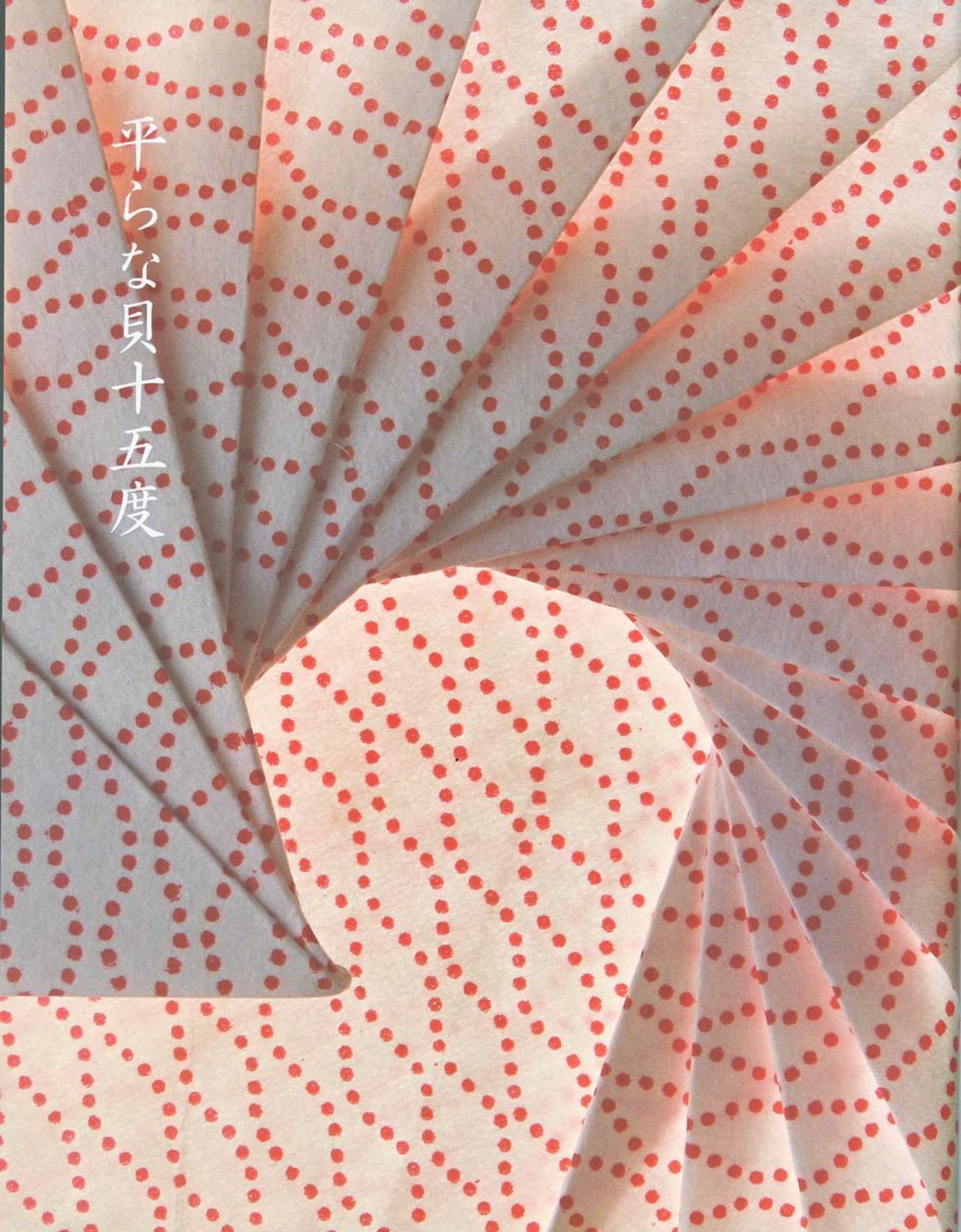
12 segments







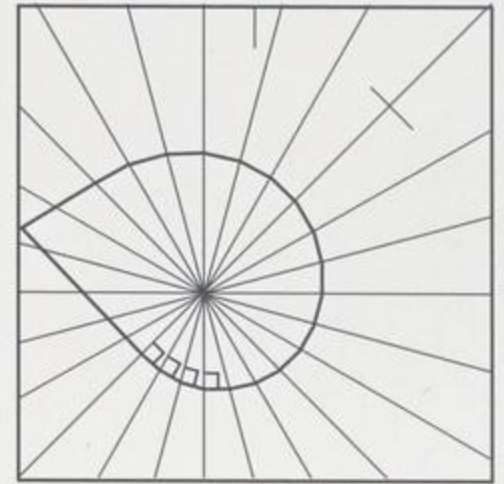
平らな貝十五度



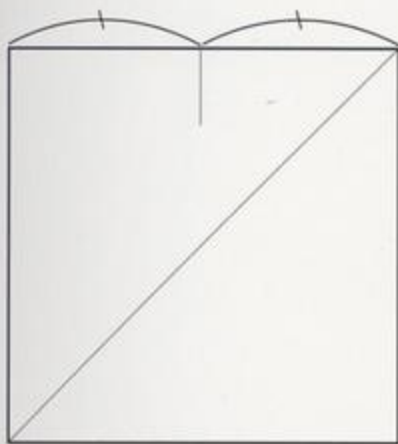
FLAT SHELL 15° SEGMENTS

For this shell the paper is divided into 24 segments of 15° each. The folding method is the same as in »Flat Shell 22.5° Segments« on page 71. The exact position of the centre point is not critical. Steps 2 and 3 help you find a centre position that will work. Do your own experiments with different positions! To get the most beautiful result the amount of paper that is folded away in step 13 should neither be too much nor too little.

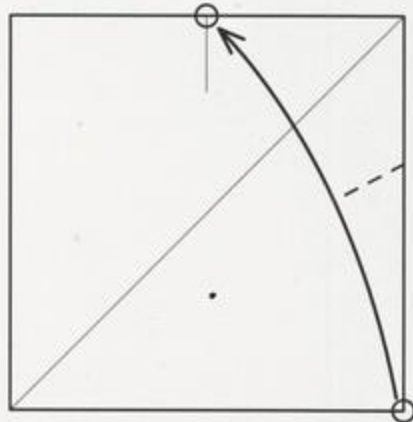
Fig. 2



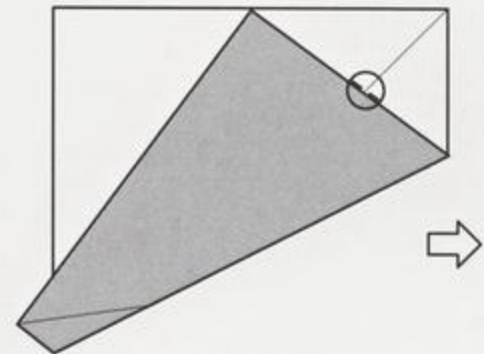
FLAT SHELL WITH 17 SEGMENTS



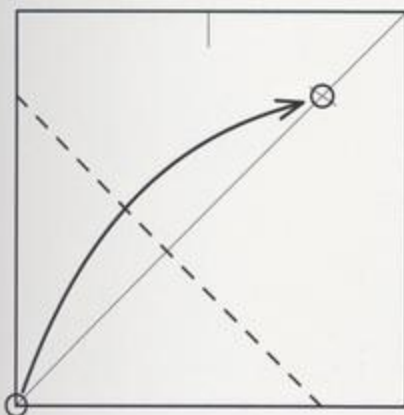
1



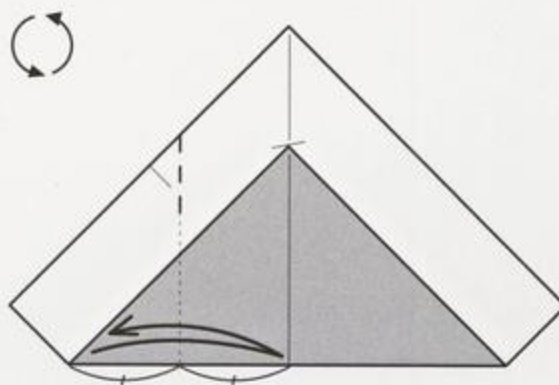
2 Pinch near the raw edge only.



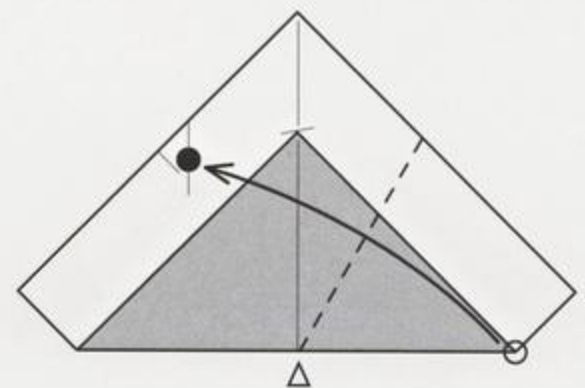
3 Mark intersection of raw edge and diagonal crease.



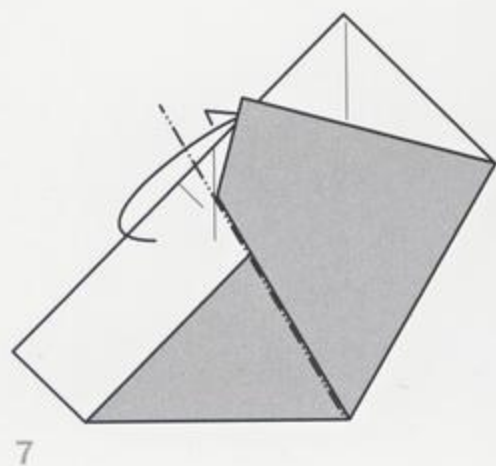
4



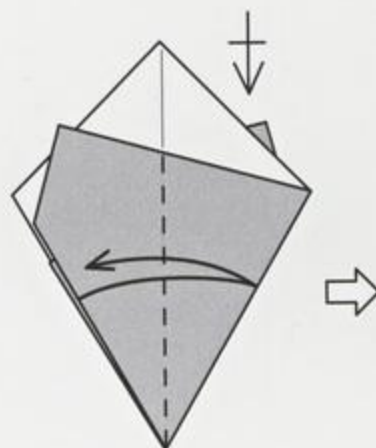
5



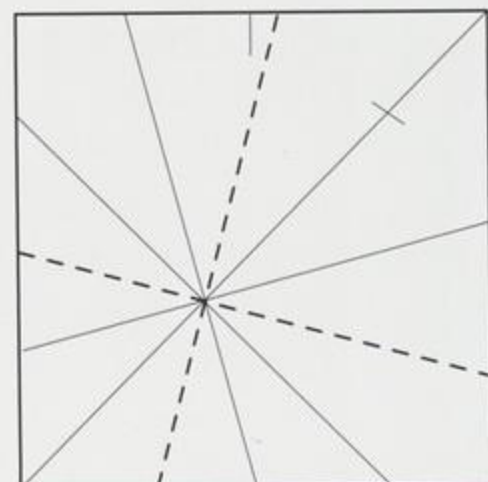
6



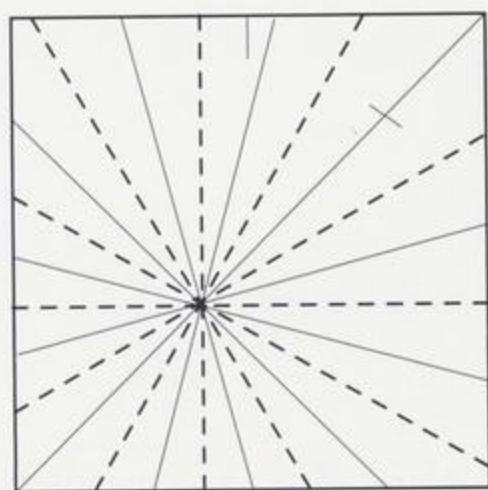
7



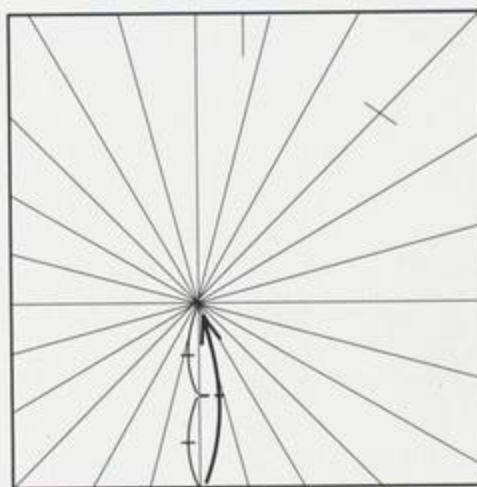
8 Repeat behind.



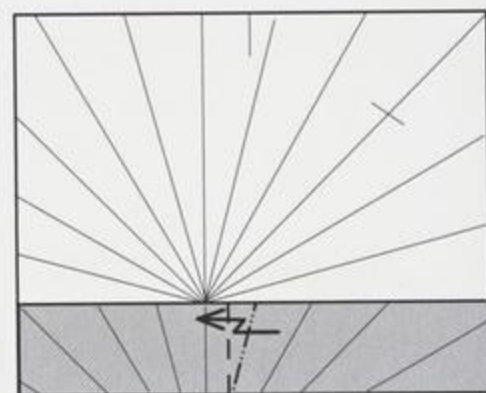
9 Reverse mountain creases to valley creases.



10 Add more angle-bisecting valley creases.



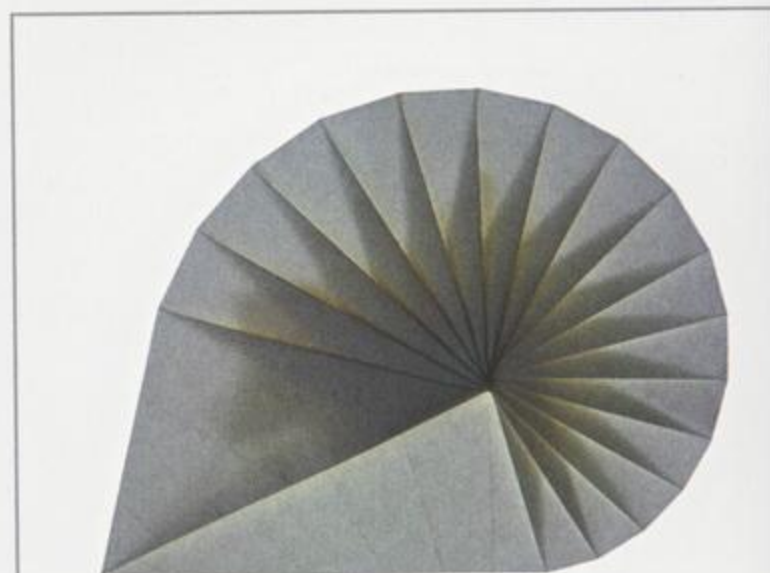
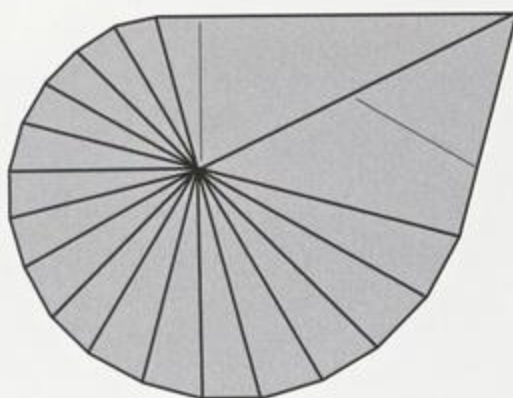
11



12 Complete in the same way as in «Flat Shell 22.5° Segments» on page 71 from step 6 on.



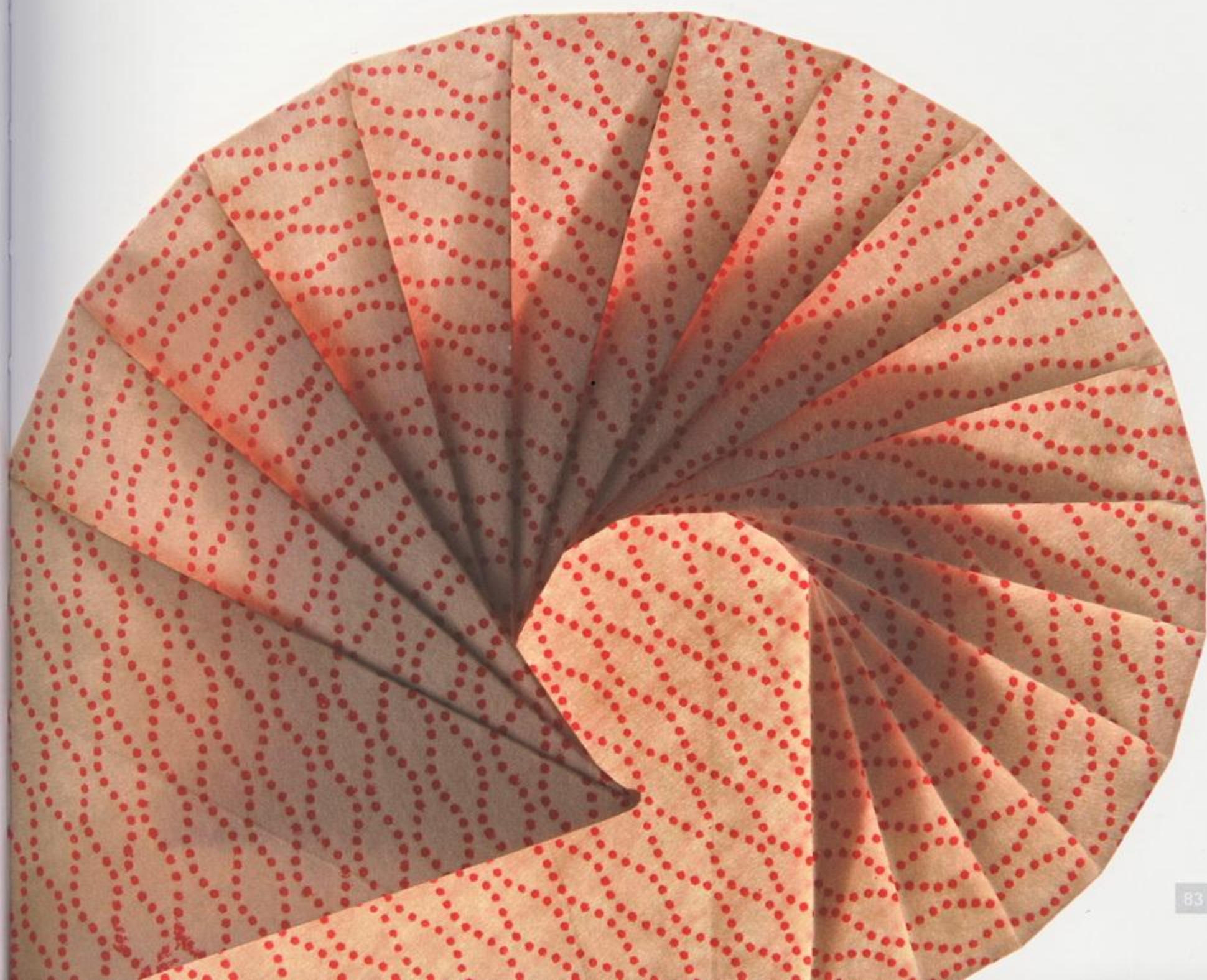
13 Fold inside.



FLAT SHELL

WITH 18 SEGMENTS

Make and use the additional creases as in »Flat Shell
Variation with 11 Segments« on page 74.



平らな貝十八度



FLAT SHELL 18° SEGMENTS

For this shell the paper is divided into 20 segments of 18° each.

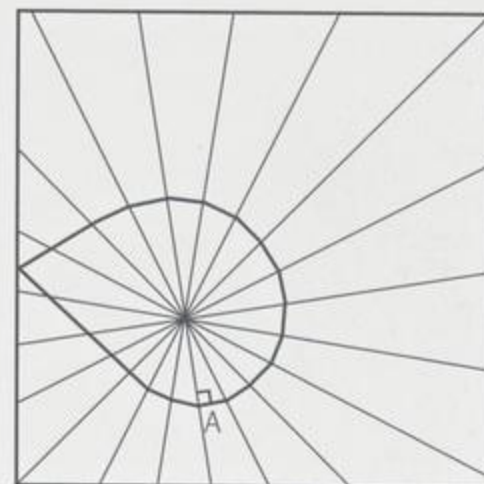
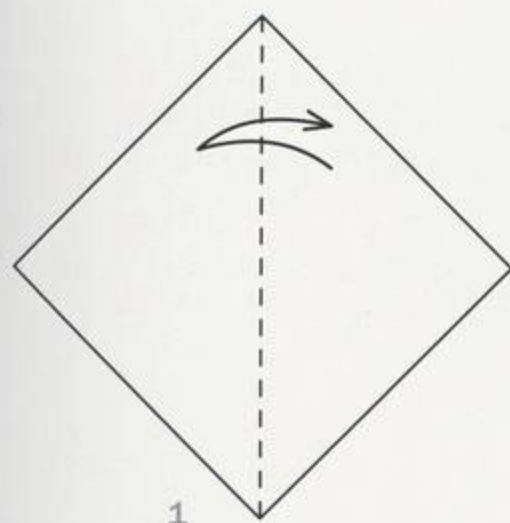
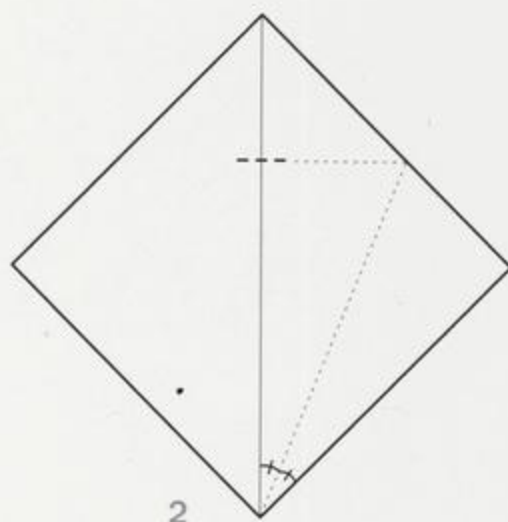


Fig. 3

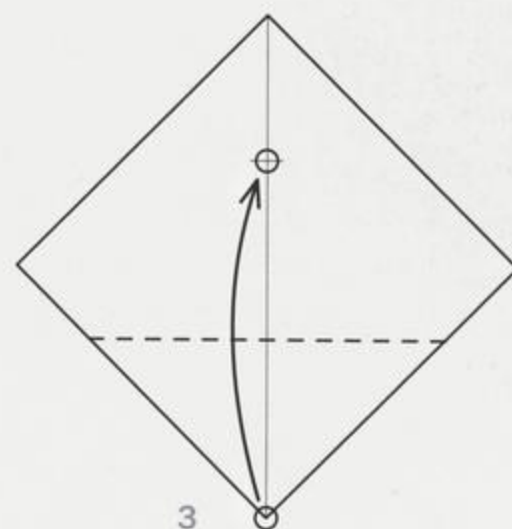
FLAT SHELL WITH 14 SEGMENTS



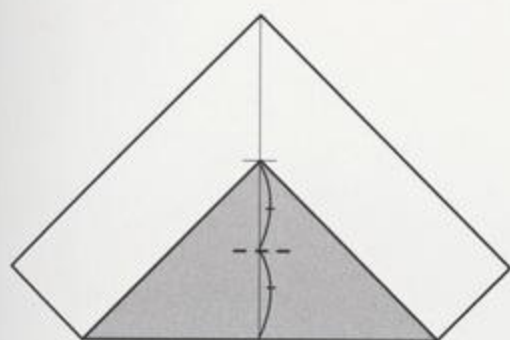
1



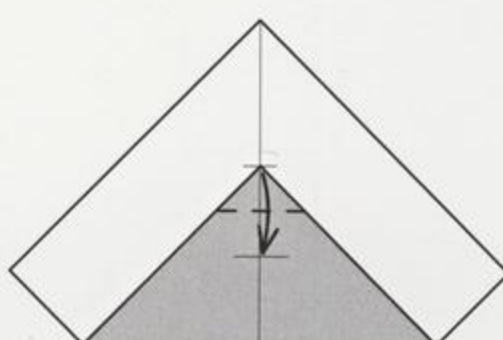
2



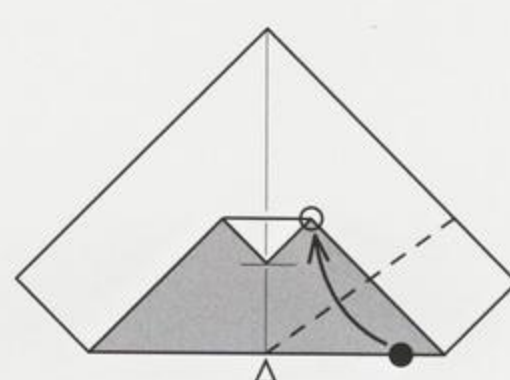
3



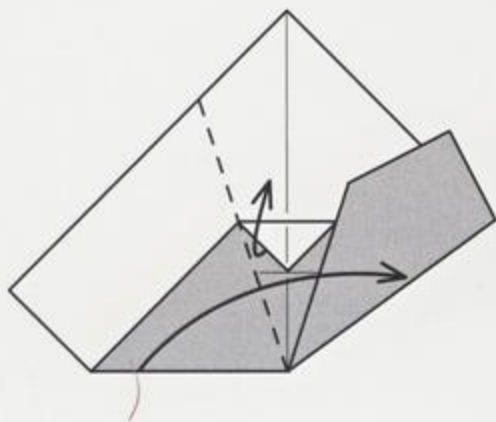
4 Mark on top layer only.



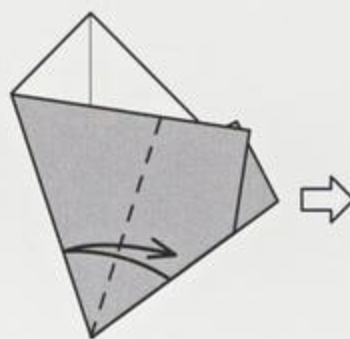
5



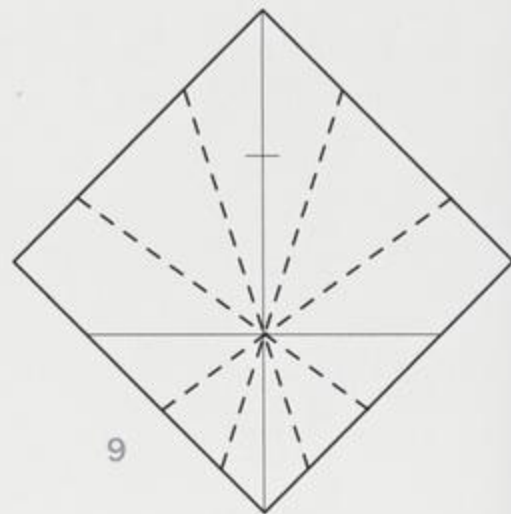
6



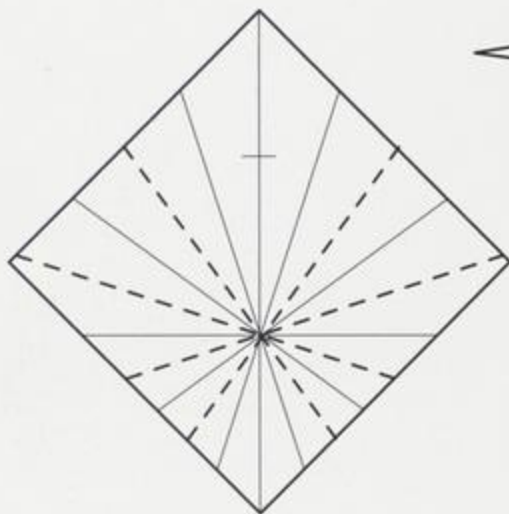
7



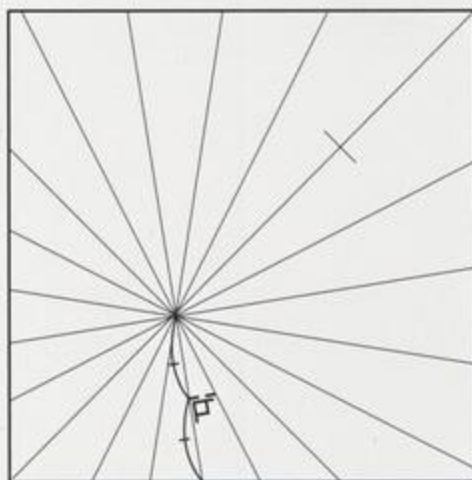
8 Fold all layers.



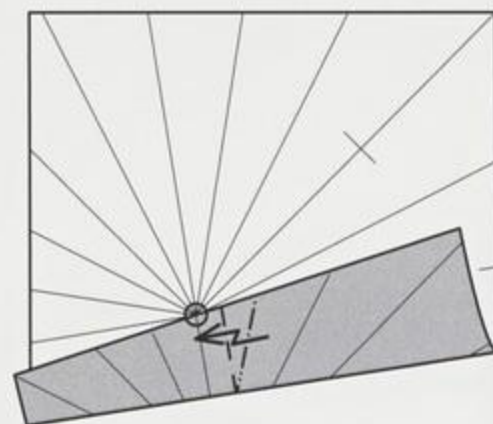
9



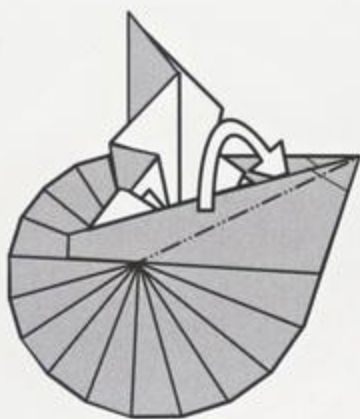
10 Add more angle-bisecting valley creases.



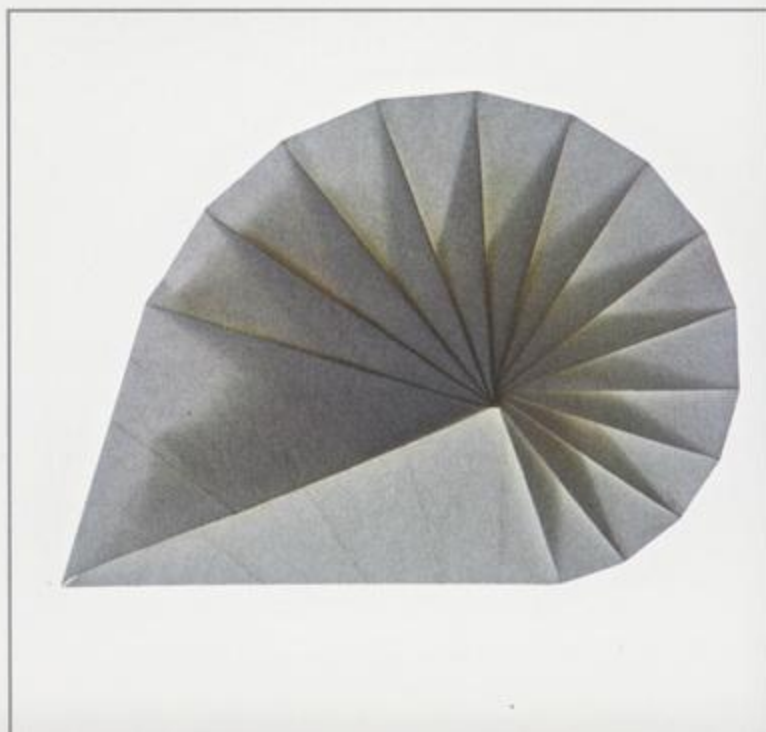
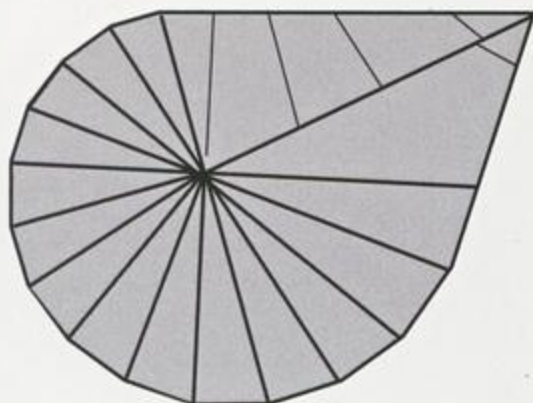
11 Fold line A.



12 Complete in the same way as in »Flat Shell 22.5° Segments« on page 71 from step 6 on.



13 Fold inside.



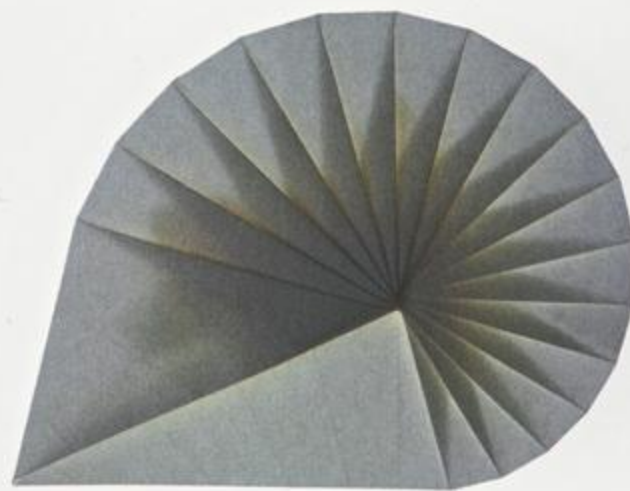
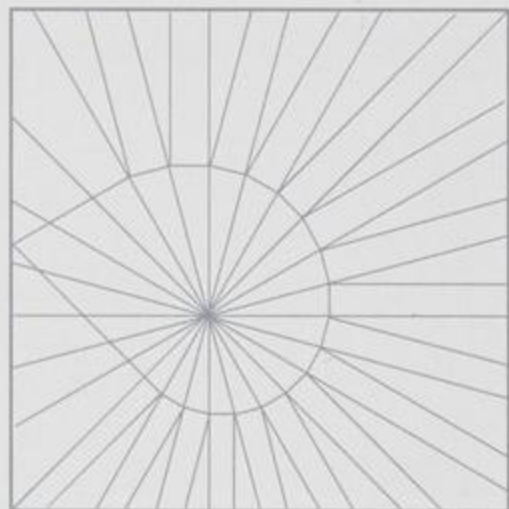
22.5°

10 | 11 | 12 segments



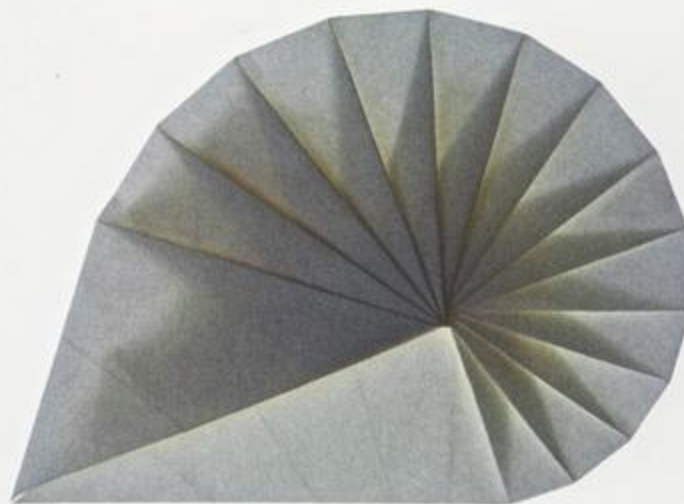
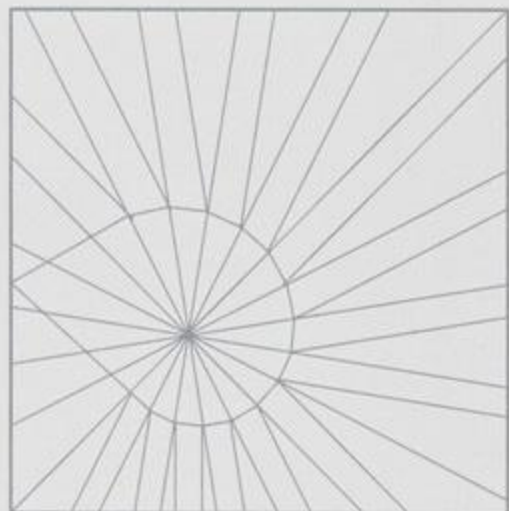
15°

17 segments



18°

14 segments

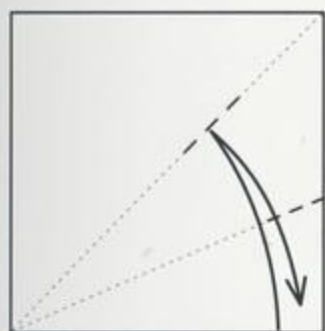


葉にとまる蝶

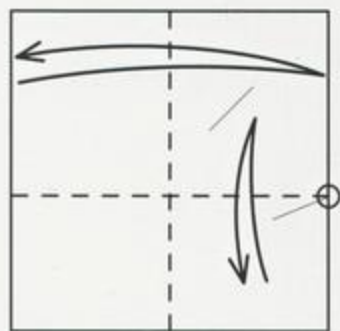


BUTTERFLY ON LEAF

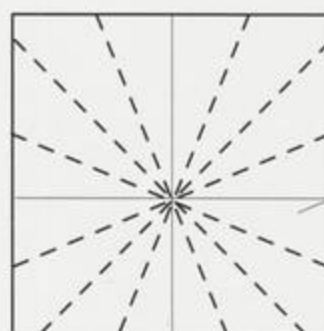
Although not a shell, the model is included in this chapter, because the folding method is the same. When you use translucent paper, you can see the veins of the leaf clearly. Four corners of a square become the wings of a butterfly. This is one of my favourite models, because a square sheet of paper is perfectly brought to life.



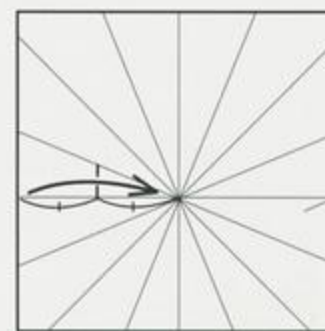
1



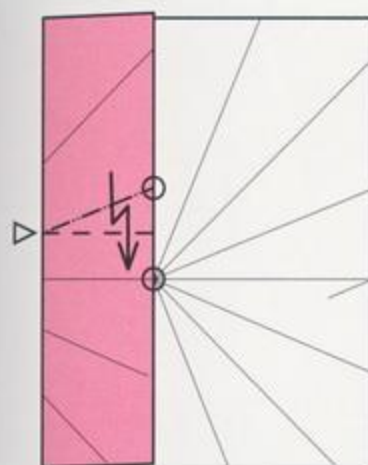
2



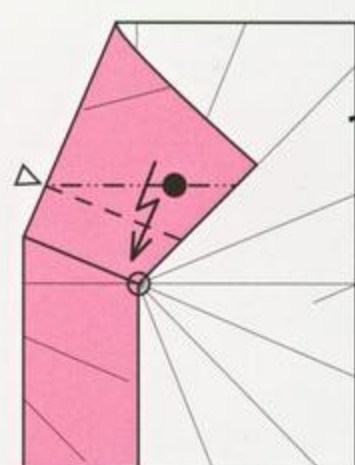
3



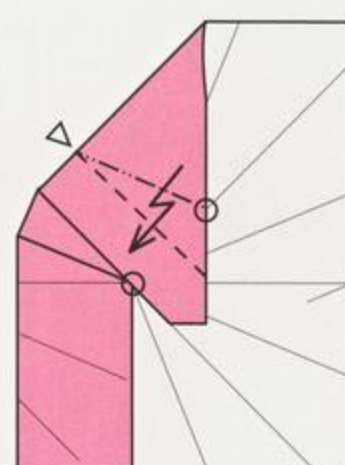
4



5



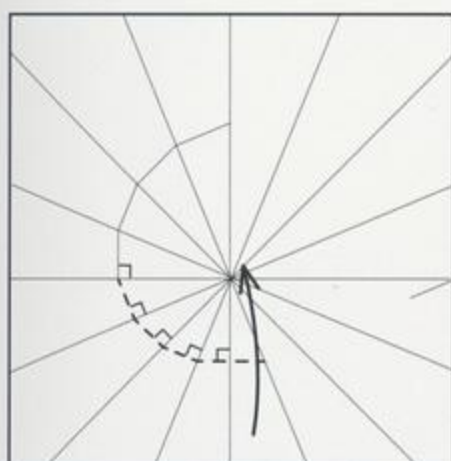
6



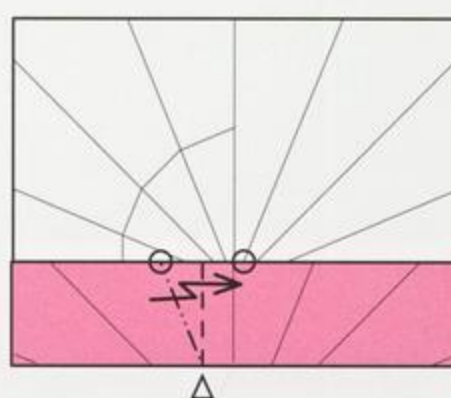
7



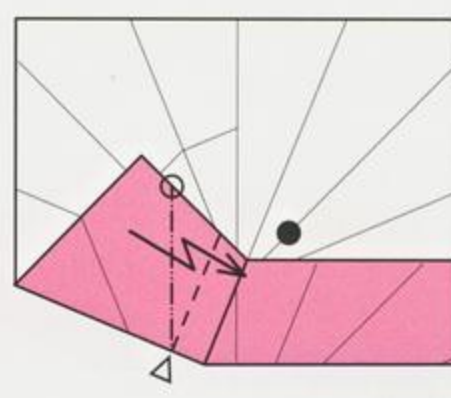
8



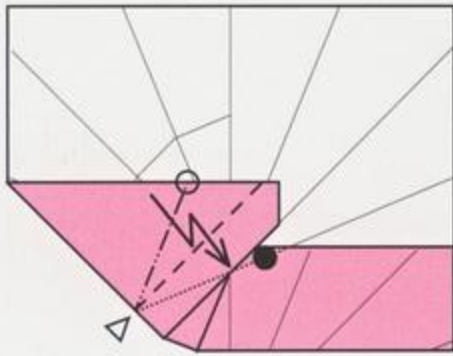
9 Fold right angle on each radial crease to continue the spiral curve.



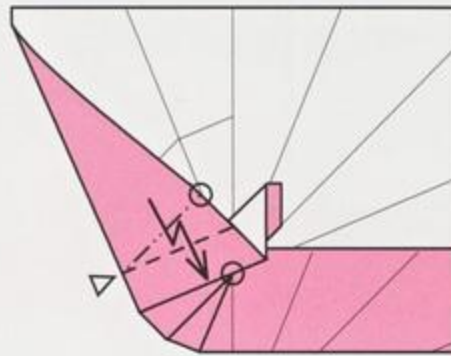
10



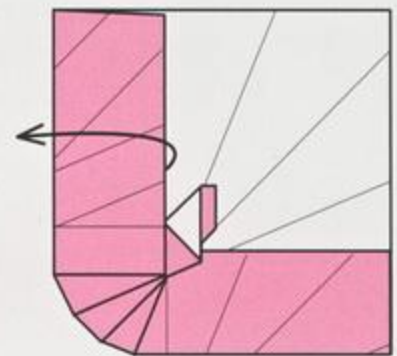
11



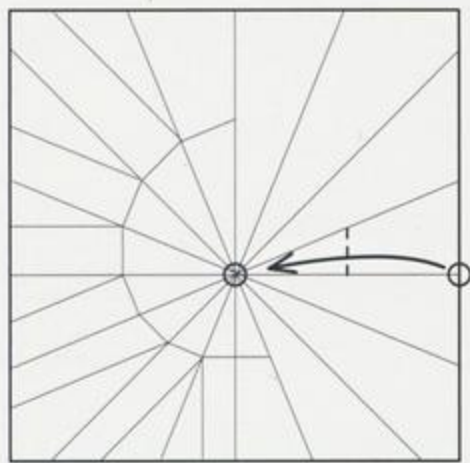
12



13



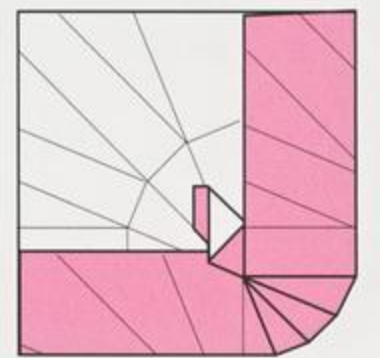
14



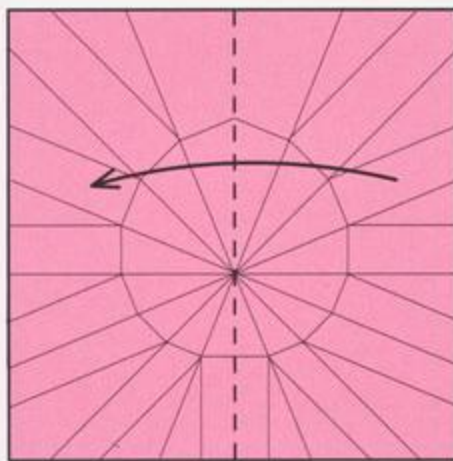
15



16 Fold the other side in the same way as steps 5 to 14.



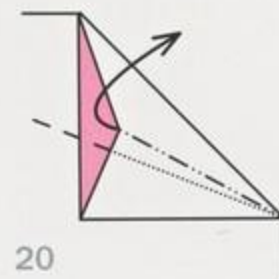
17



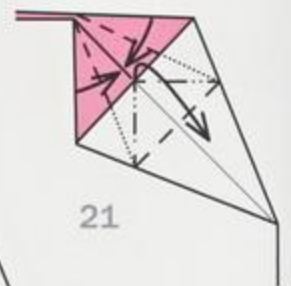
18



19



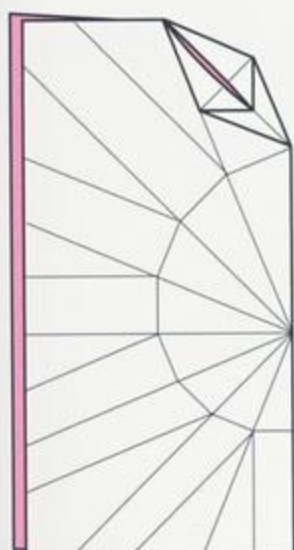
20



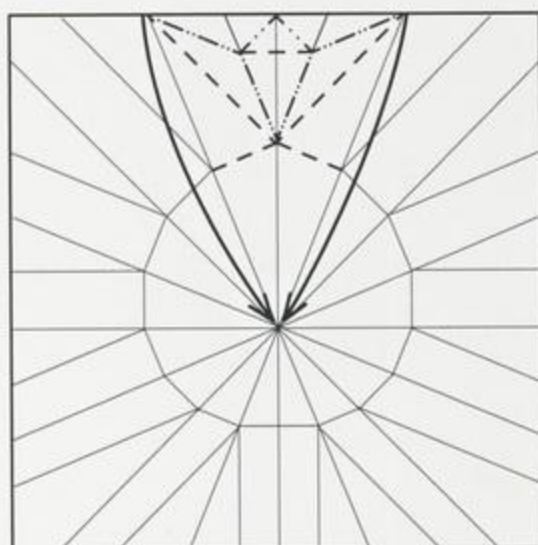
21



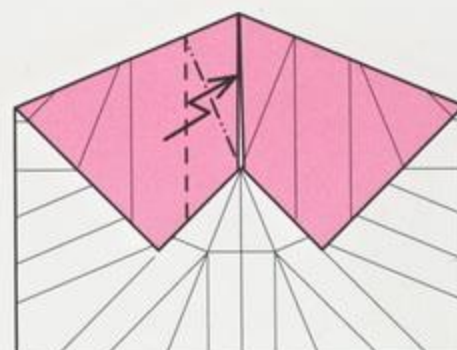
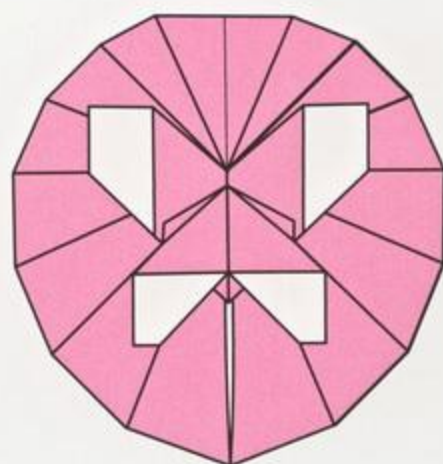
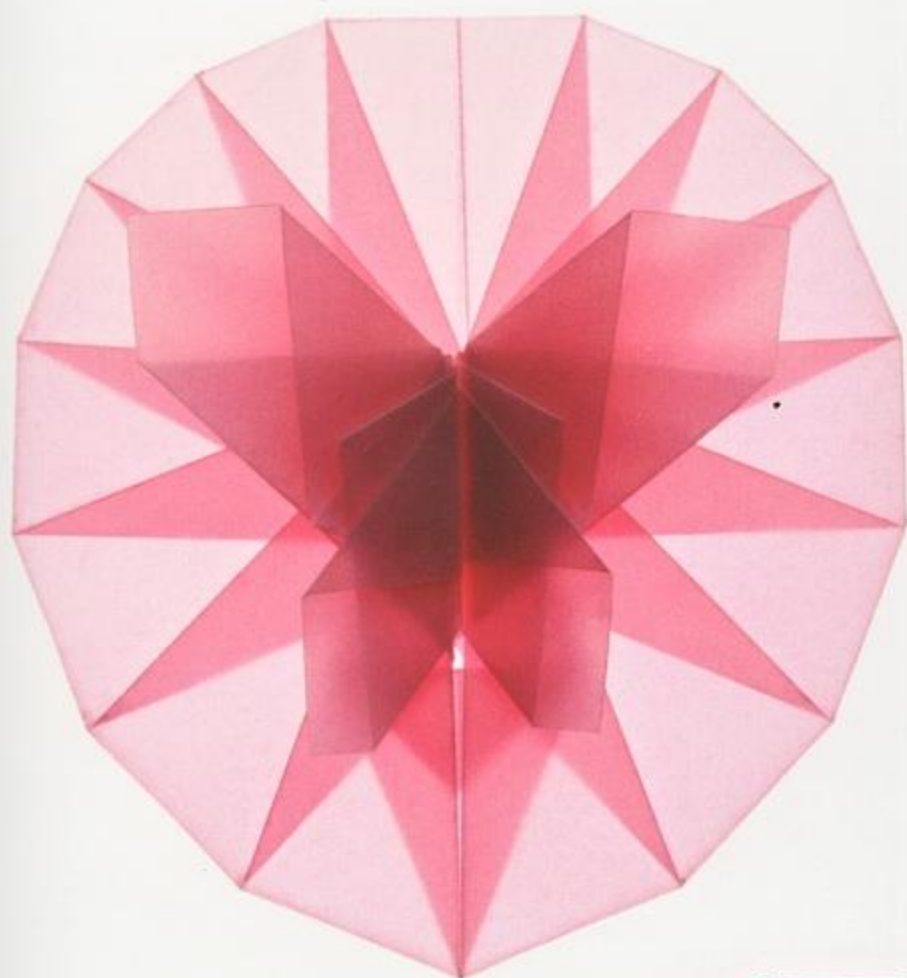
22 Petal fold.



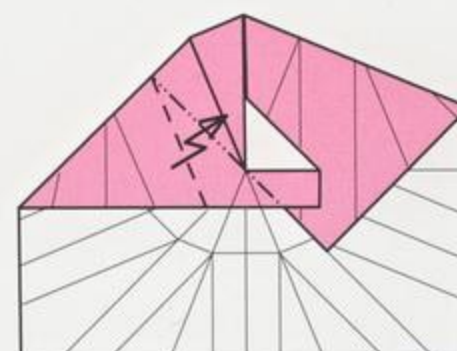
23



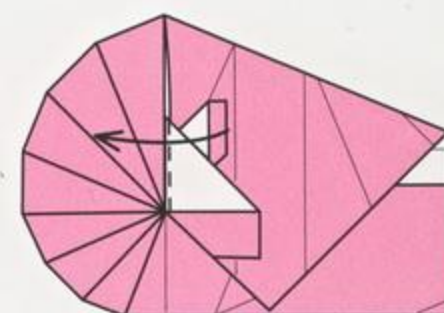
24 Use the petal fold creases to collapse. The petal fold is hidden inside.



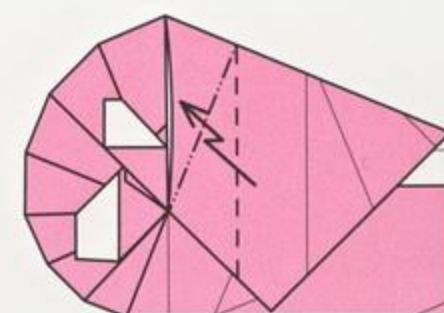
25 Pleat using existing creases. The wing should be on the outside.



26 Pleat the other precreases in the same way taking care that excess paper (the wings) always comes to the outside.



27 Fold the wings to the other side.

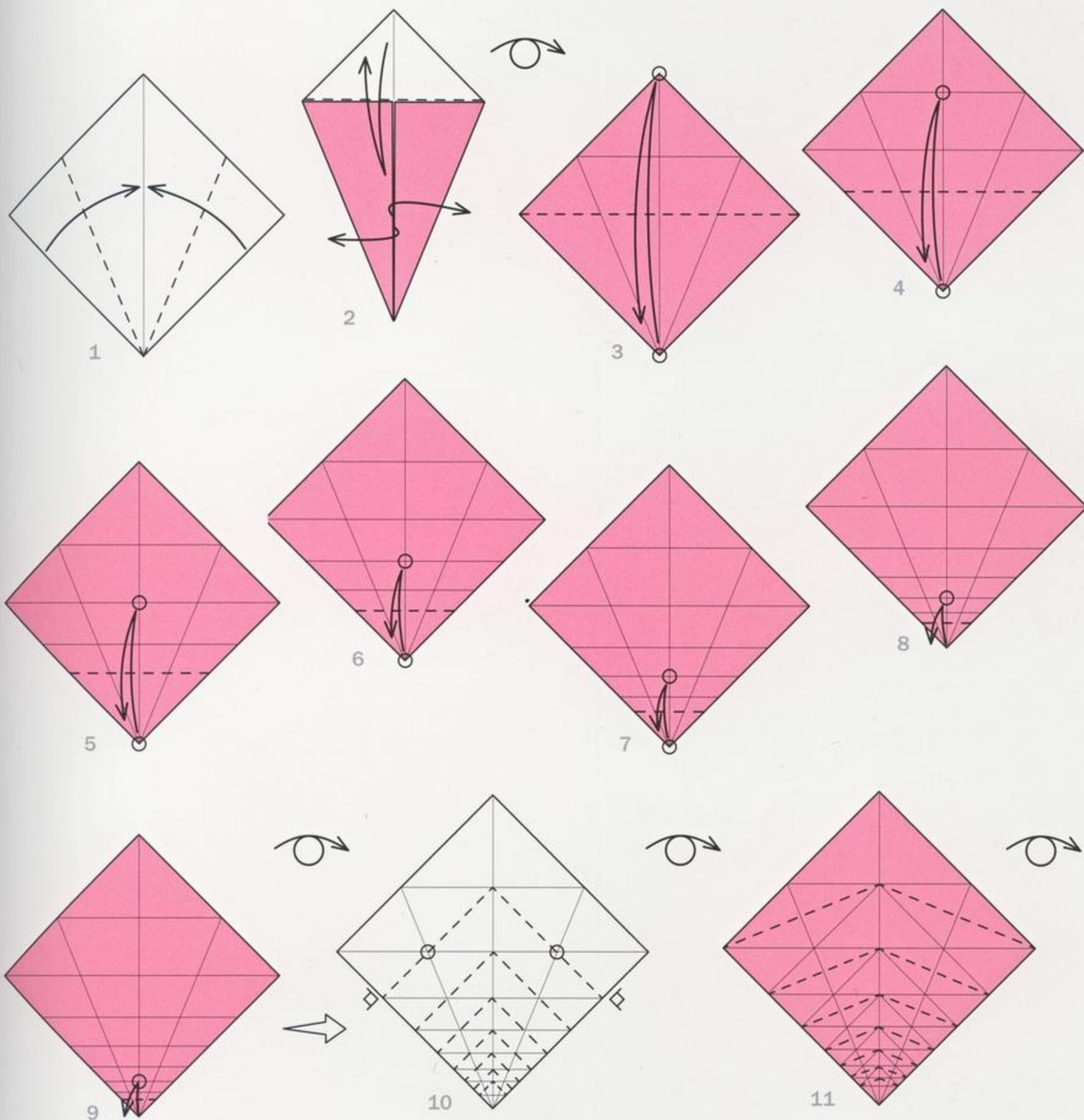


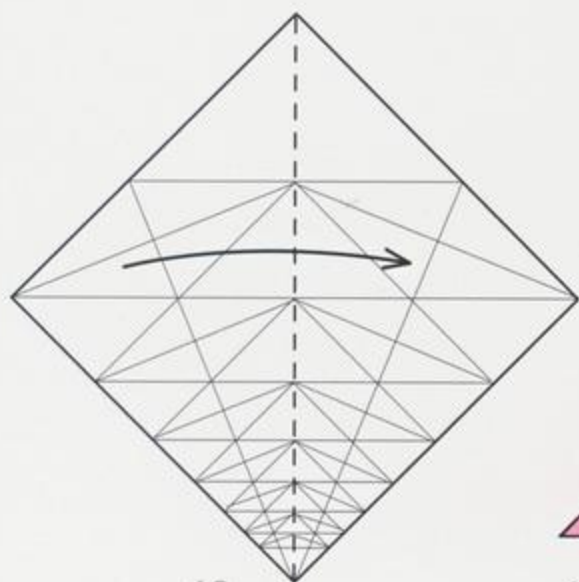
28 Repeat steps 25 to 27 on the other side.

タコブネ

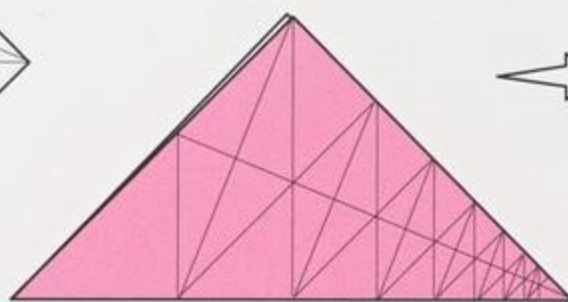


ARGONAUT

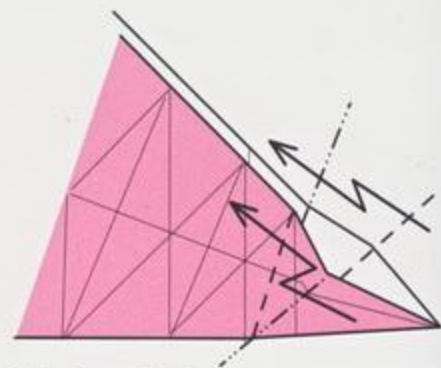




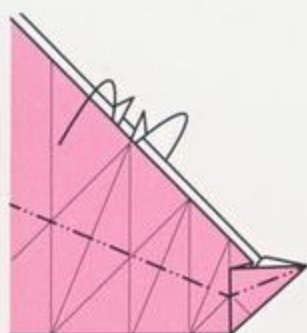
12



13



14 Cover fold on narrow end.



15



16

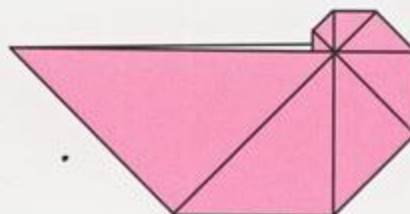


17 Cover fold on wide end.



18

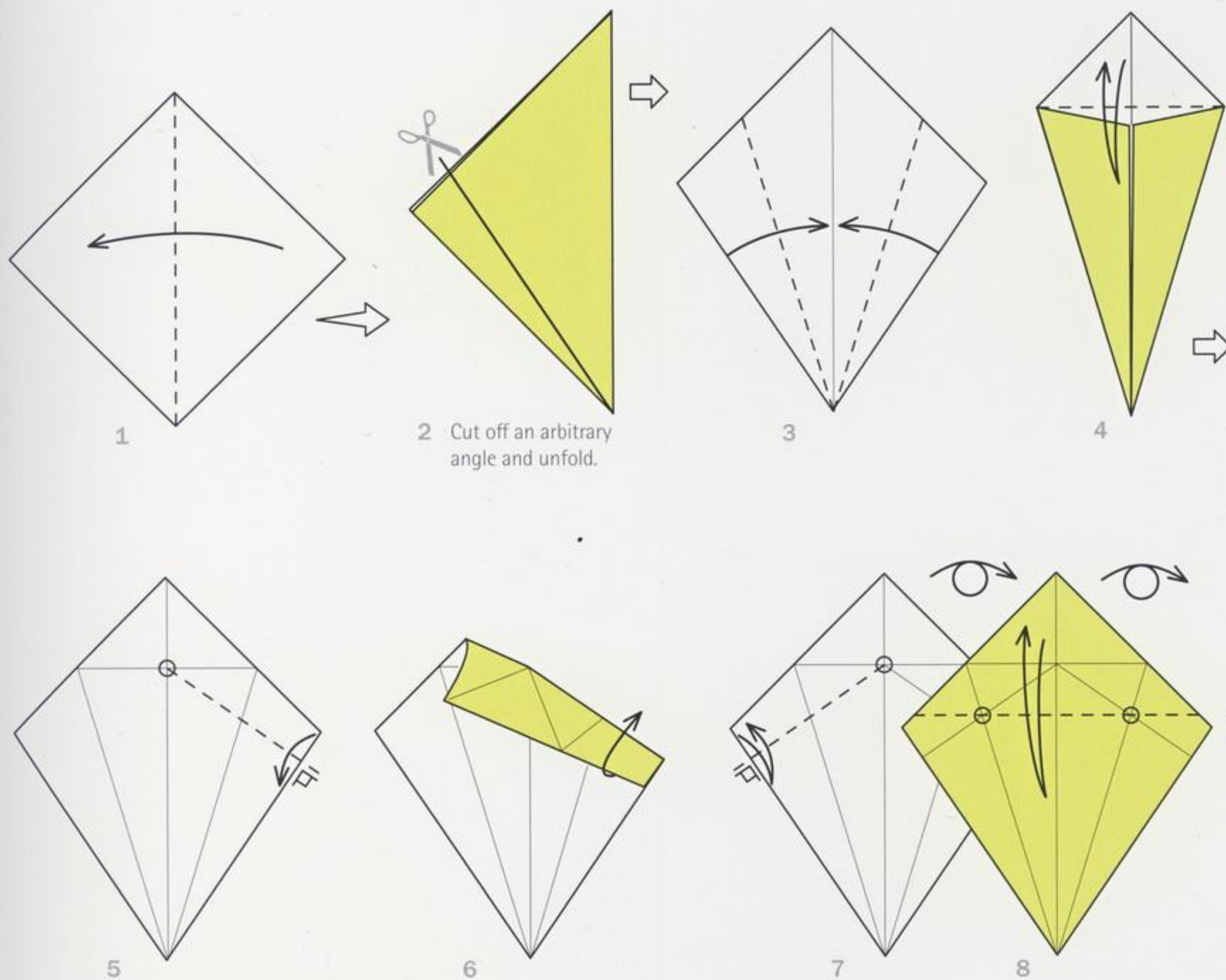
...

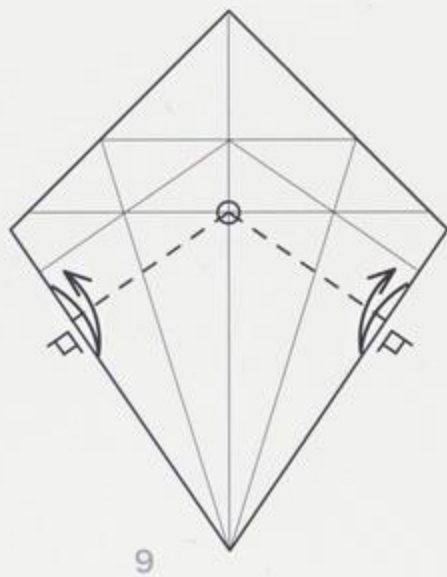


ARGONAUT

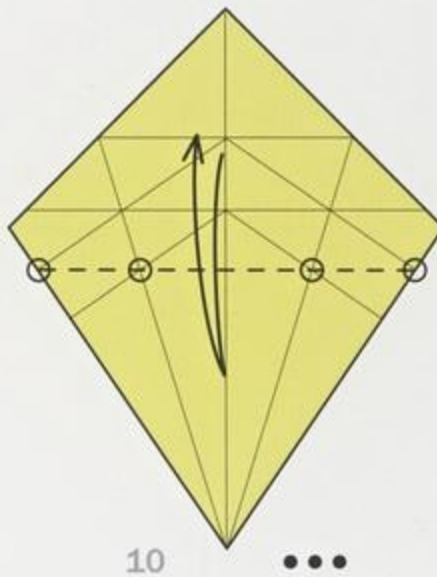
VARIATION

By changing the shape of the paper you can create different Argonaut variations.



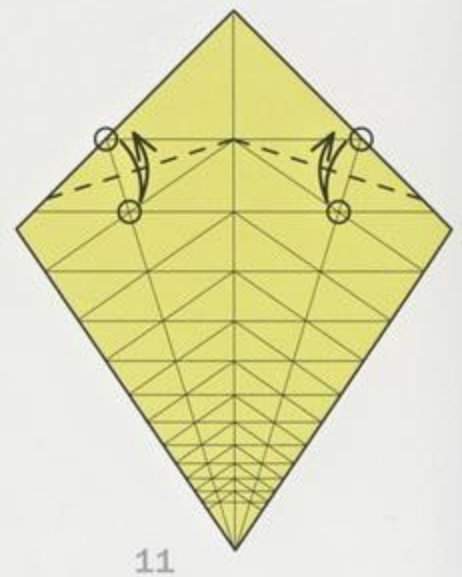


9

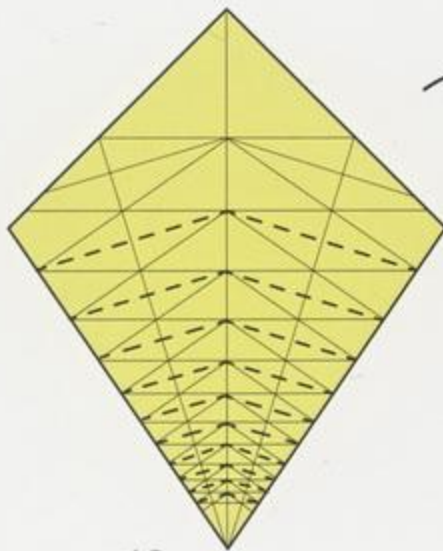


10

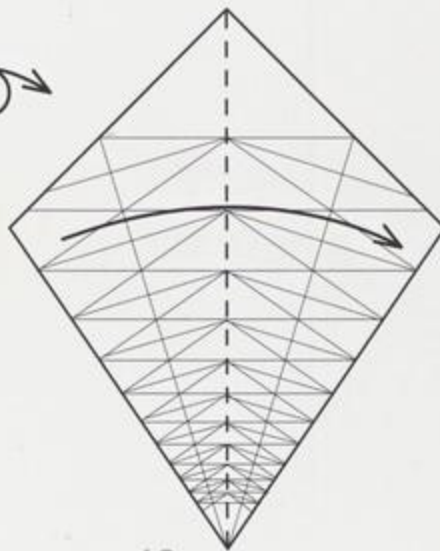
...



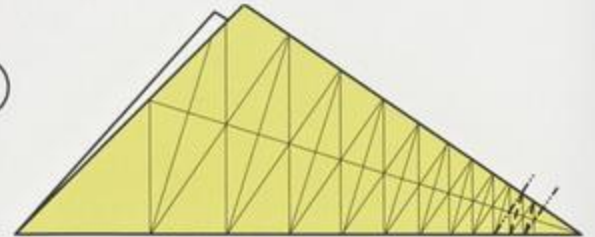
11



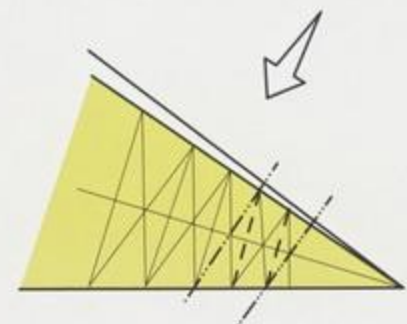
12



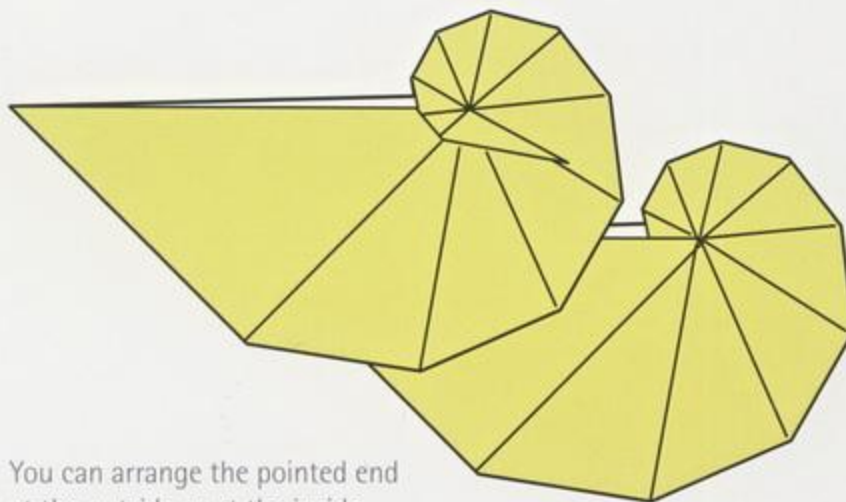
13



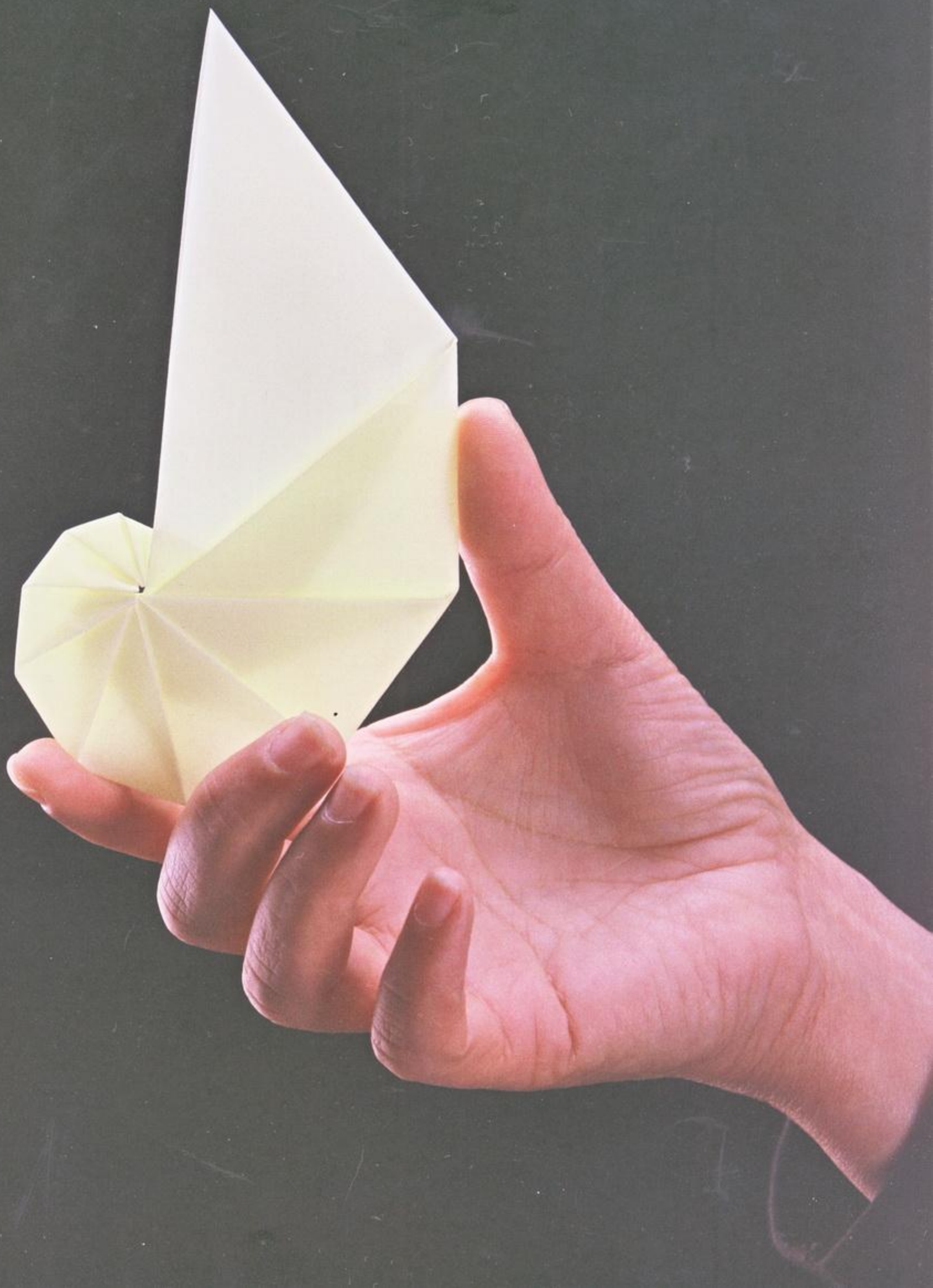
14 Continue in the same way as in «Argonaut» from step 14 on page 94.



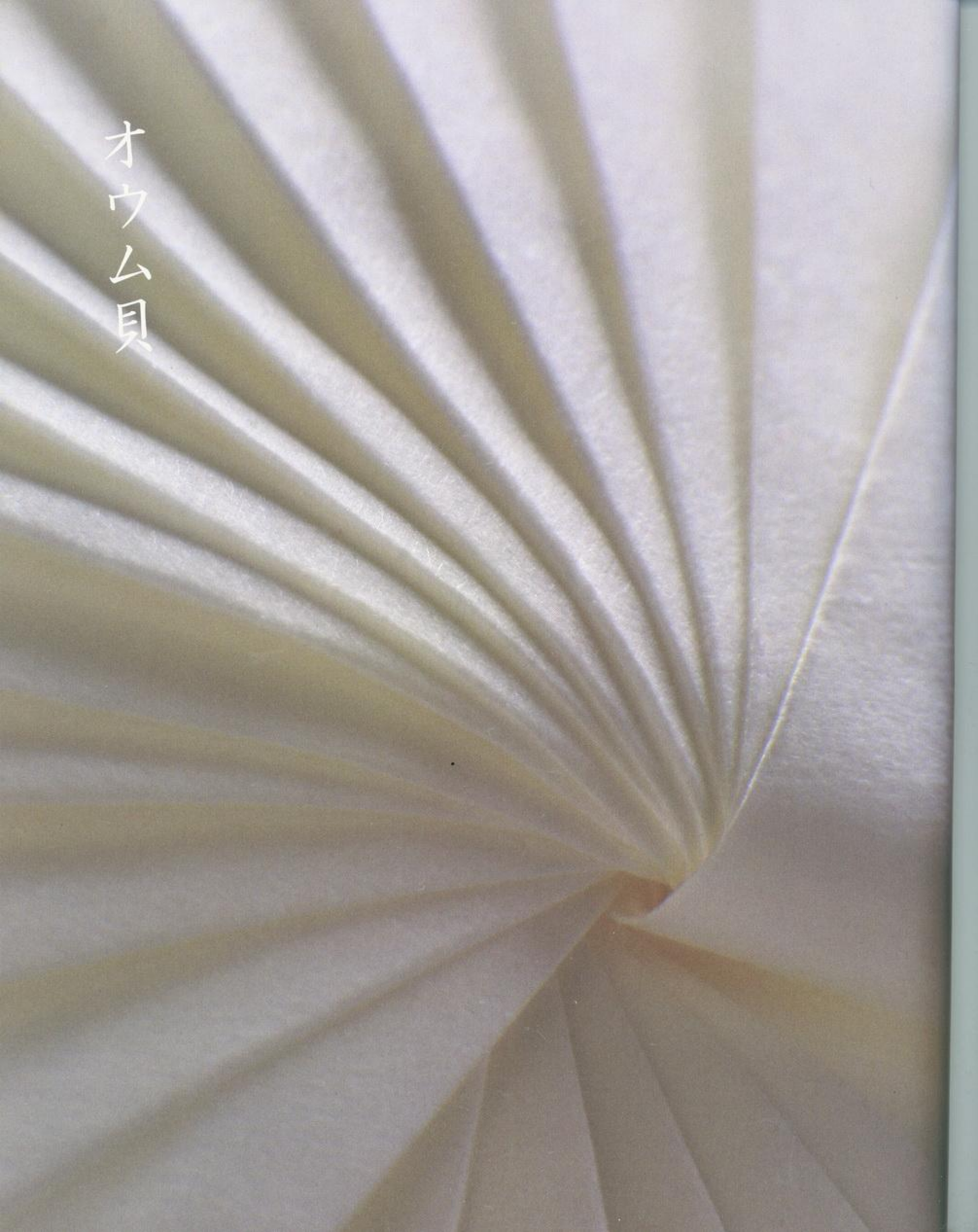
15



You can arrange the pointed end at the outside or at the inside.



オウム貝

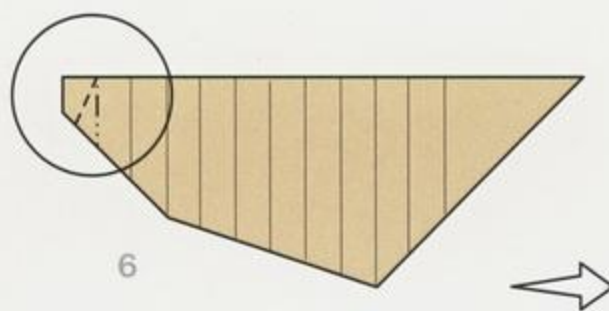
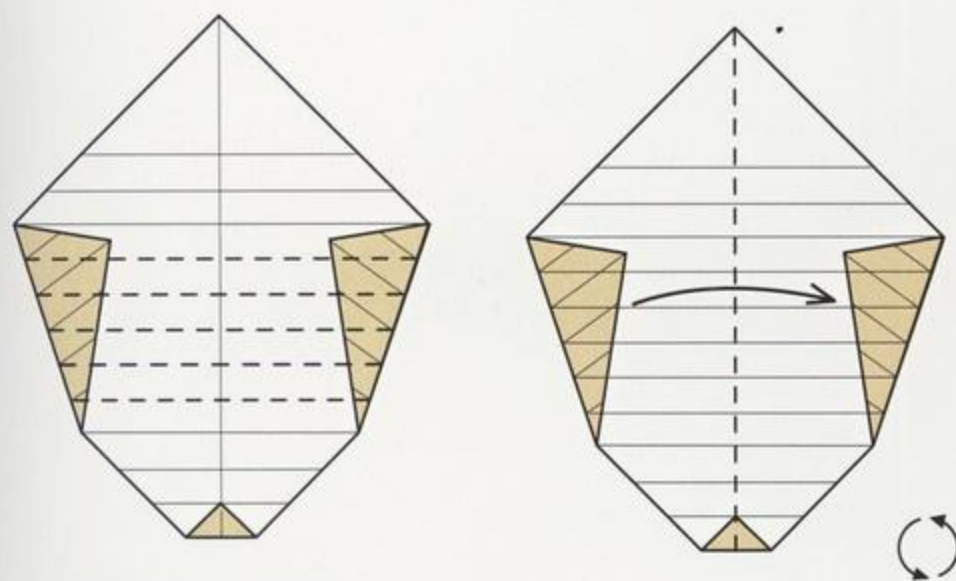
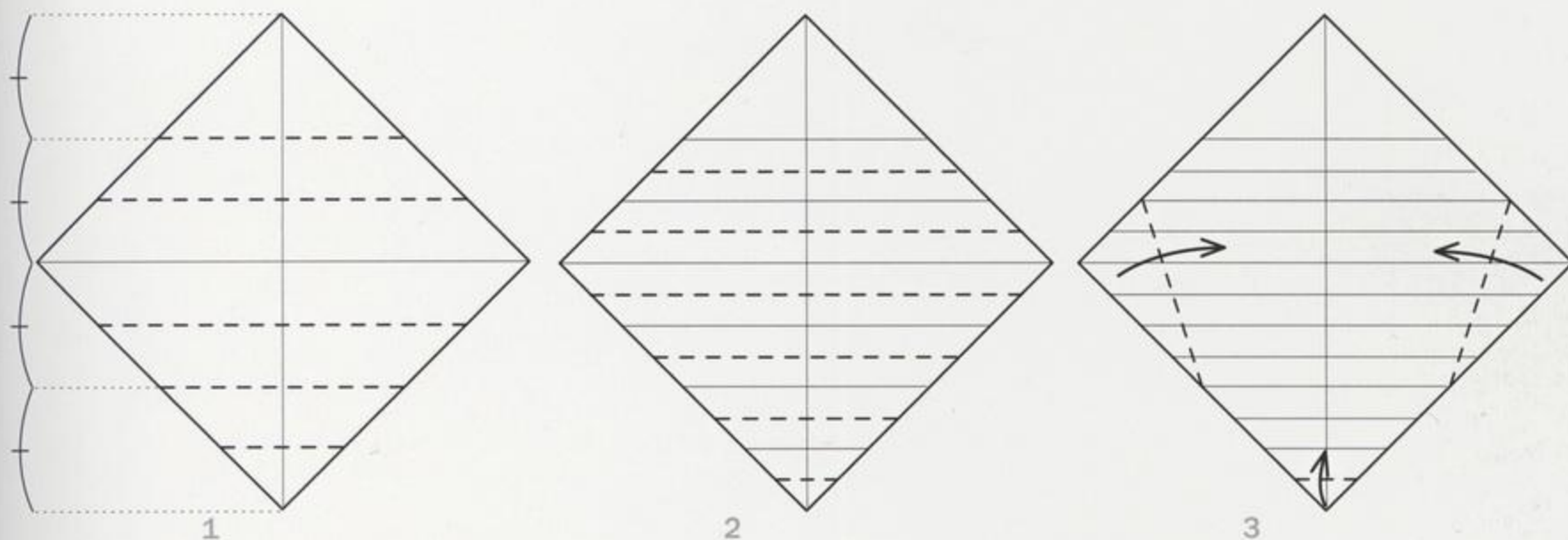


NAUTILUS

WITH 12 SEGMENTS

The number of creases made in steps 1 and 2 determine the number of segments of the nautilus.

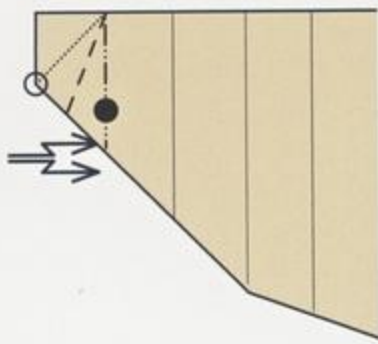
The key to smooth rolling is shown in step 3. You can also cut off the unwanted parts. Recommended paper size is 20 x 20 cm or larger.



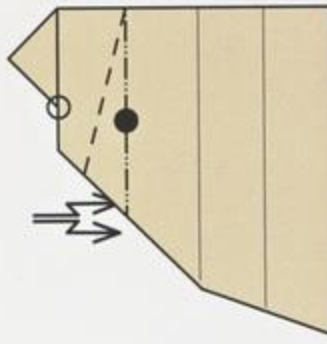
4 Copy creases to upper layer.

5

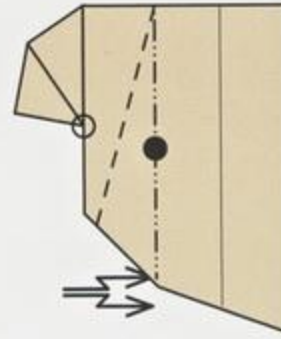
6



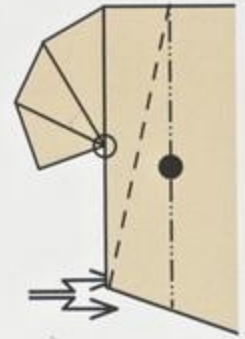
7 Push in both sides. Marked corner meets mountain crease.



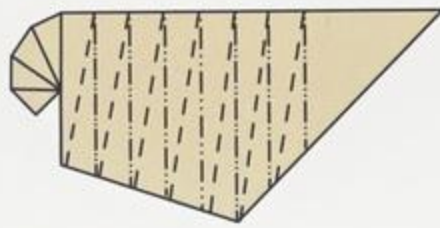
8



9



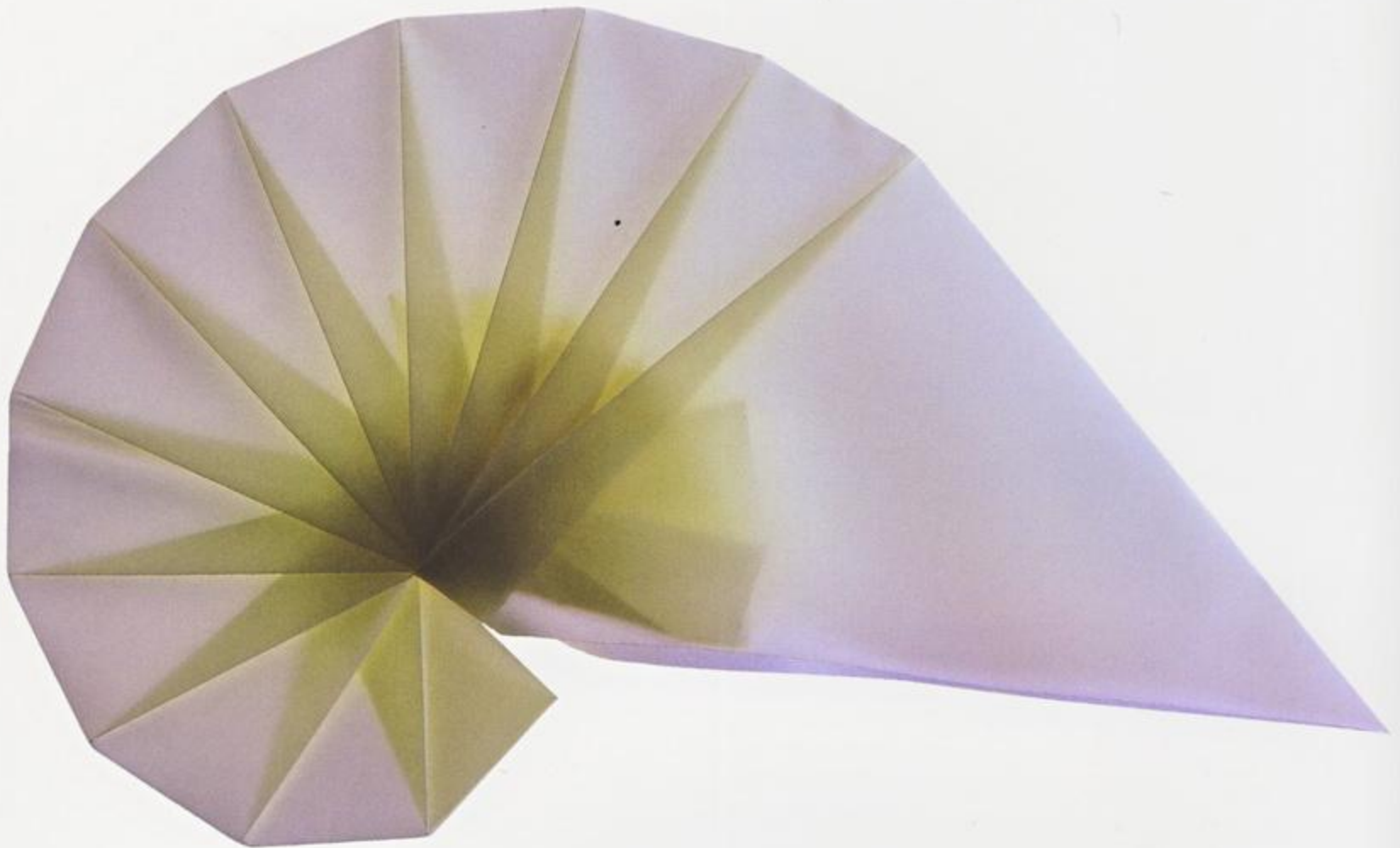
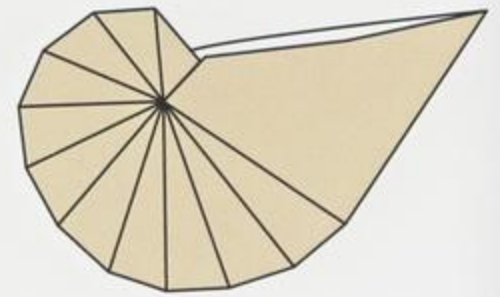
10 ...



11

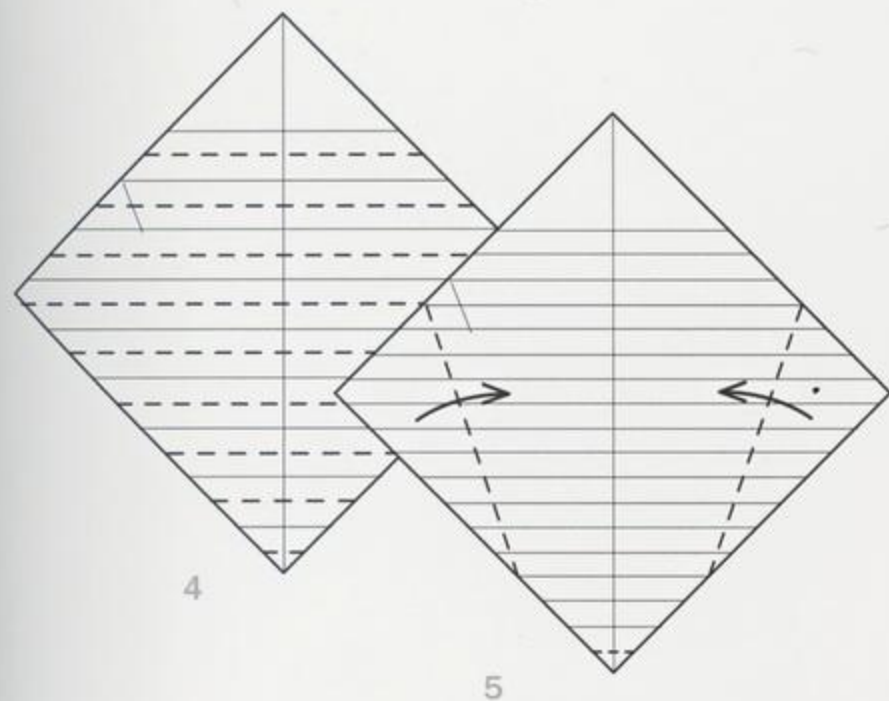
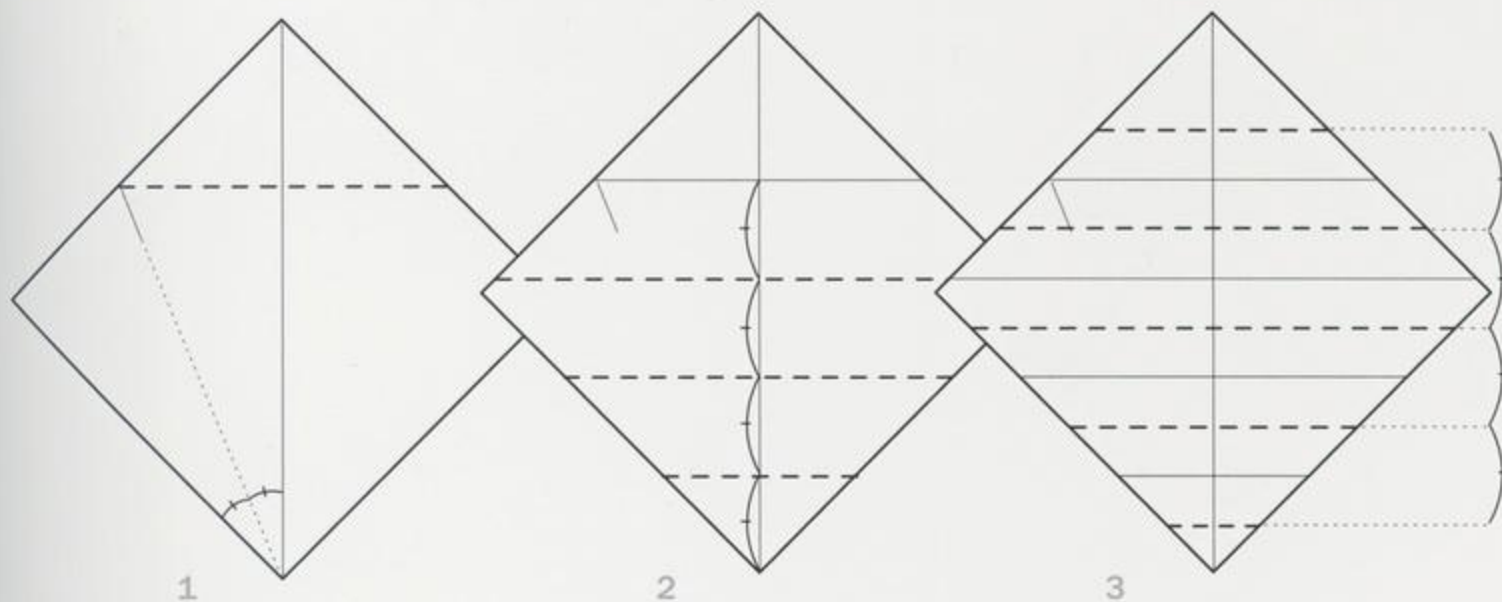


12 Fold in the protruding parts on both sides.

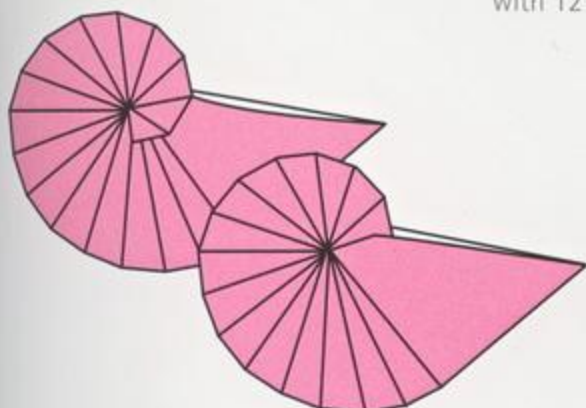


NAUTILUS

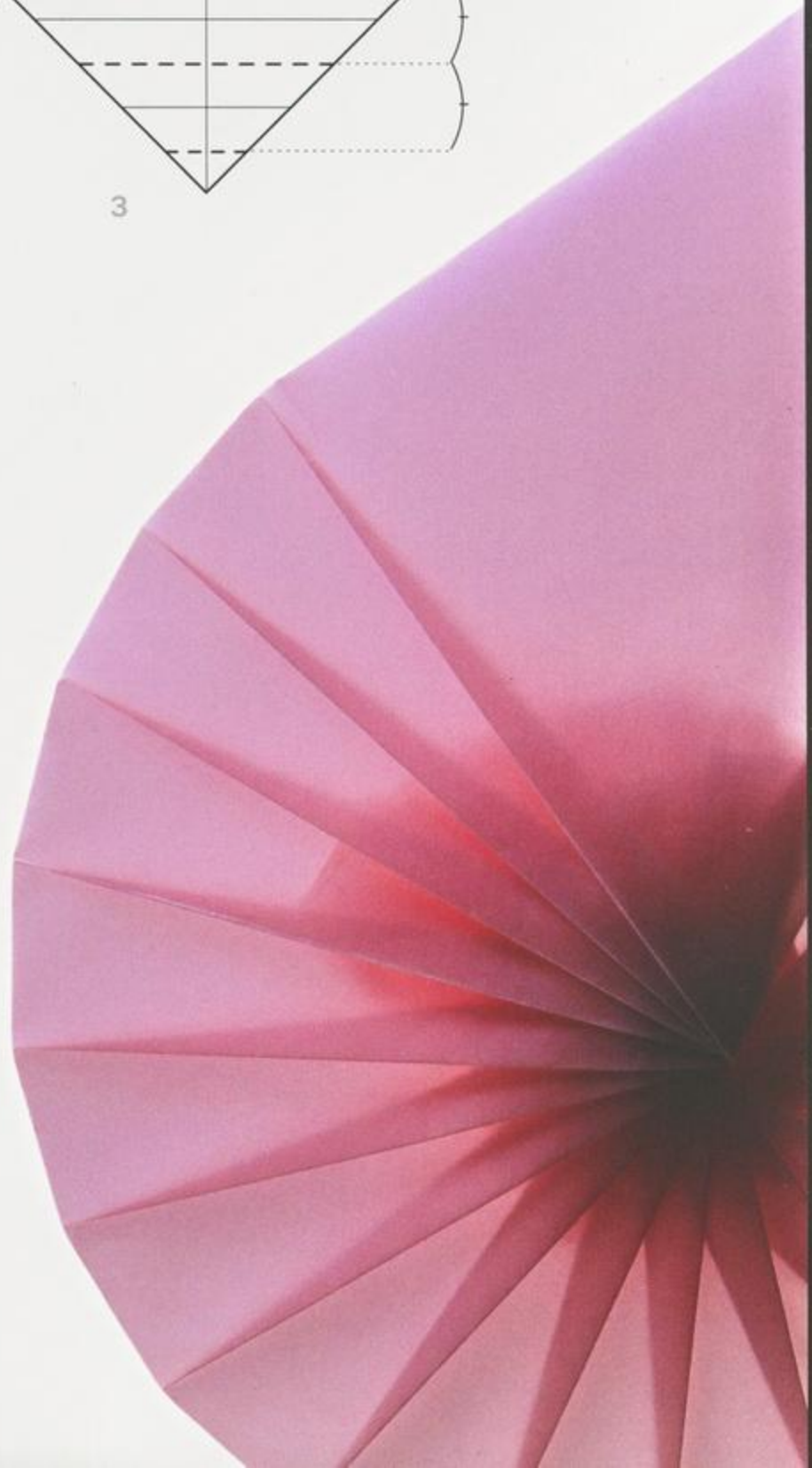
WITH 18 SEGMENTS



5
Fold in the same way as «Nautilus
with 12 Segments» on page 99.

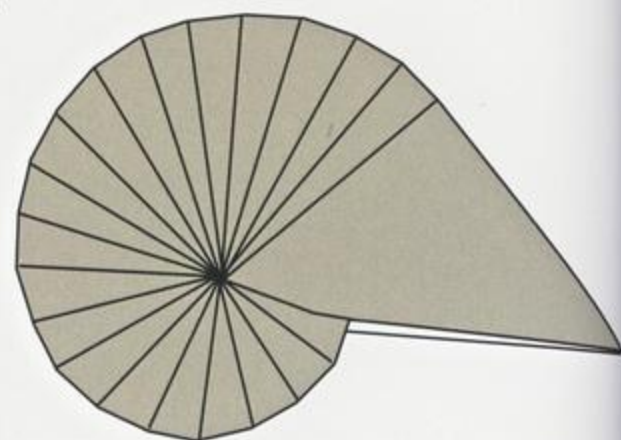
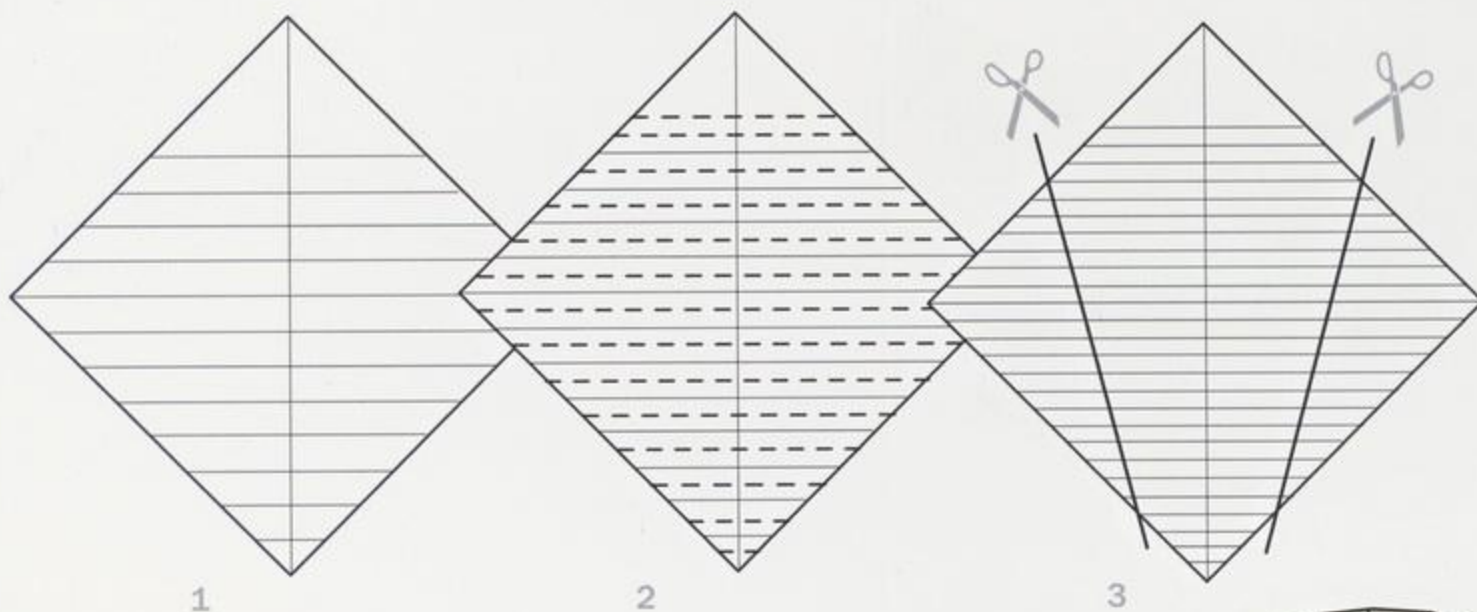


The beginning part
can stay outside or be
arranged inside the shell.

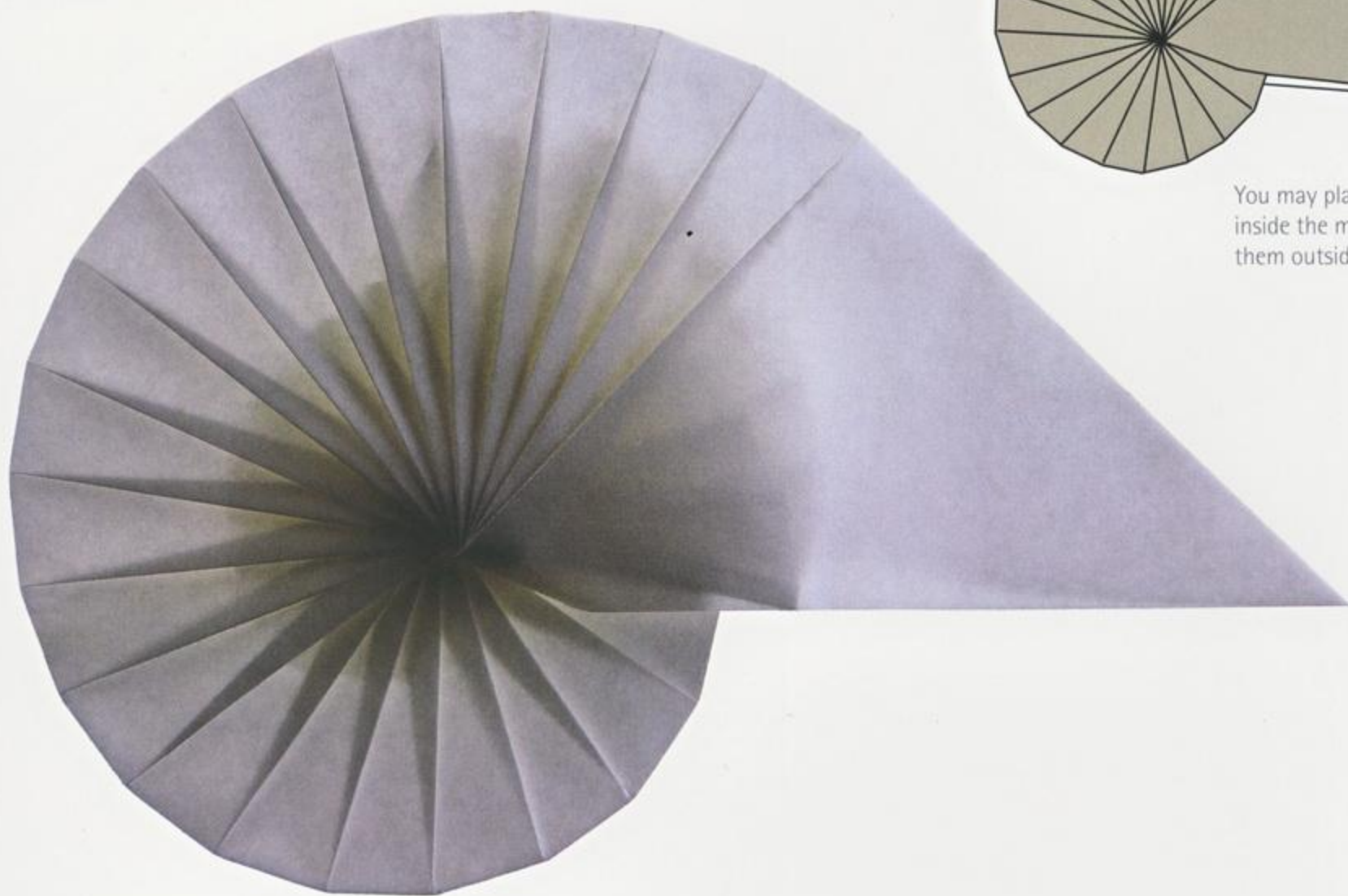


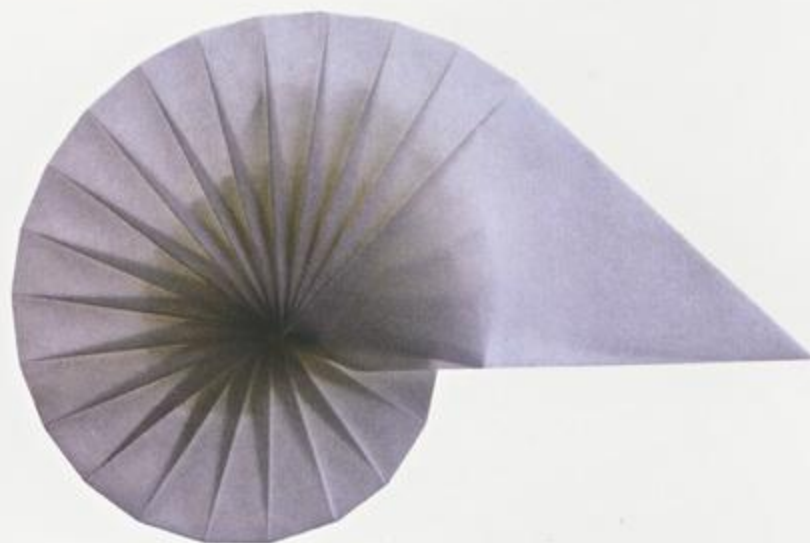
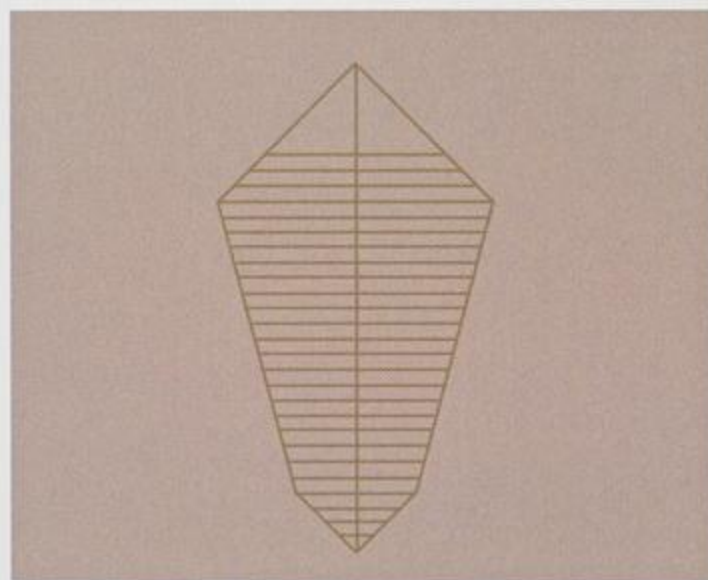
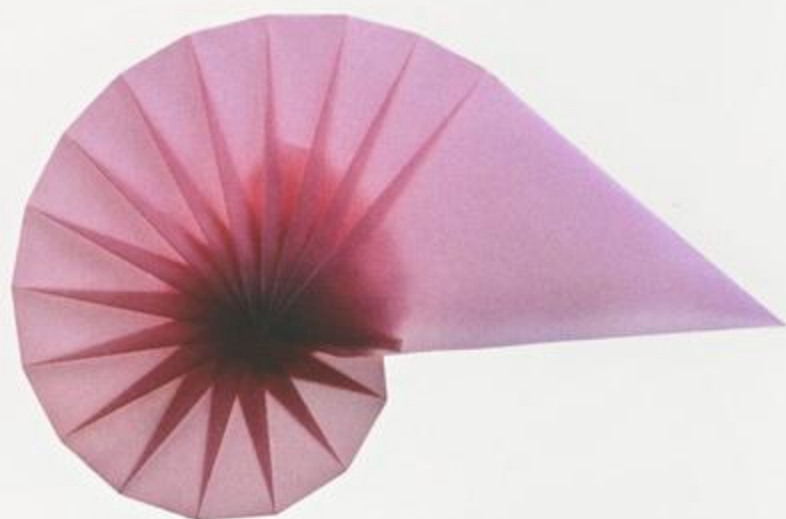
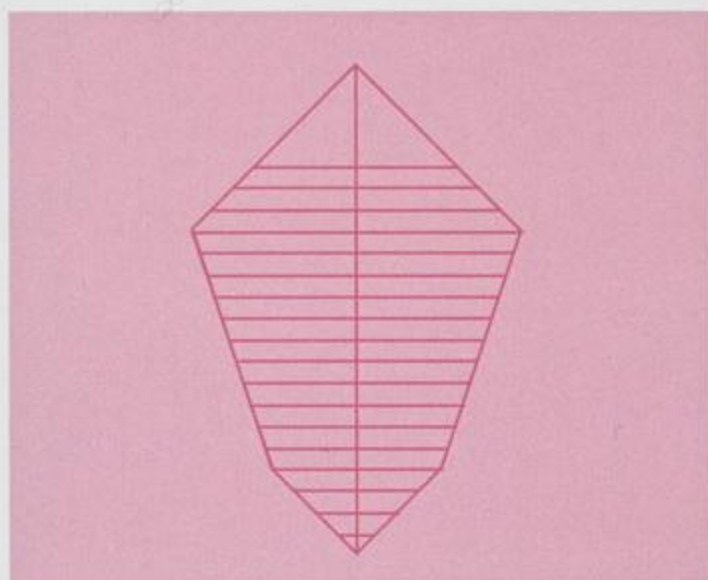
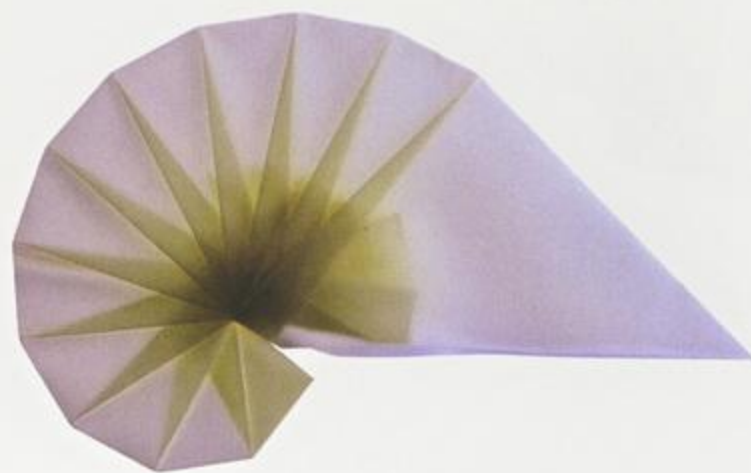
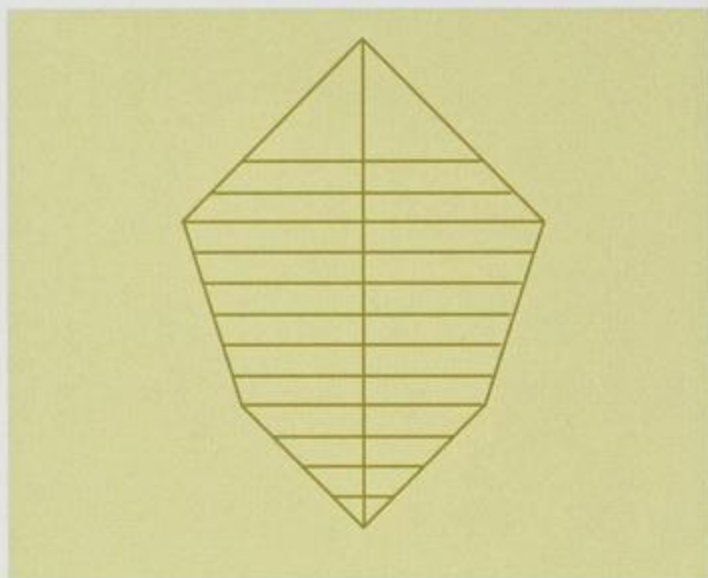
NAUTILUS

WITH 26 SEGMENTS



You may place the flaps inside the model, or leave them outside.

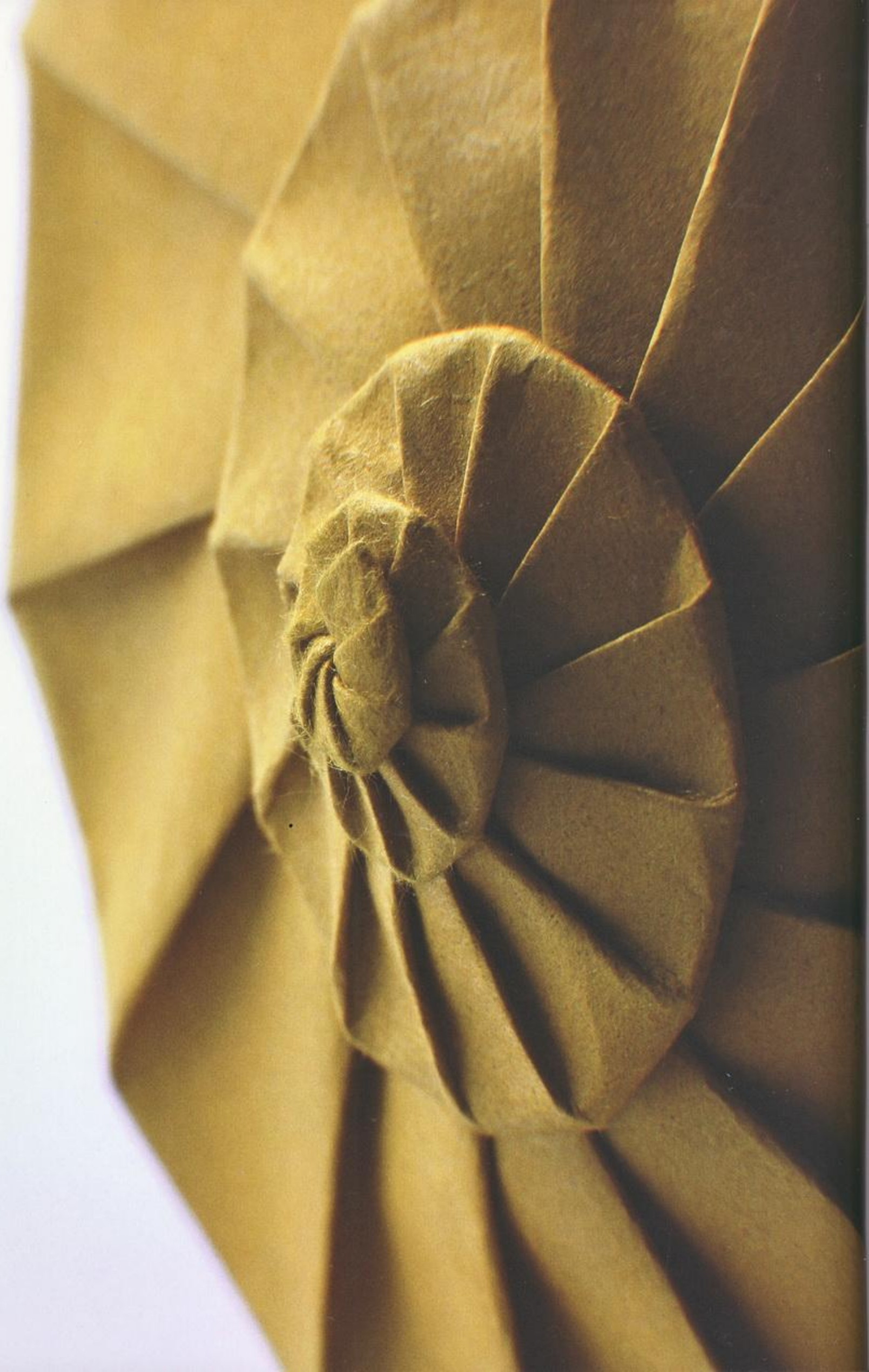






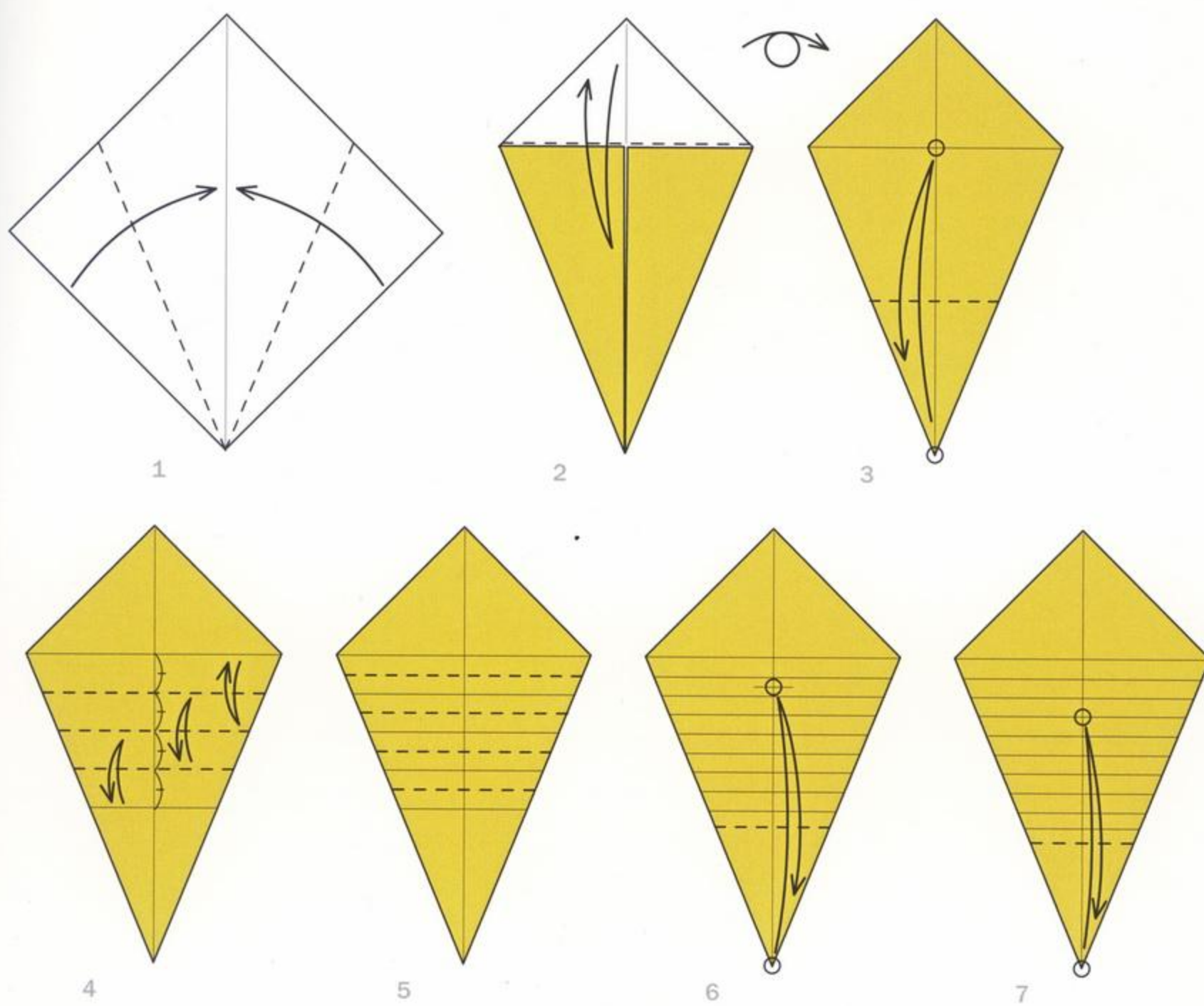


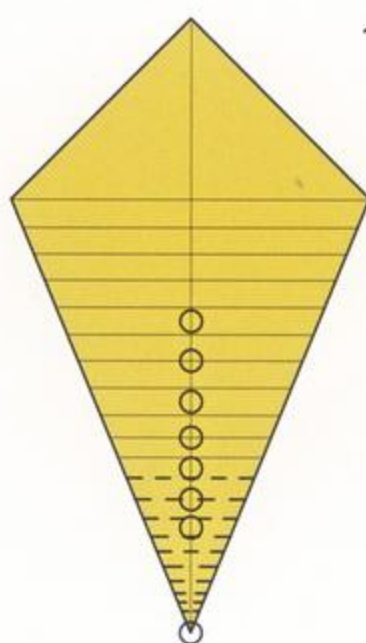
裏に孔のあいた貝



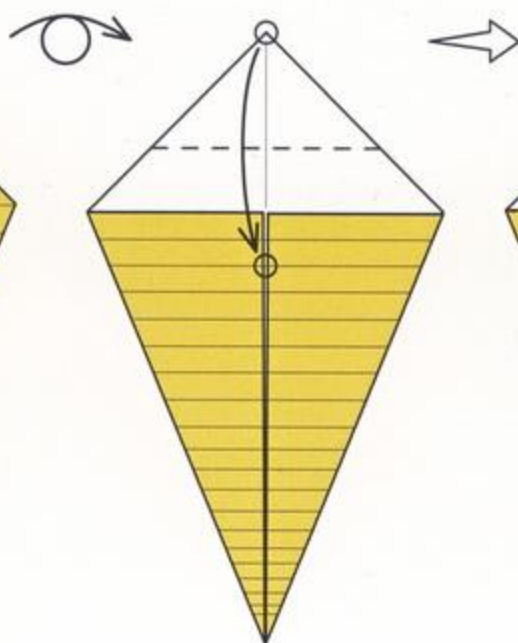
NAVEL SHELL

This origami shell is folded from a square. In nature, there is a real species called Moon Snail Shell on which this model is based. But I've chosen the name Navel Shell (freely translated from 裏に孔のあいた貝, the Japanese name for this species), because of the navel-like hole that appears on the bottom of the shell. It is not a regular spiral.

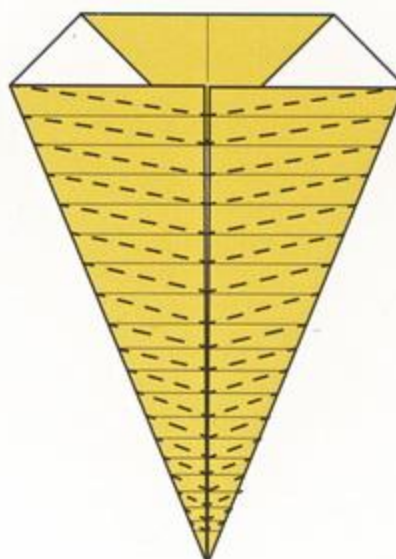




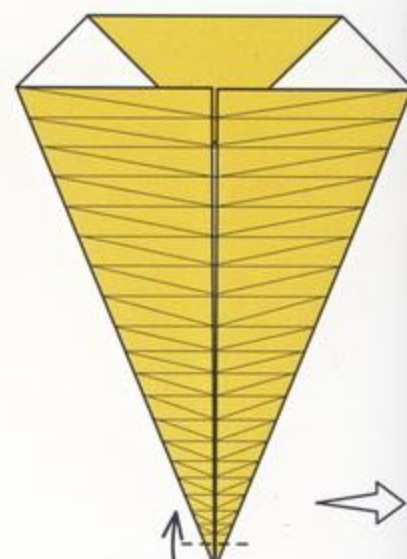
8 Fold with increments of 1.5 each a total of 19 steps in the same way.



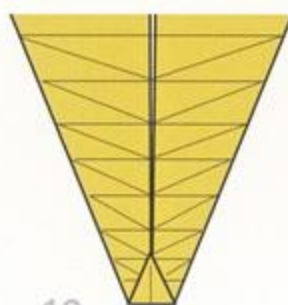
9



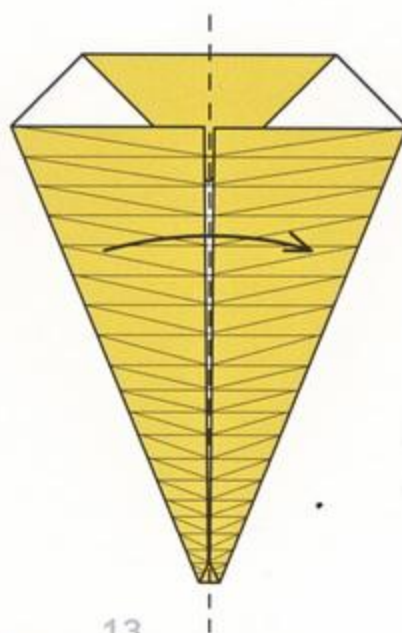
10



11



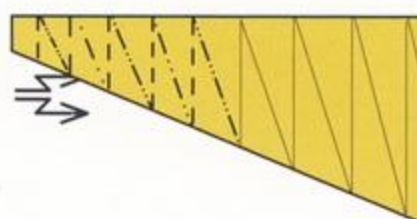
12



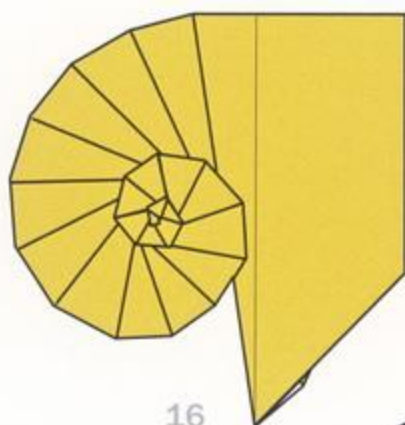
13



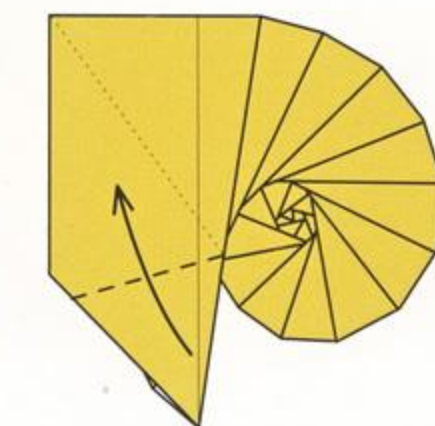
14 Start folding cover folds at the narrow end.



15 Put the curling end on top.

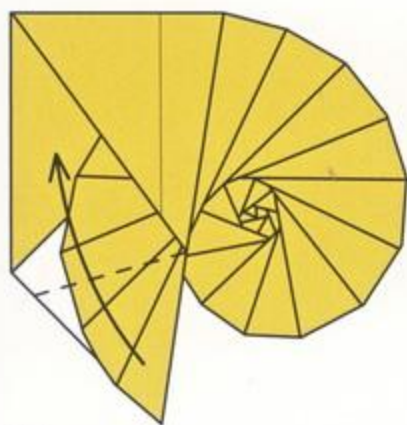


16

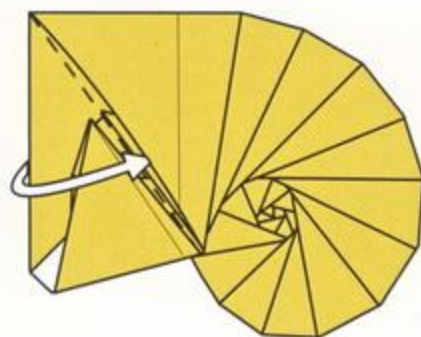


17 Valley fold, align folded edge on auxiliary line.

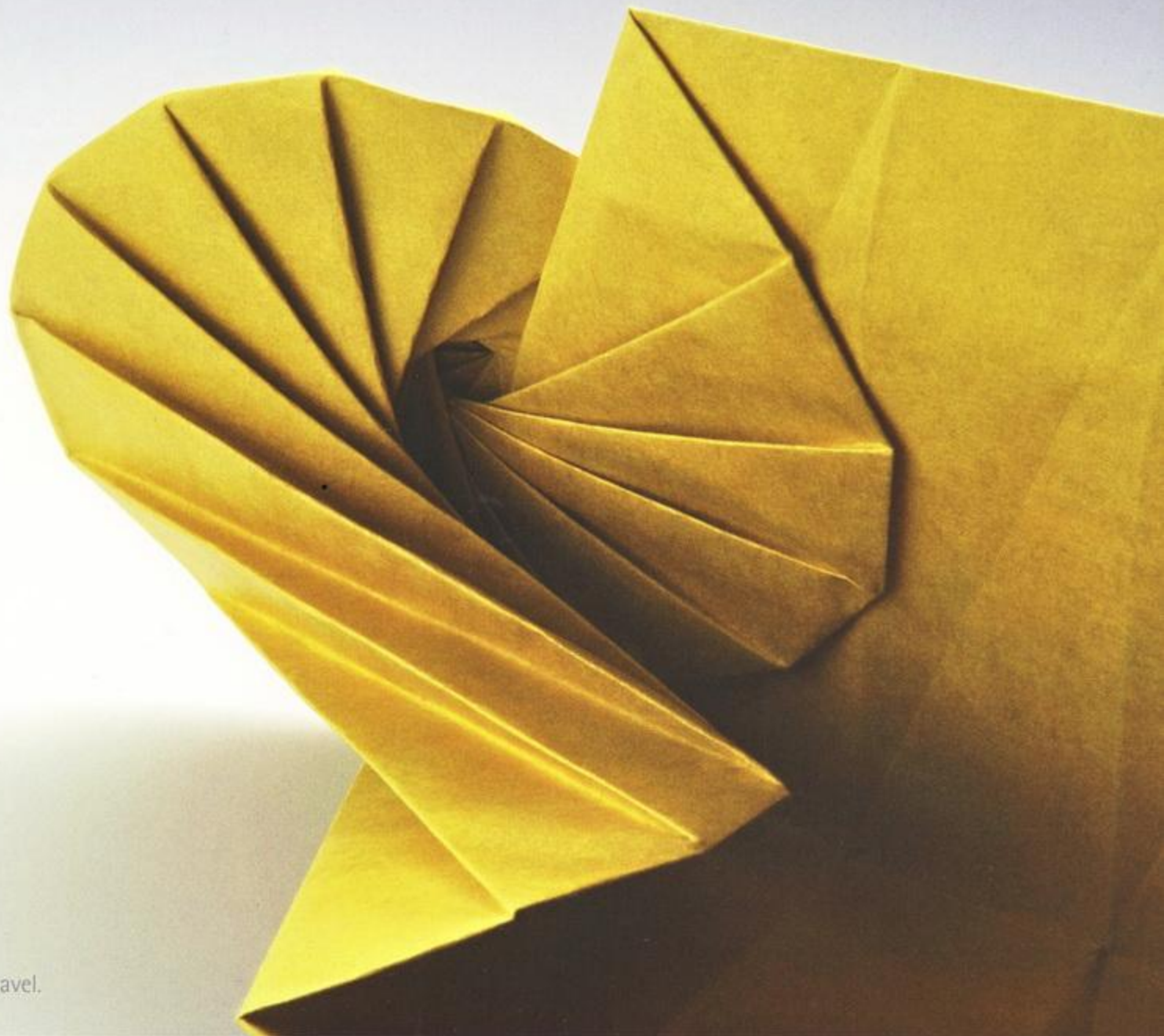
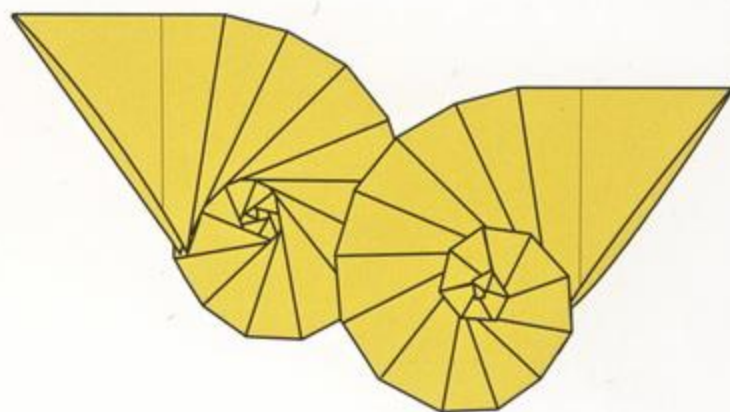
18



19

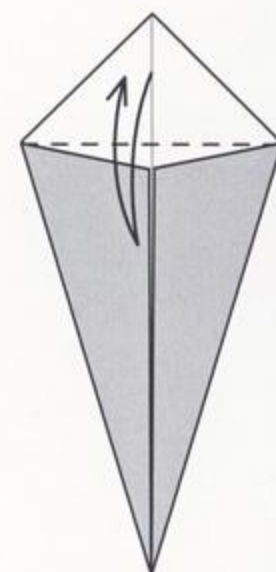
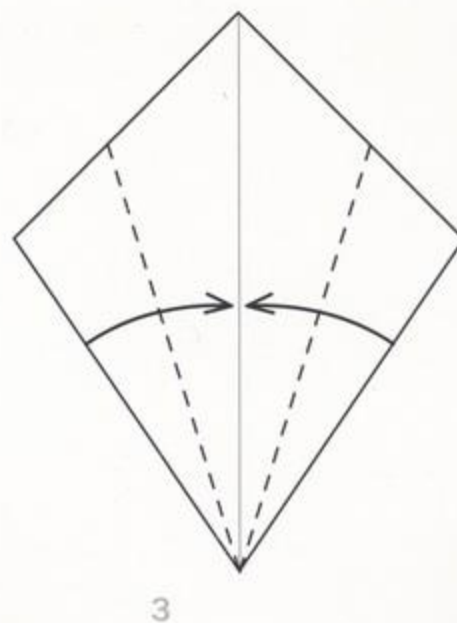
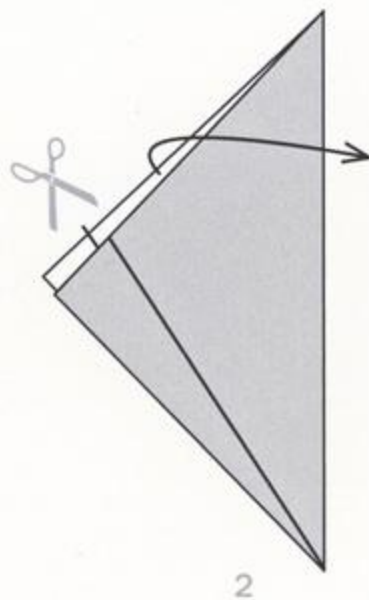
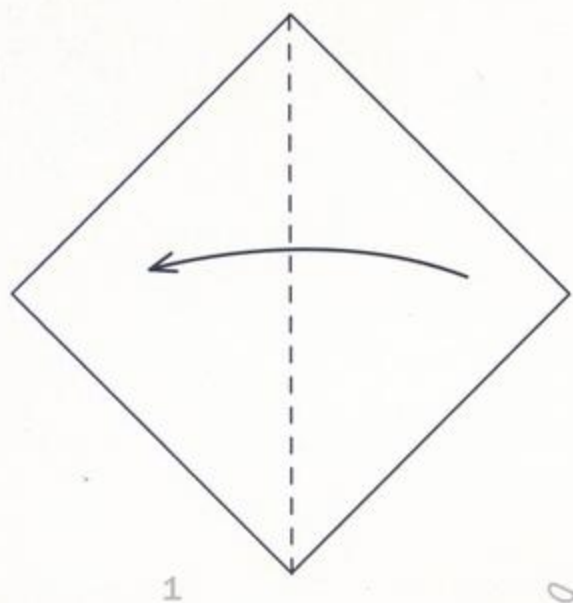


20



The reverse side with the navel.

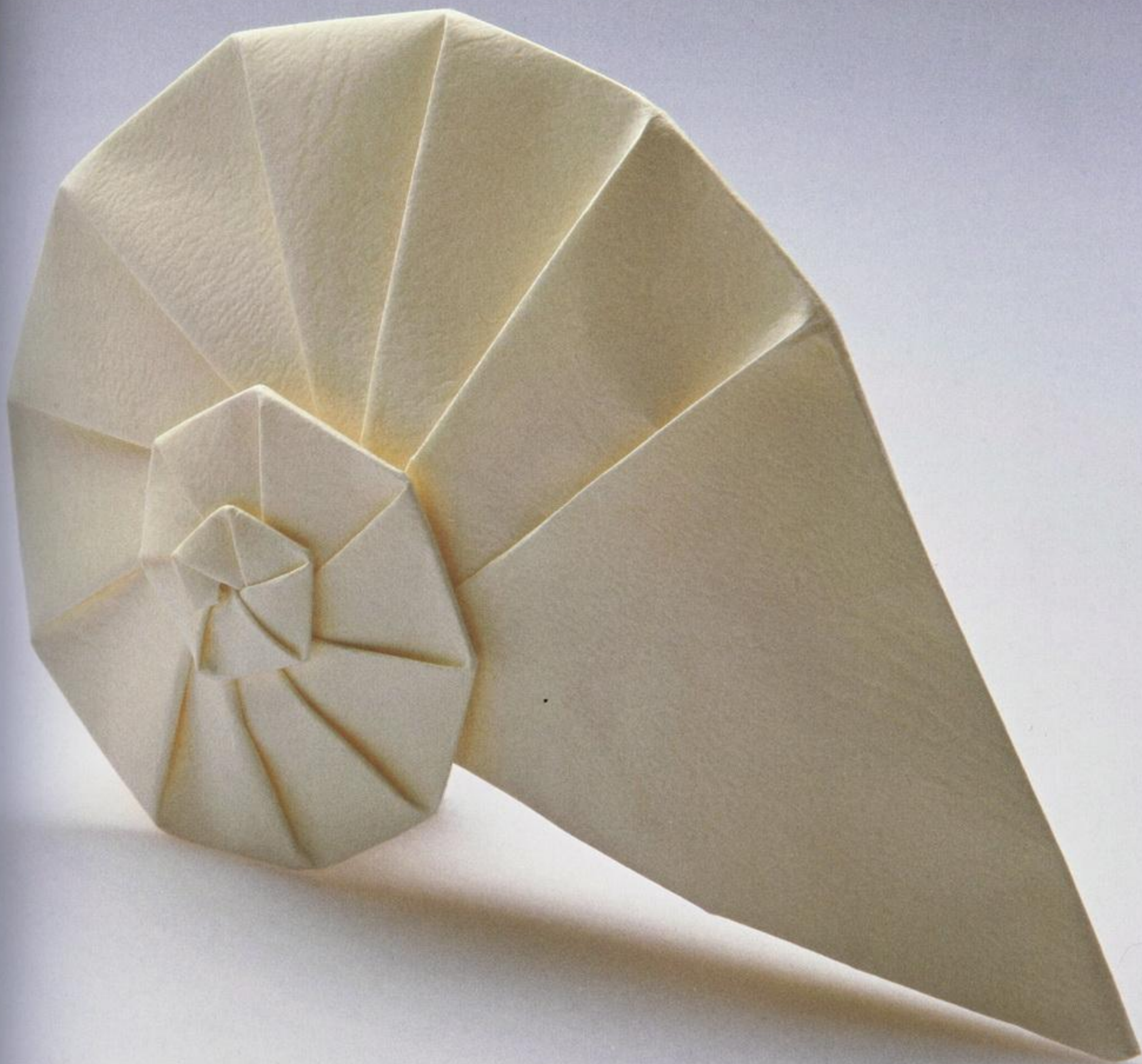
NAVEL SHELL VARIATION



Continue with step 3 of «Navel Shell» on page 107.



With different shapes of the initial paper you get various Navel Shells. The sharper the pointed end of the kite form in step 4 the tighter the spiral of the shell will curl.



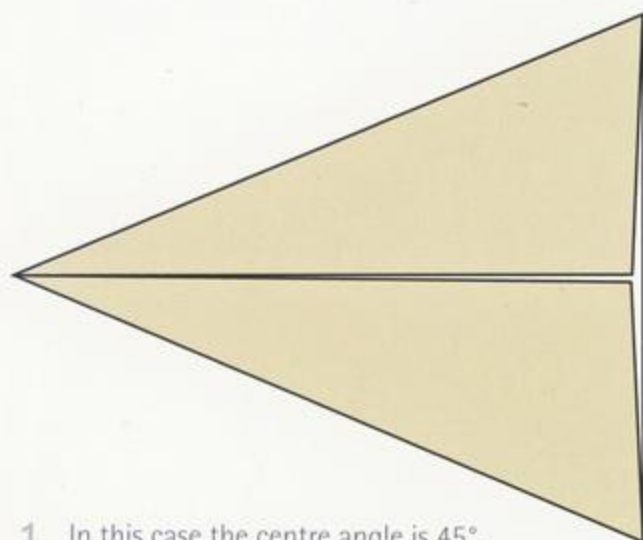
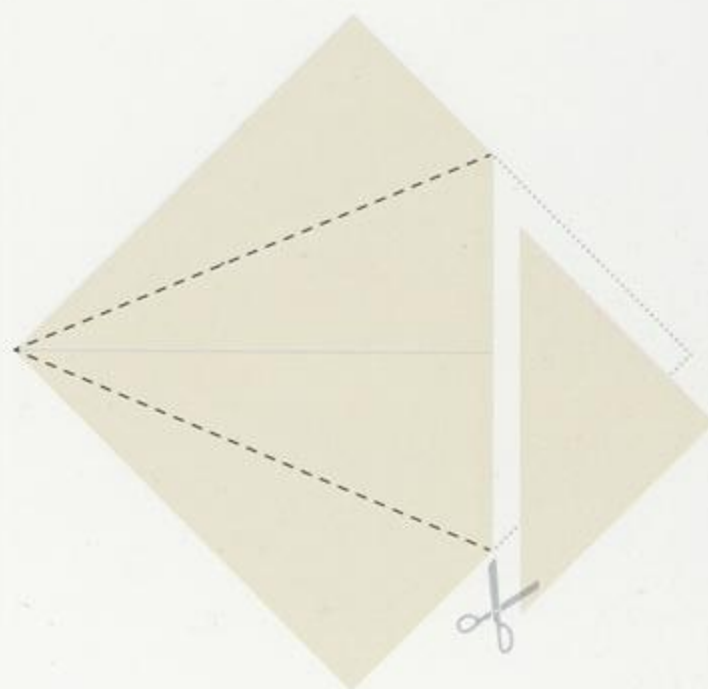
アンモナイト



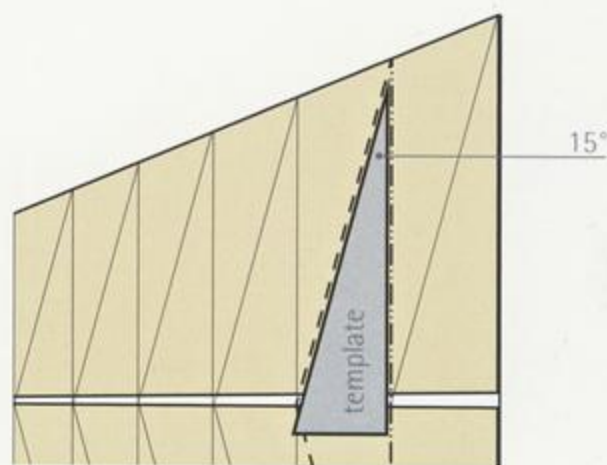
AMMONITE

You can fold the ammonite in various versions depending on the centre angle and the angle of spirality. To construct the crease pattern for this model use a template to mark the angle of spirality.

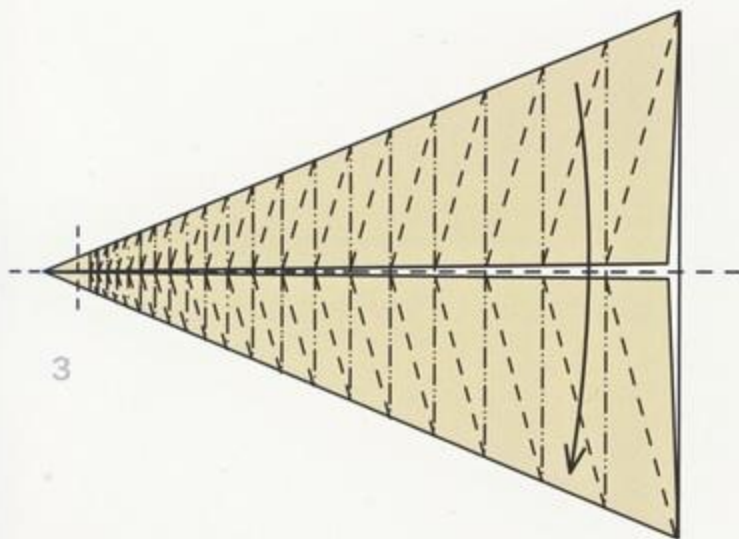
The instructions on this page refer to an ammonite with 45° centre angle and an angle of spirality of 15°.



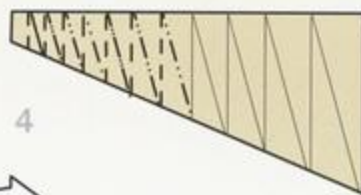
1 In this case the centre angle is 45°.



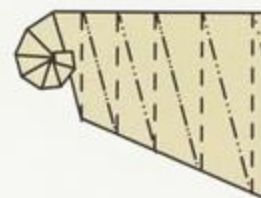
2 Use a template to create the crease pattern.



3

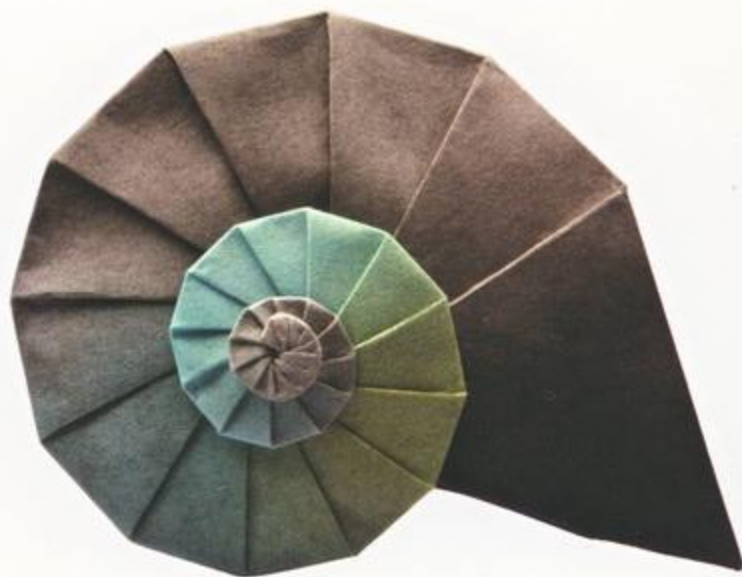
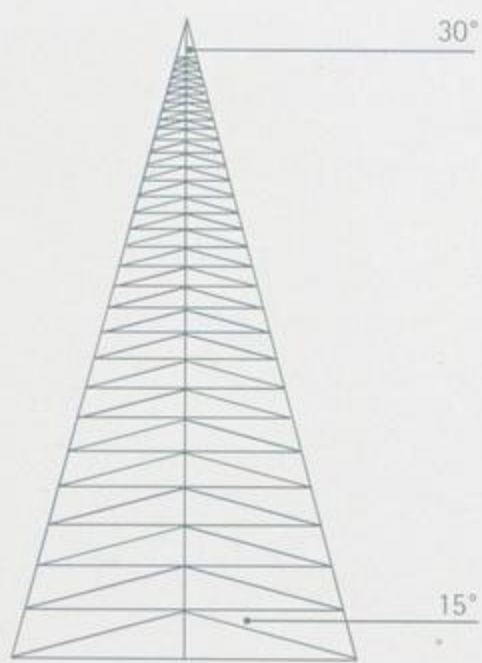
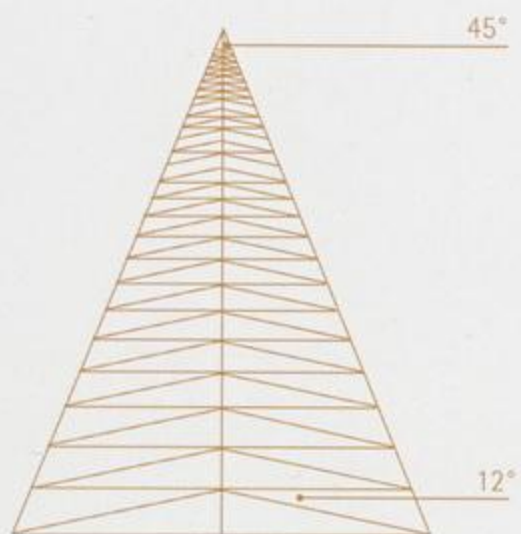
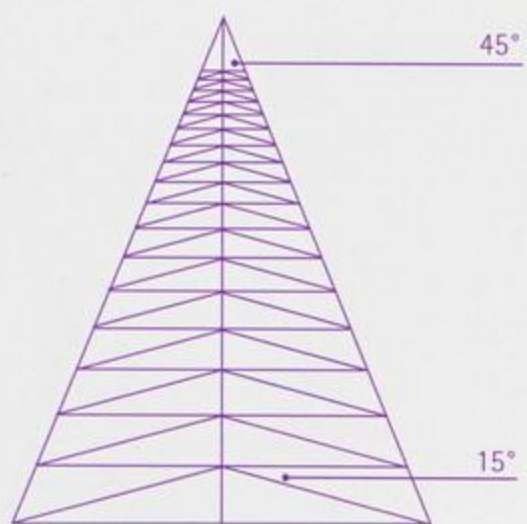


4



5 Fold in the same way as in »Navel Shell« from step 15 on page 108.

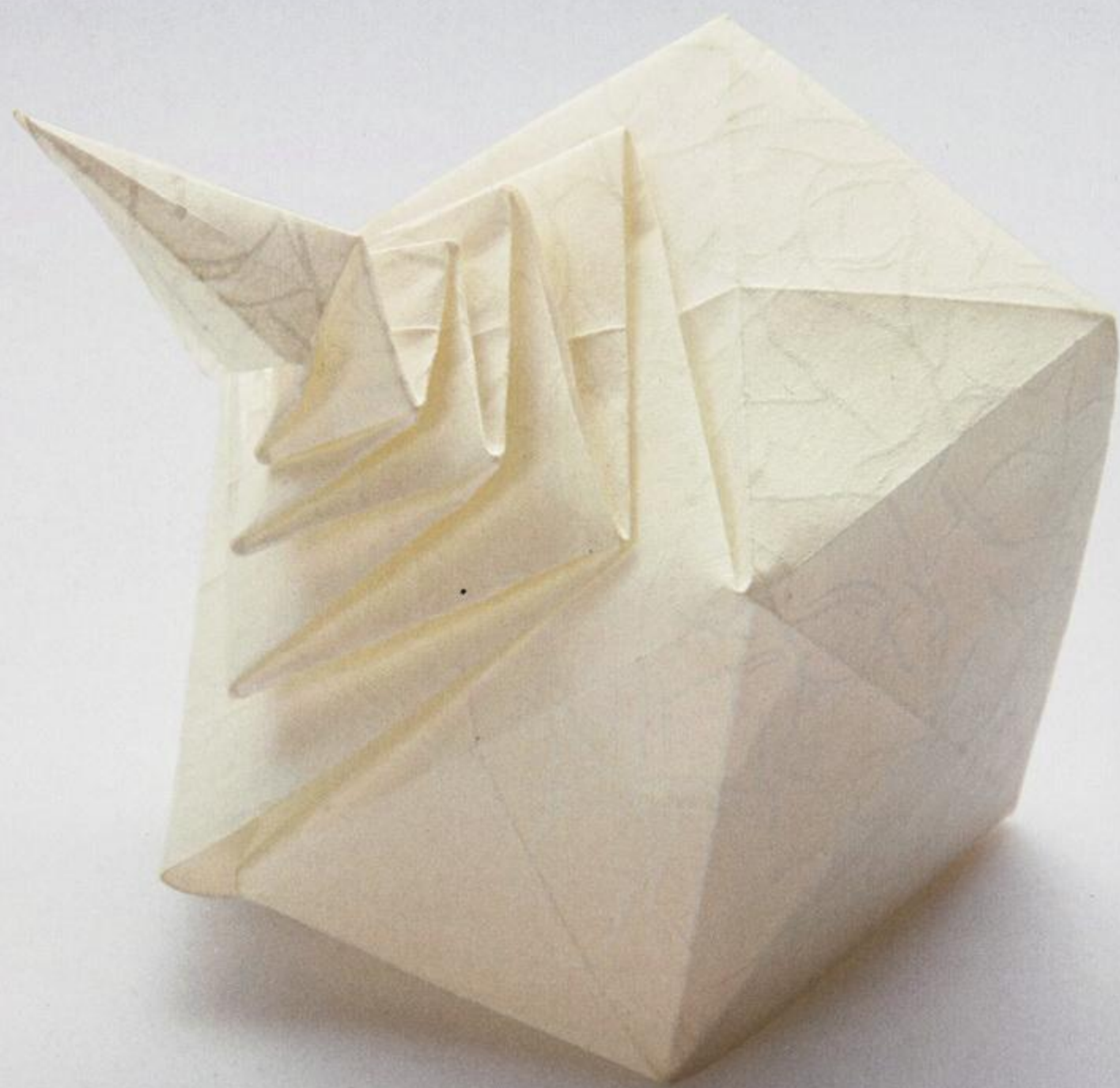






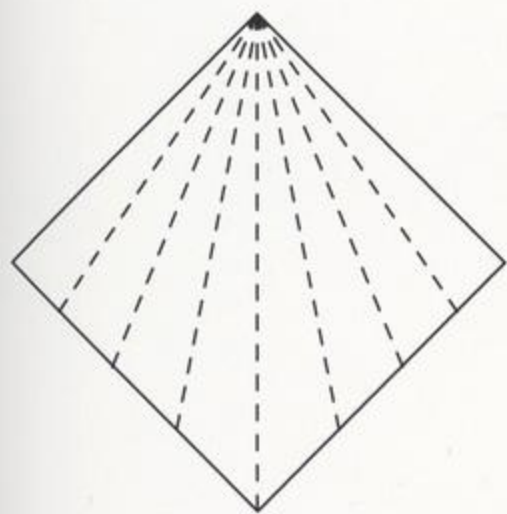


ねじ巻き貝ー正方形から

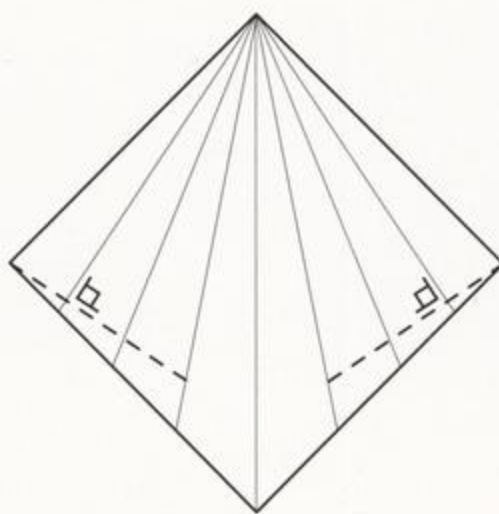


SCREW SHELL FROM A SQUARE

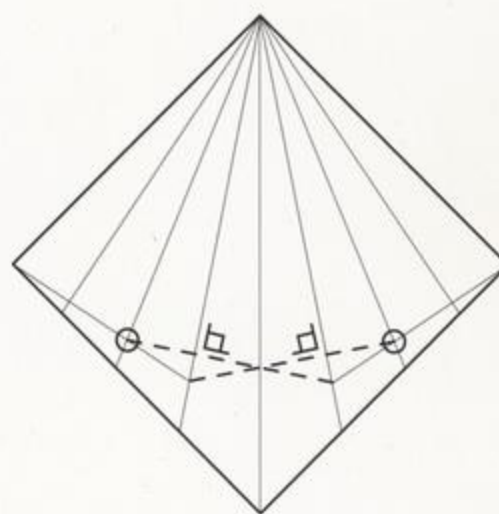
Although this model can be folded without using a tool, the finished model may become more beautiful if you use a pointed tool like a scribe or awl to score the creases.



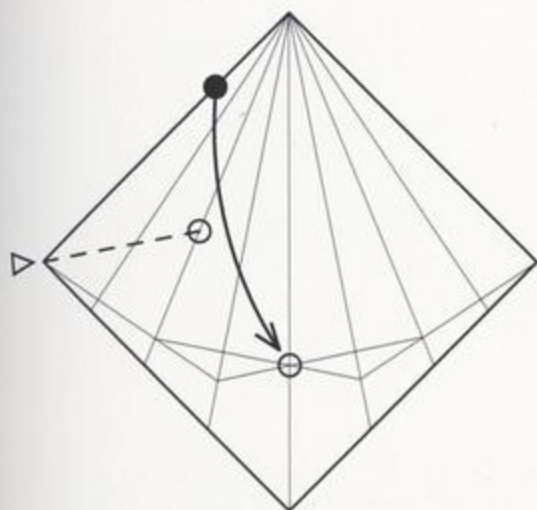
1 Divide the corner angle into eight equal parts.



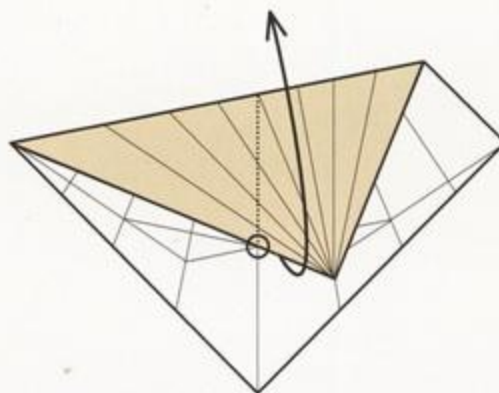
2



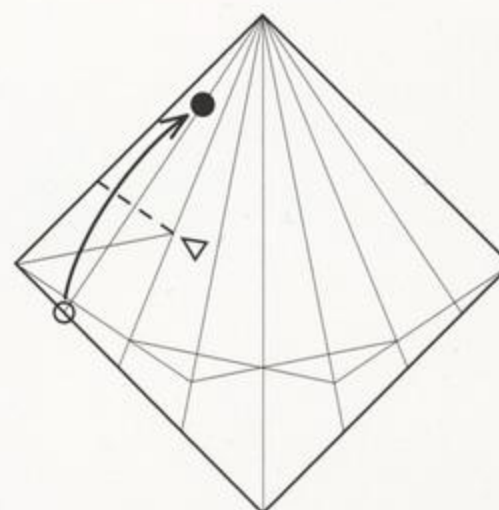
3



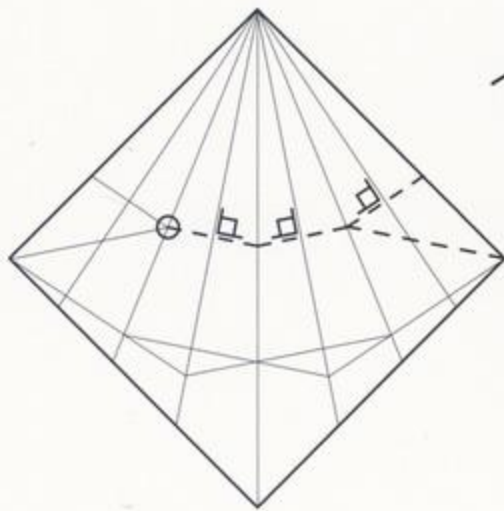
4



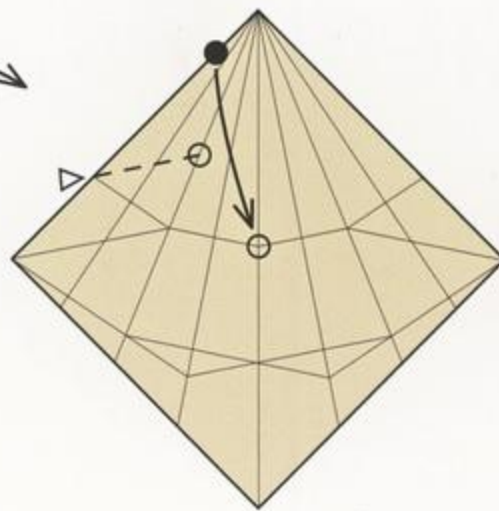
5



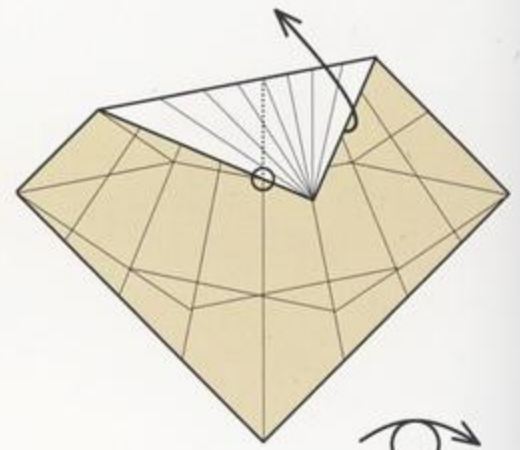
6



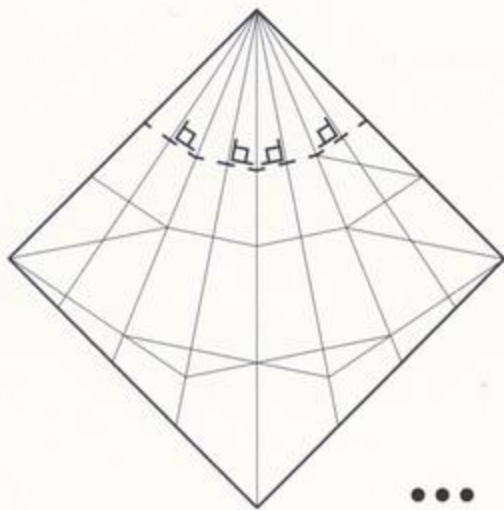
7



8

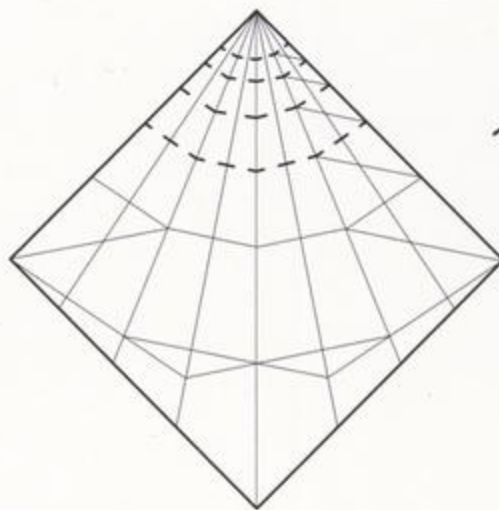


9

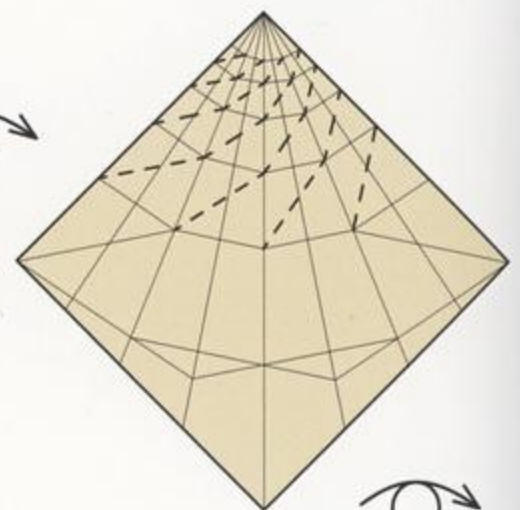


10

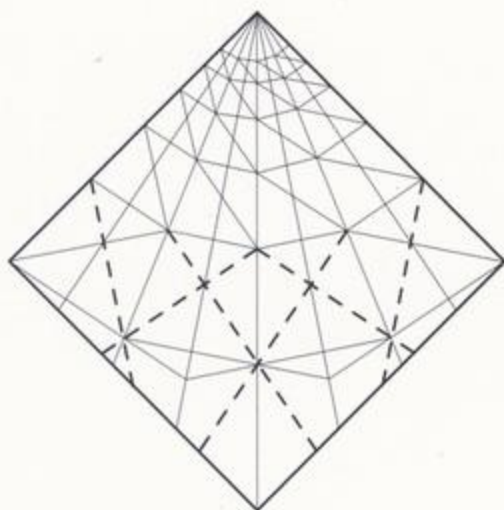
...



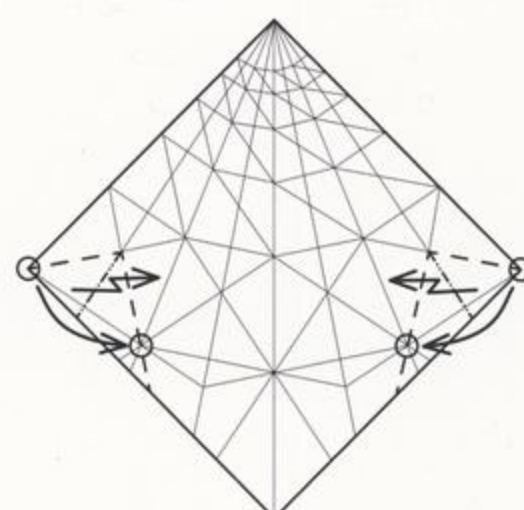
11



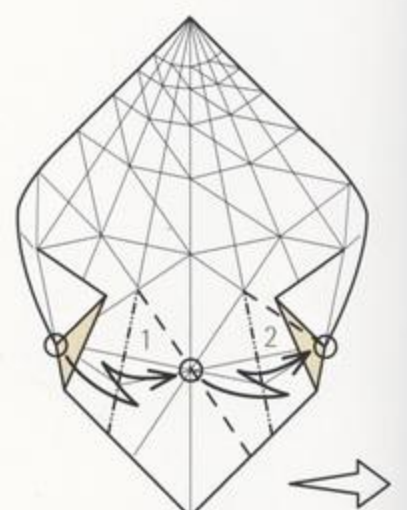
12



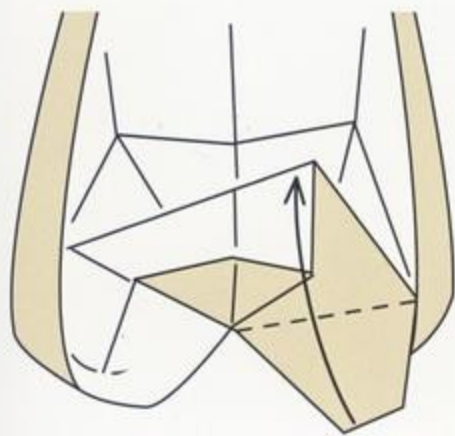
13



14



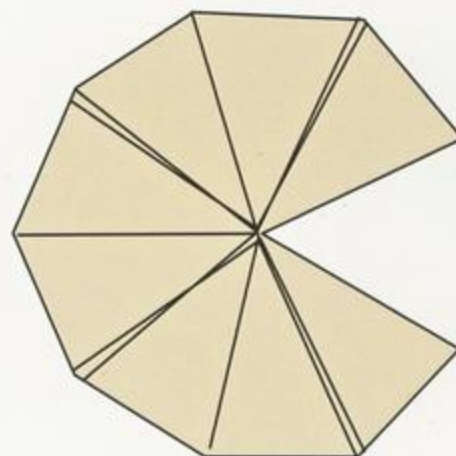
15 Make pleats to bring the three marked points together.



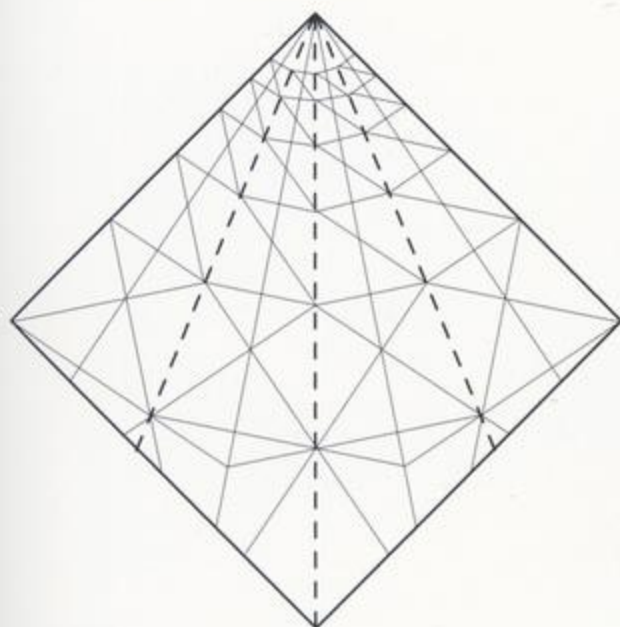
16 Fold inside.



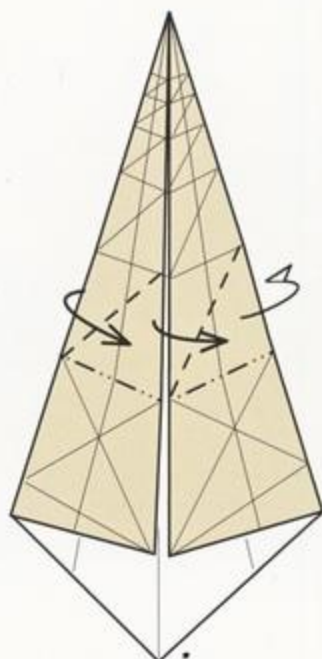
17 If you shape the shell's body whorl now, step 22 will become easier.



18 Step 17 seen from below.



19



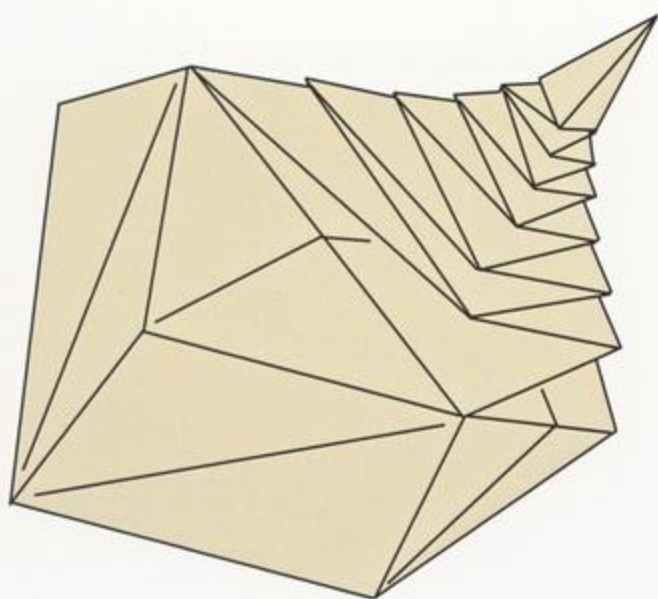
20 Twist.



21 Continue twisting to make the screw.



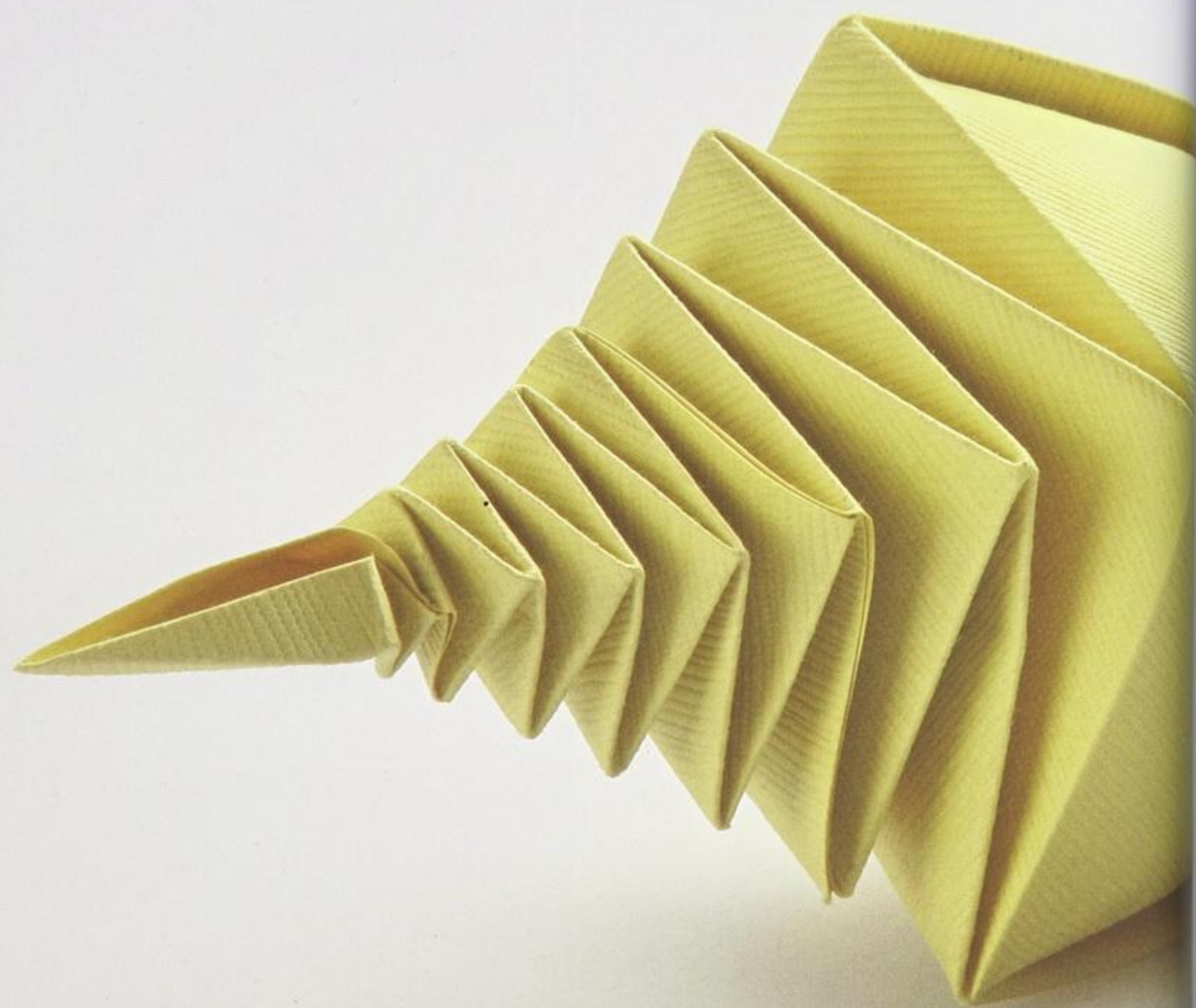
22 Fold the shells body whorl as in step 17.





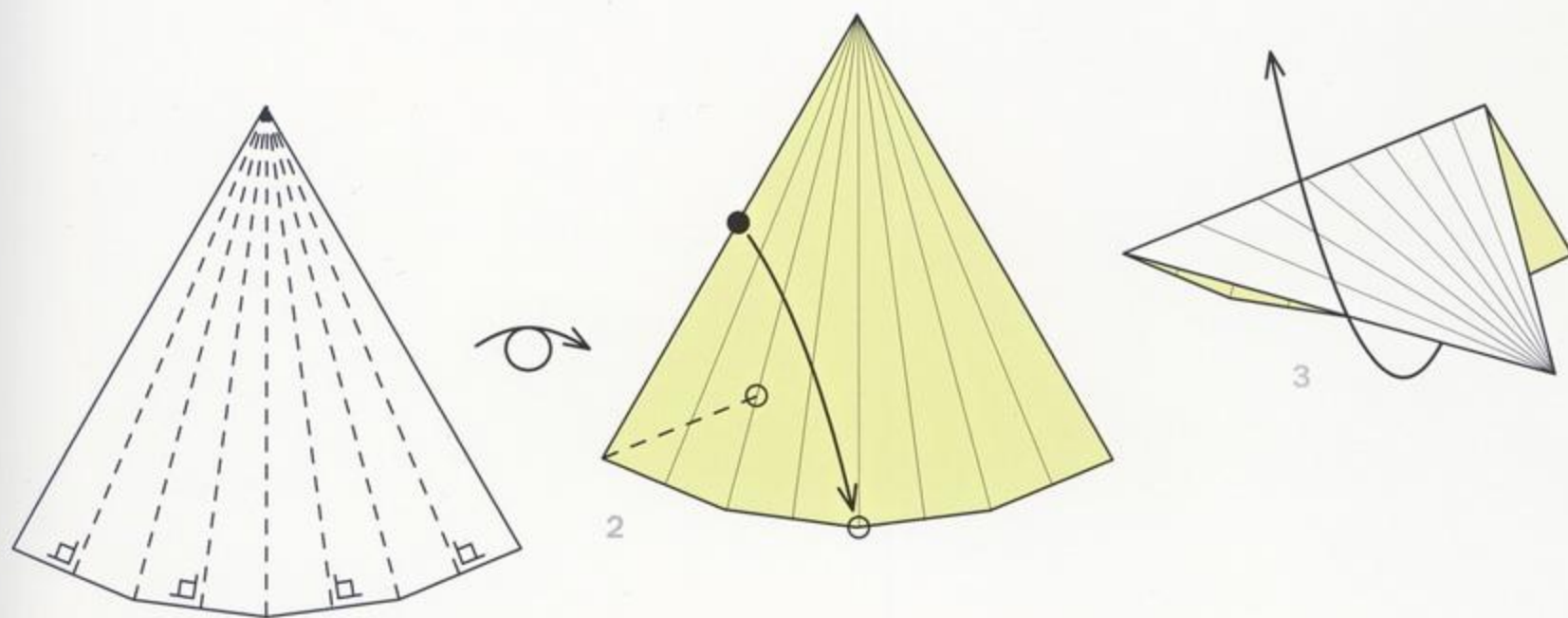


ねじ巻き貝ーねじ巻き部分

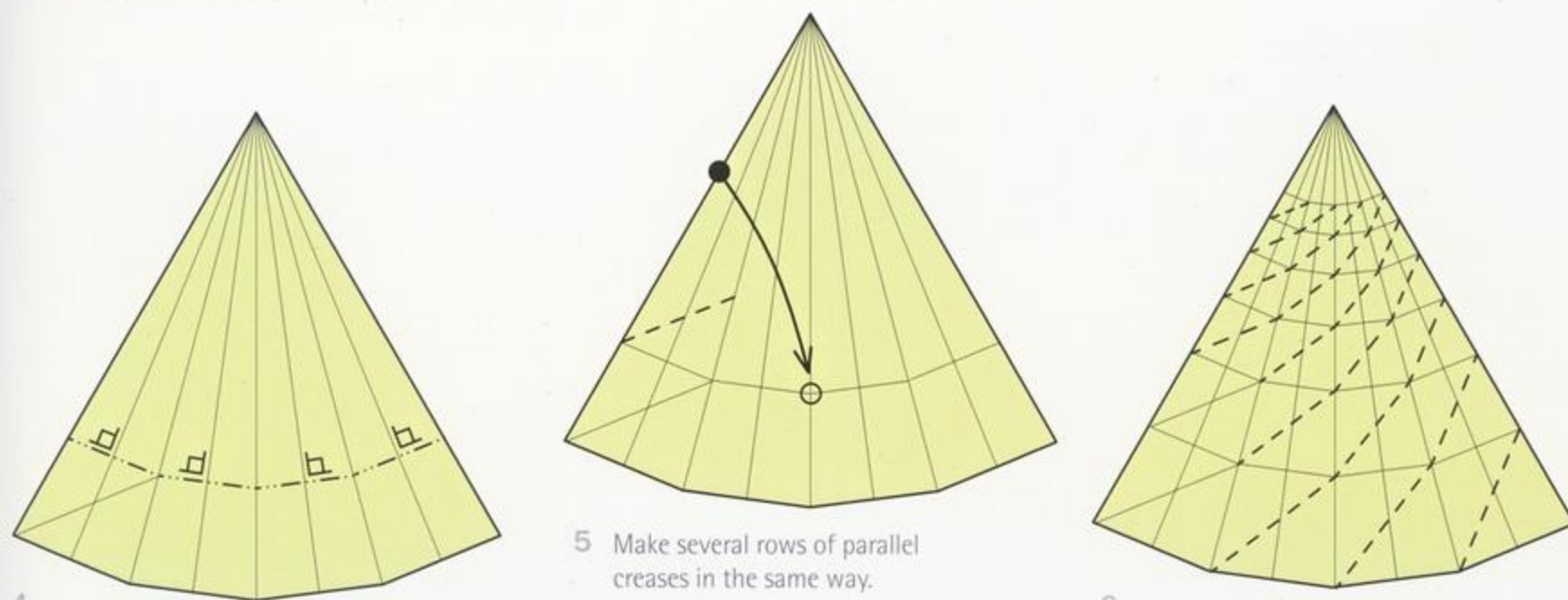


SCREW SHELL - THE SCREW

This spiral part can be folded using arbitrary central angles. Smaller angles result in smaller and tighter screws. In the instruction below we use a centre angle of 60° .



1 Divide the centre angle in 8 equal parts.

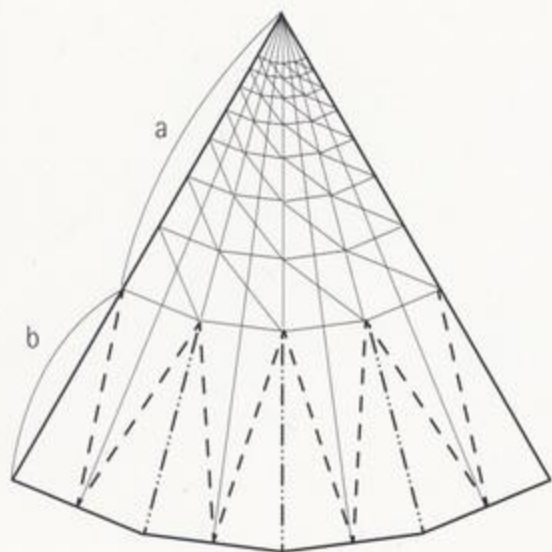


5 Make several rows of parallel creases in the same way.

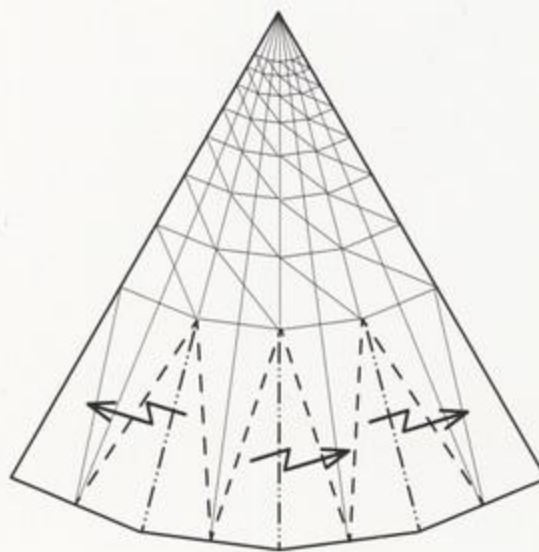
SCREW SHELL

The spiral is made from part a as shown in »Screw Shell - The Screw« on page 125. Again the centre angle is arbitrary. Also the proportion a:b is not fixed. Part b is used to make the body whorl of the shell.

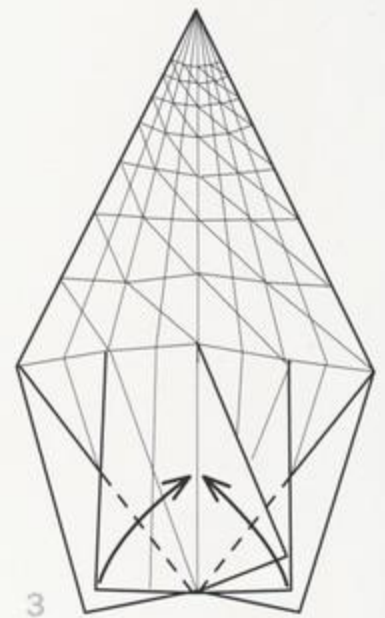
Here we show how to fold part b. Again the centre angle is 60°.



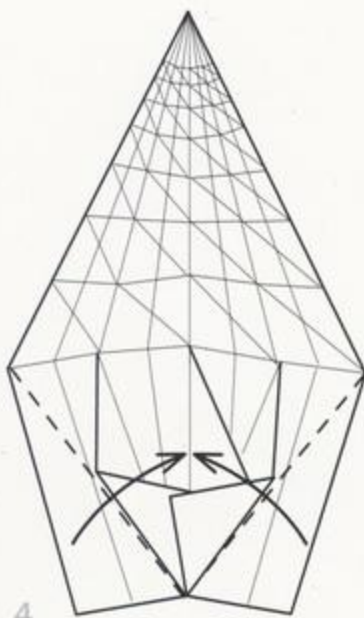
1



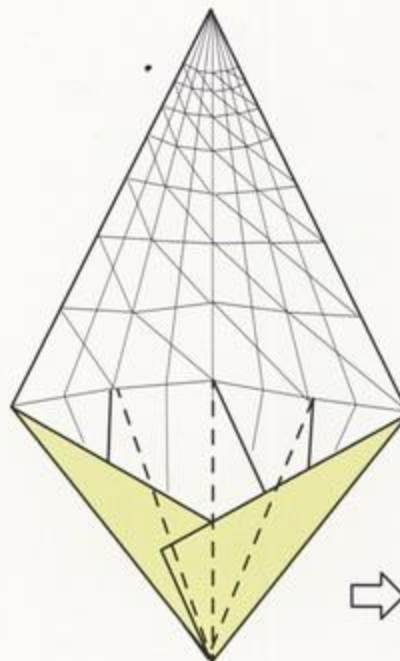
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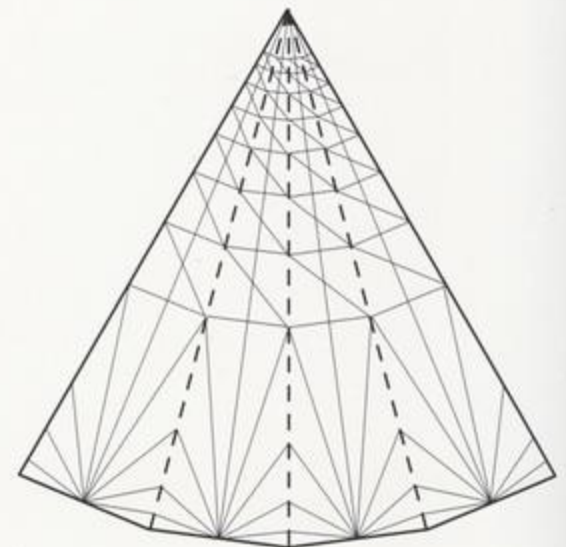
3



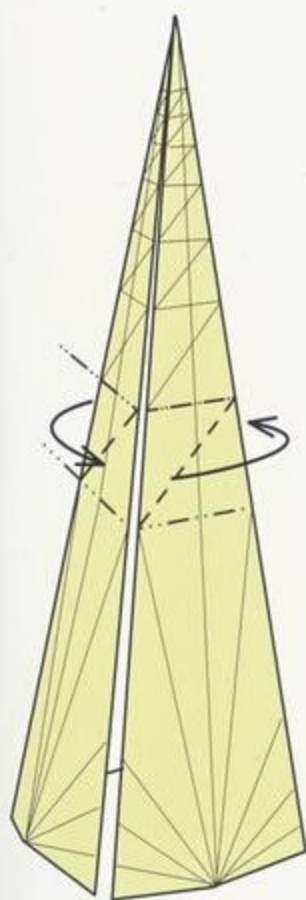
4



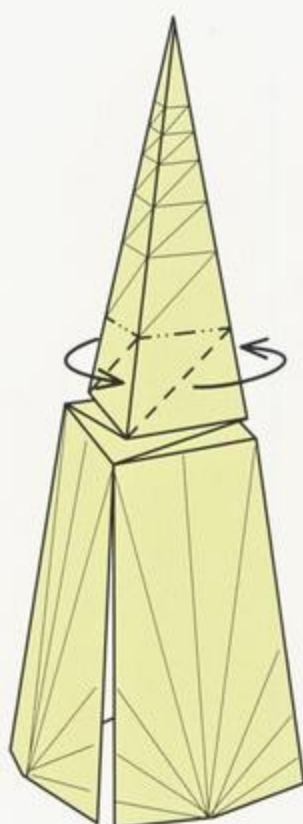
5 Make sharp creases.



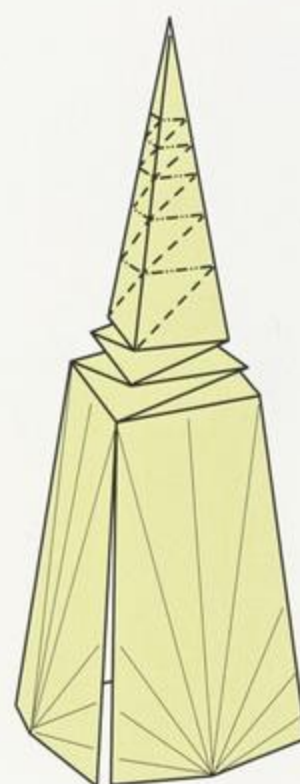
6 Make pyramid.



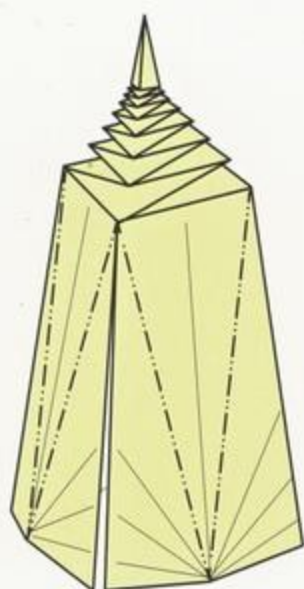
7 Twist the first row.



8 Twist the second row.

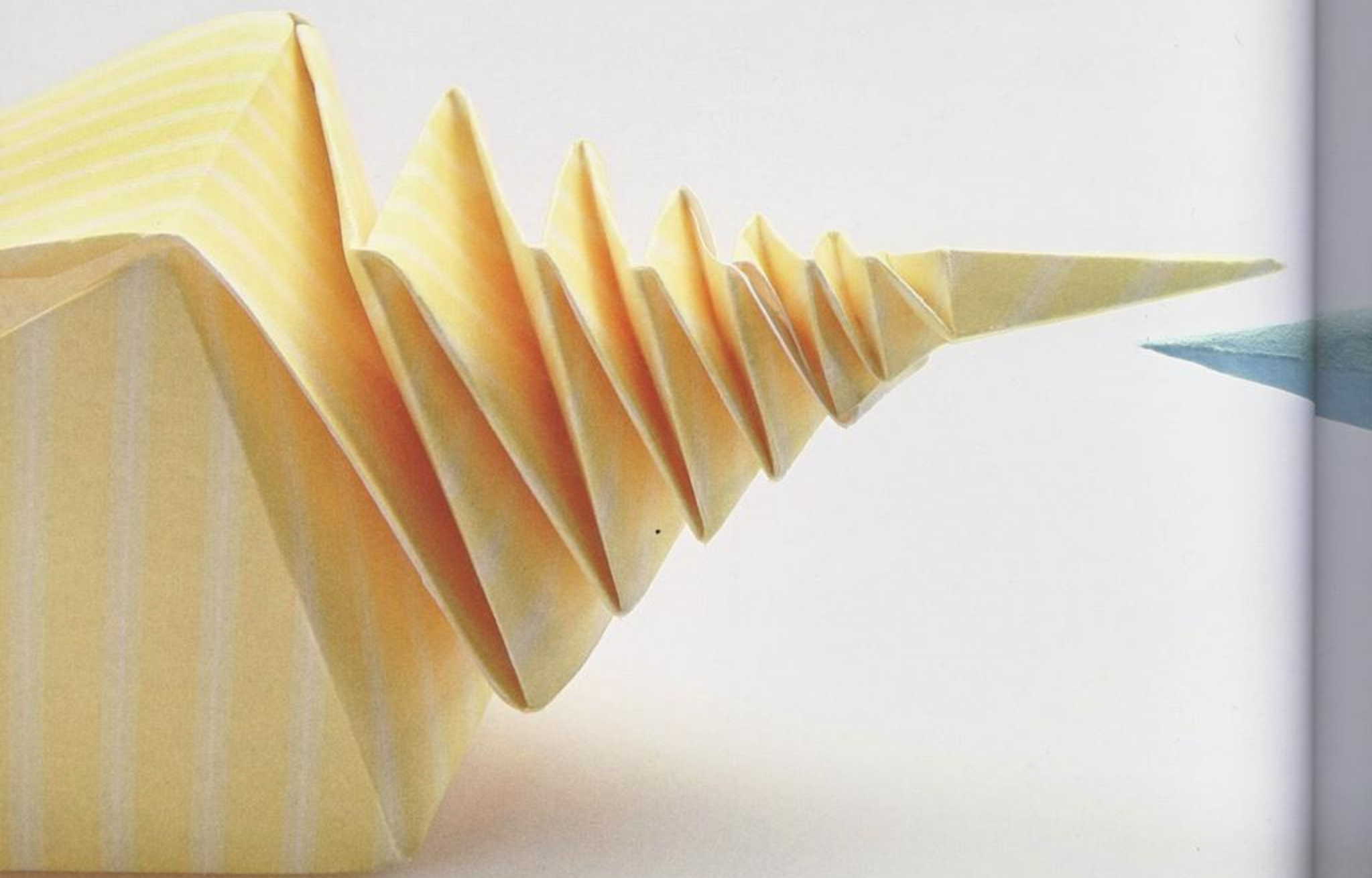


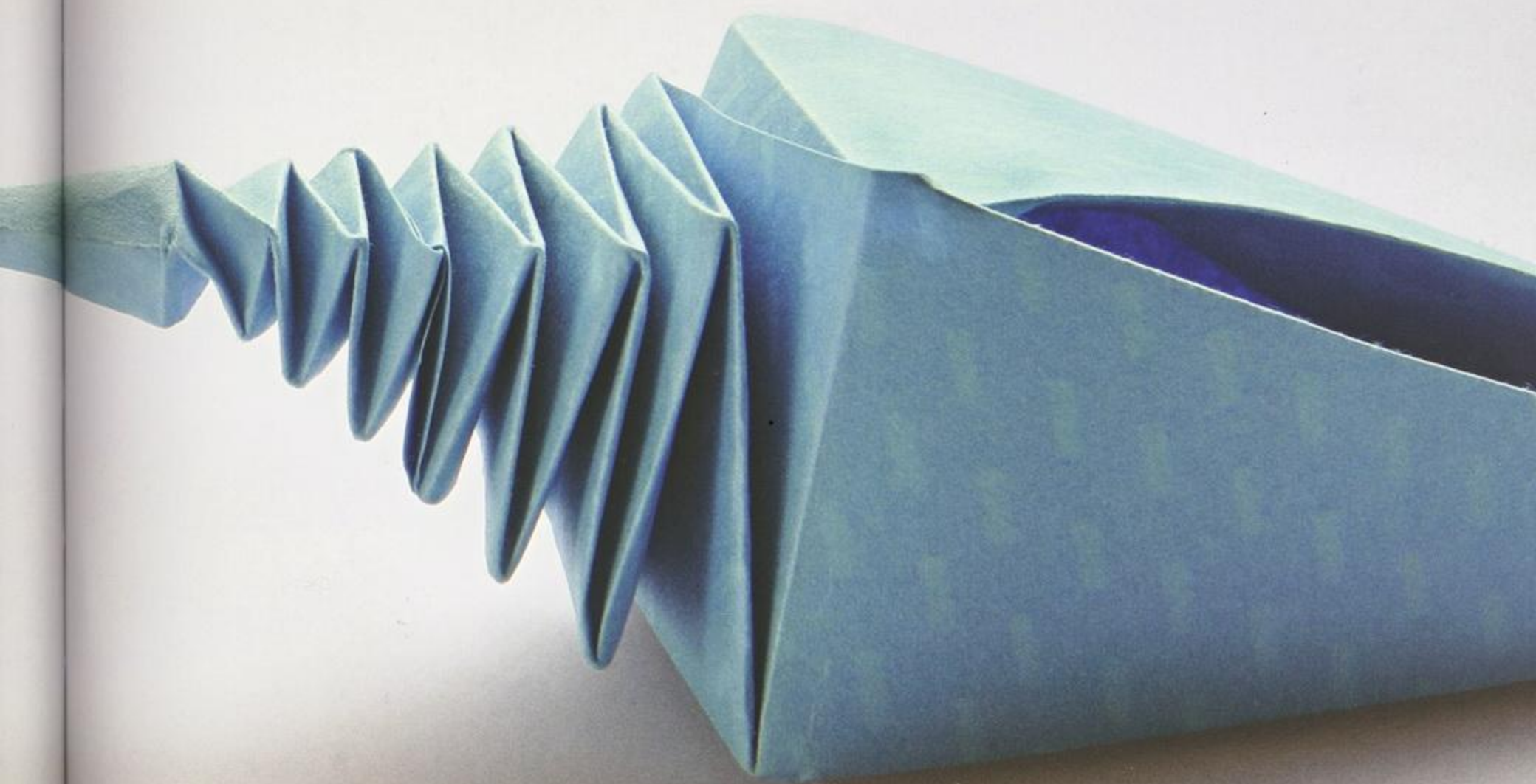
9 Twist the other rows.

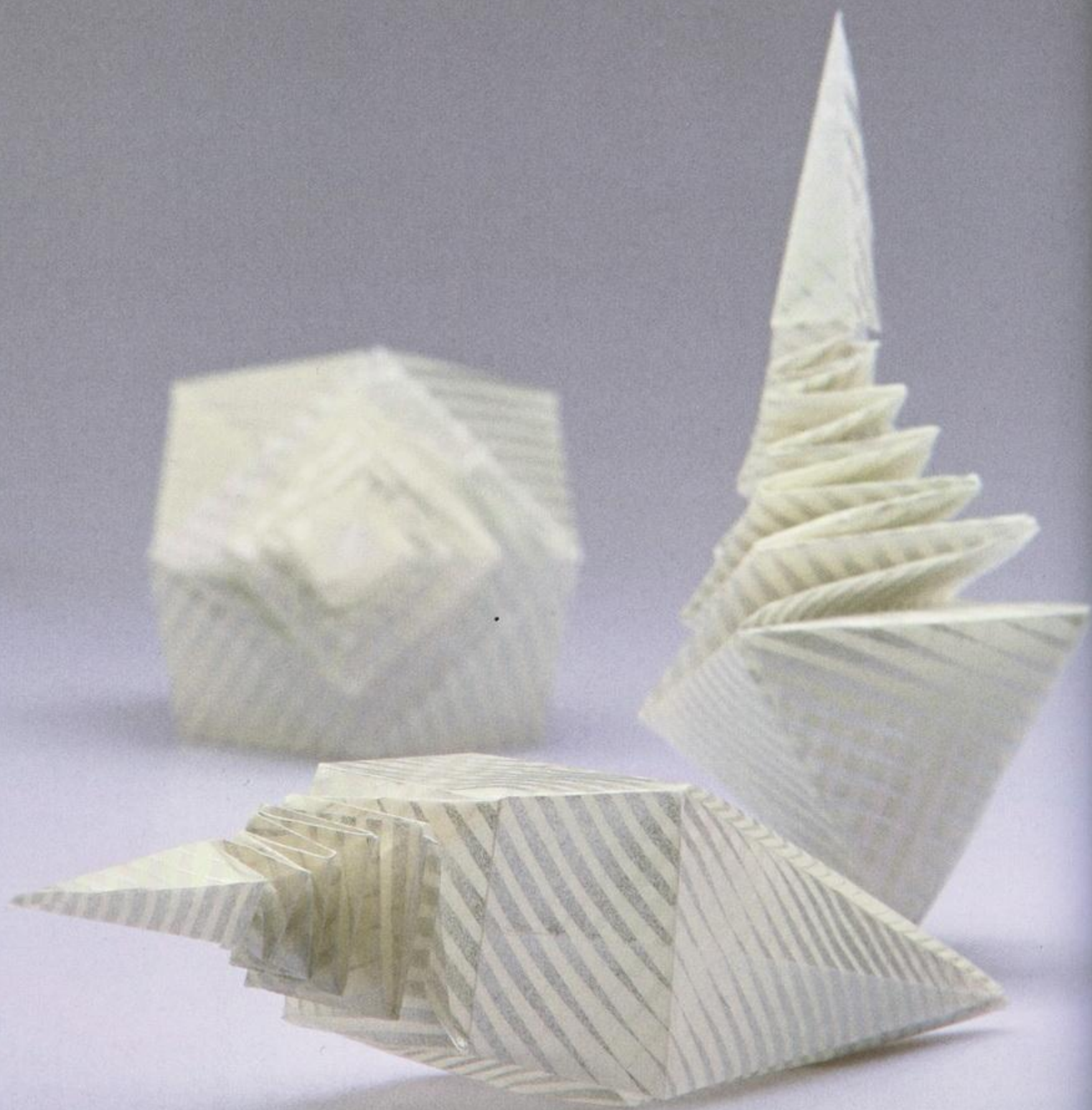


10 Fold the body of the shell using the creases made in steps 2 to 5.





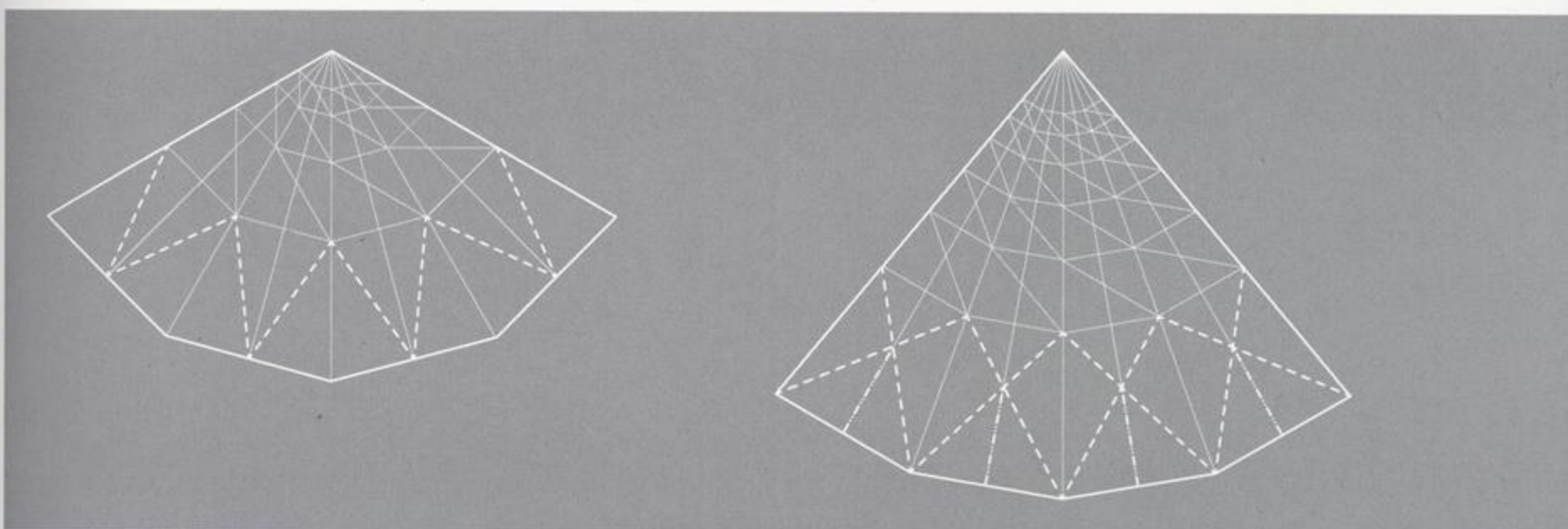
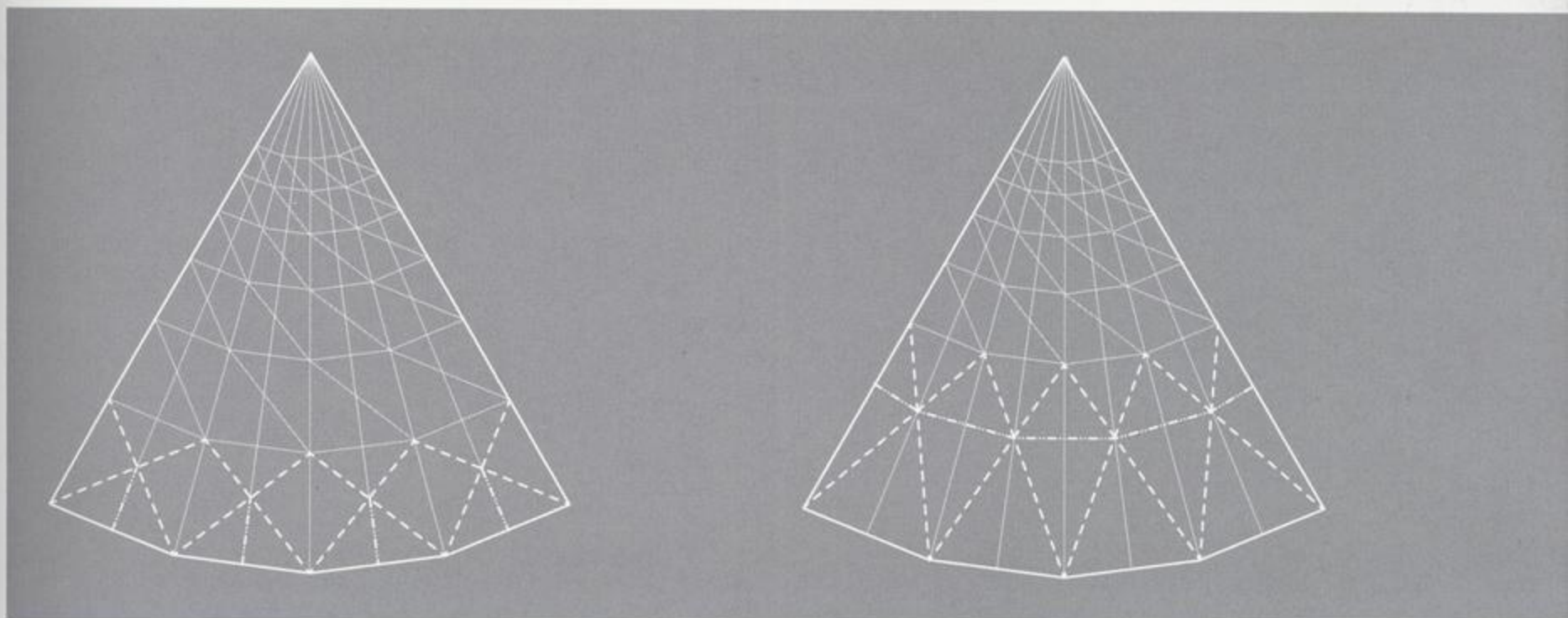
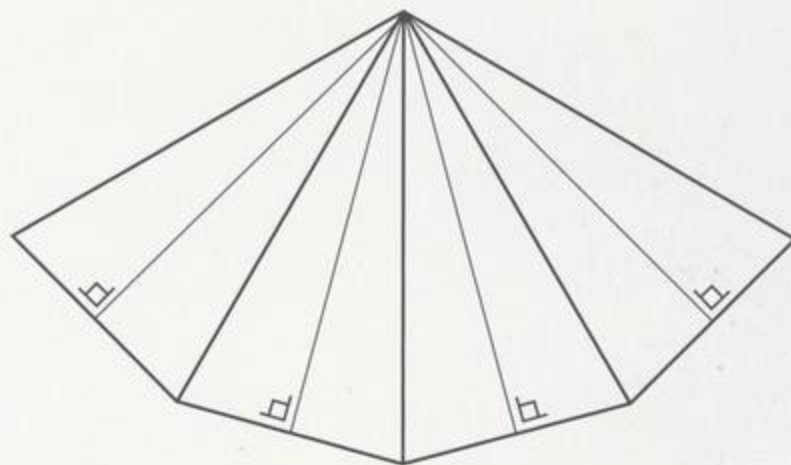




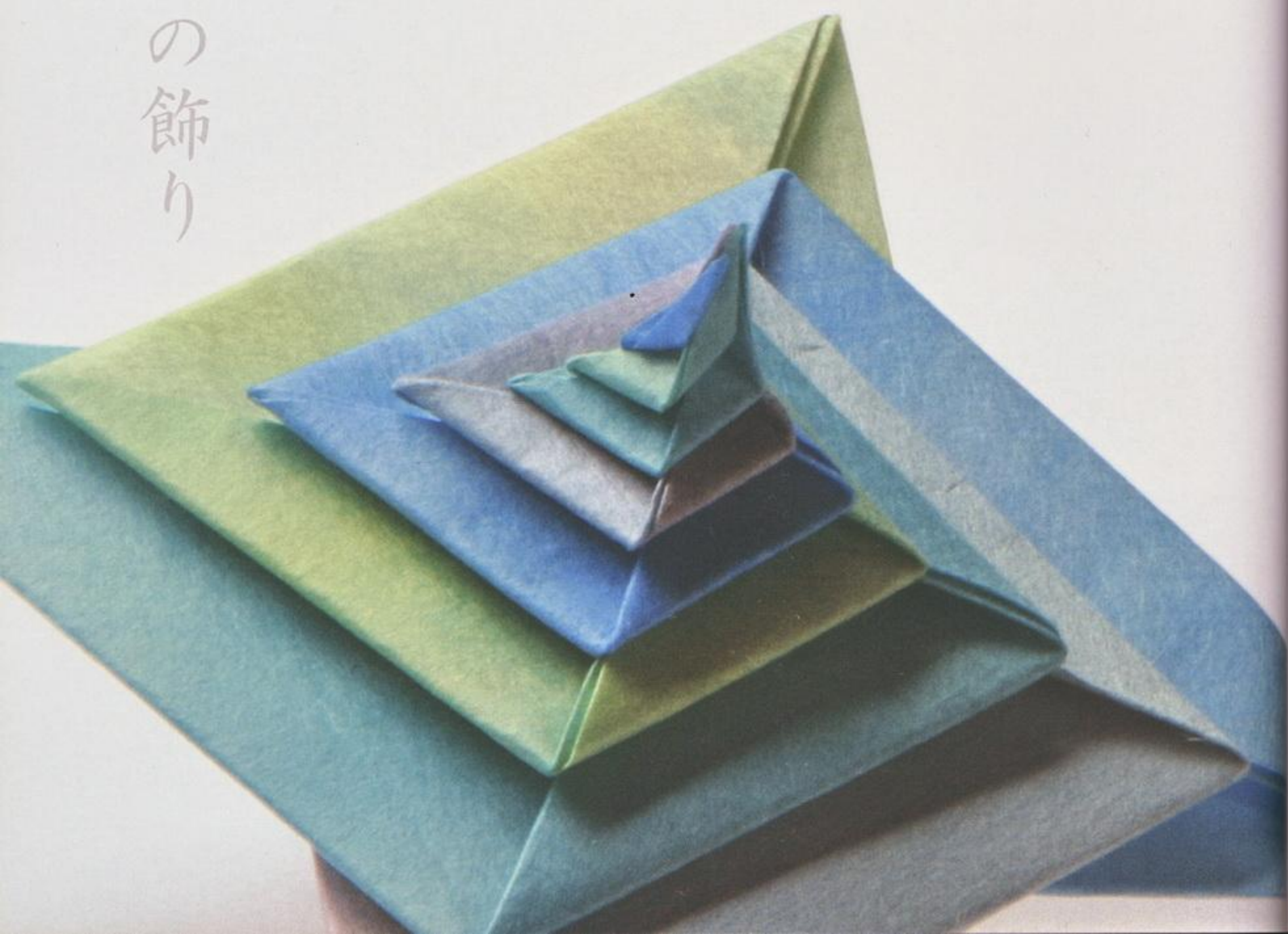
SCREW SHELL

VARIATIONS

Various shells can be made by changing how to bring the shell's mouth together, and by changing the central angle. Get inspired by the crease patterns below. Use different centre angles.

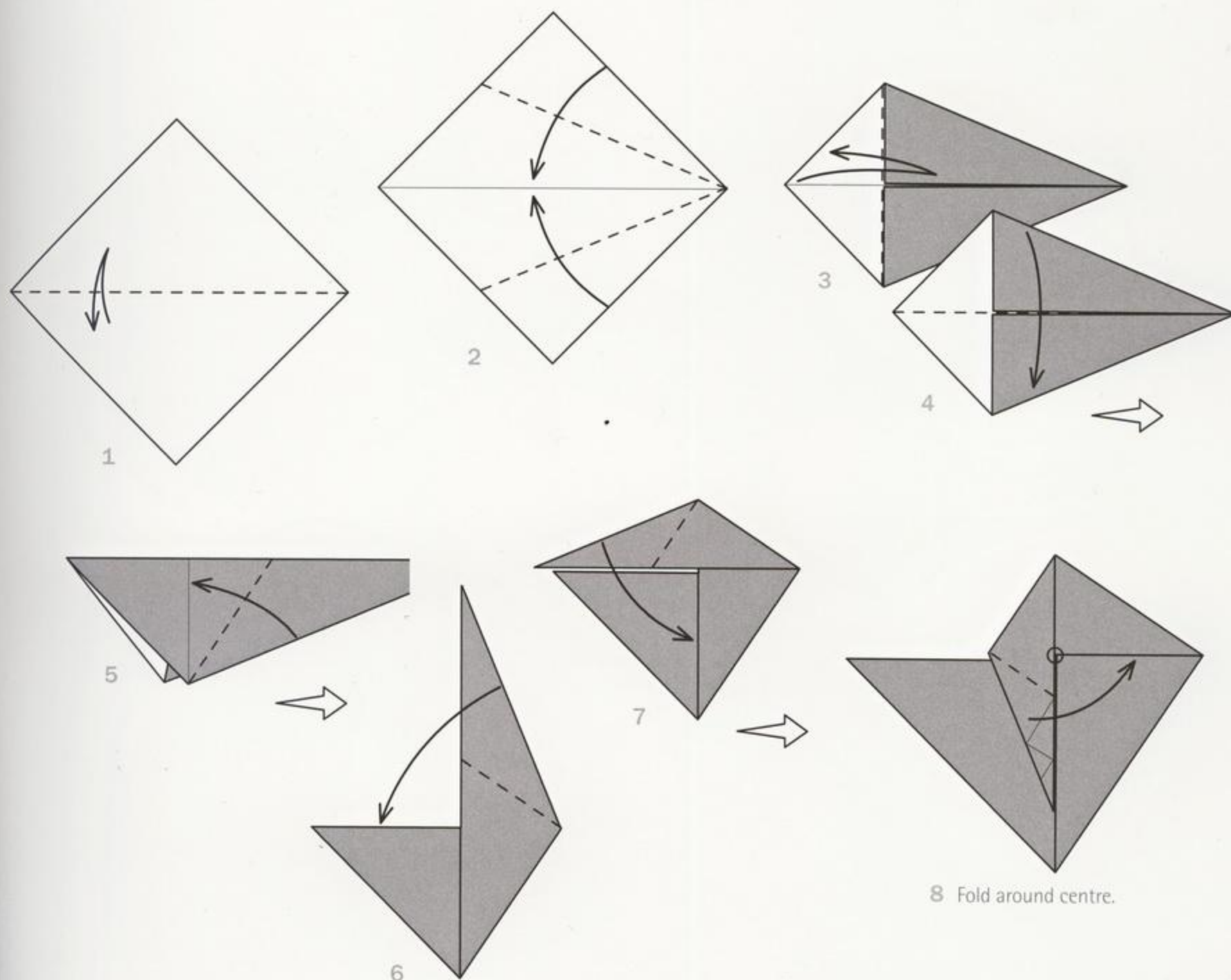


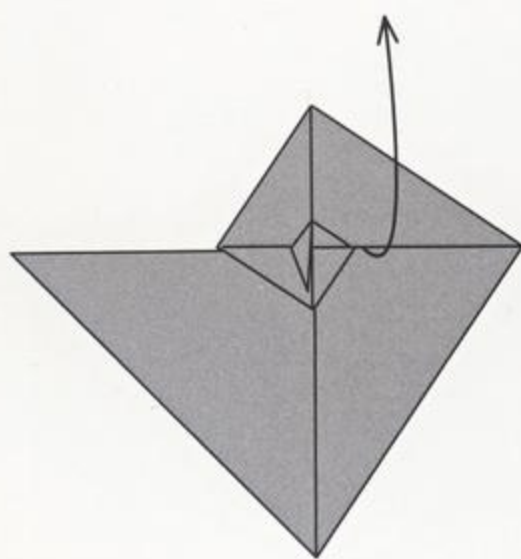
直角らせん折りの飾り



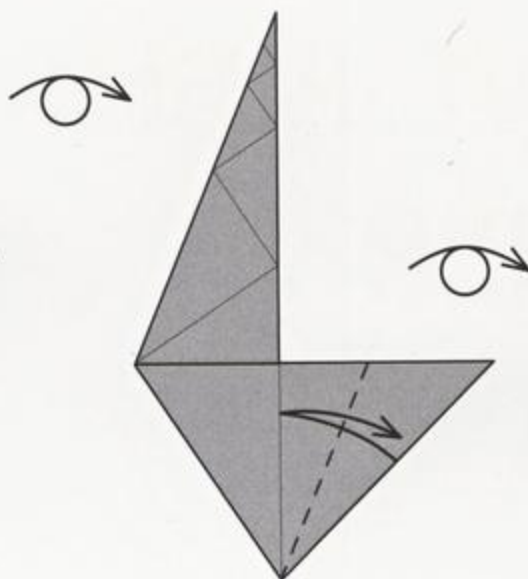
DECORATIVE RIGHT-ANGLED SPIRAL

This modular fold is based on a model by Toshikazu Kawasaki made from one sheet of paper. With modular or unit origami however it is much easier to fold and one can also combine different colours in one model. Take the opportunity to practice the Right Angled Spiral Fold. It has many applications.

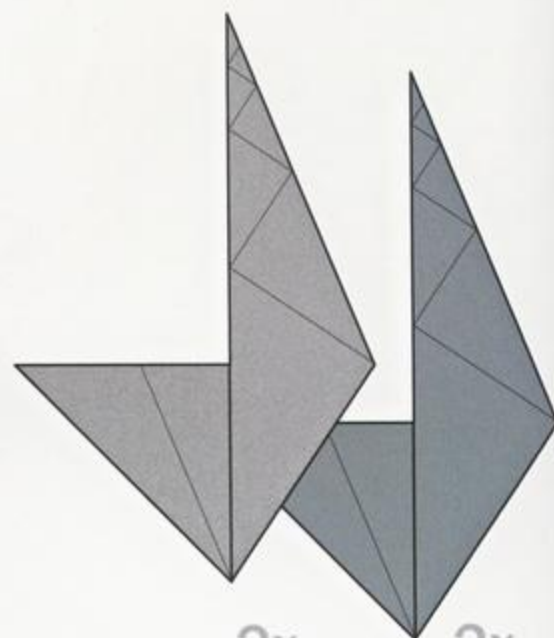




9 Unfold.



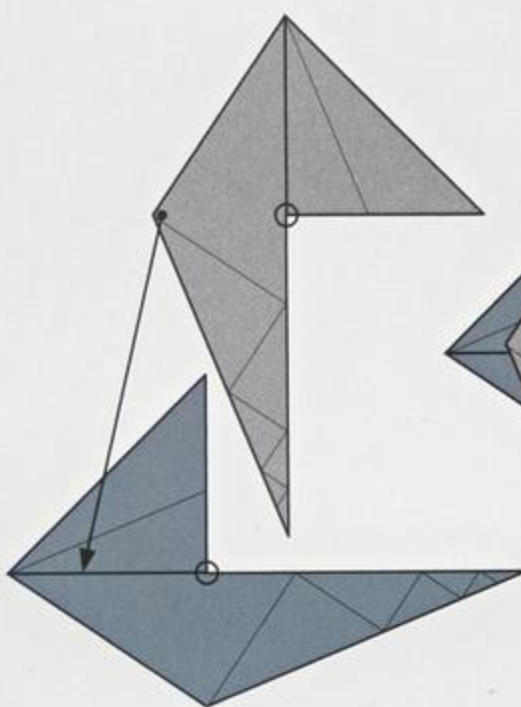
10



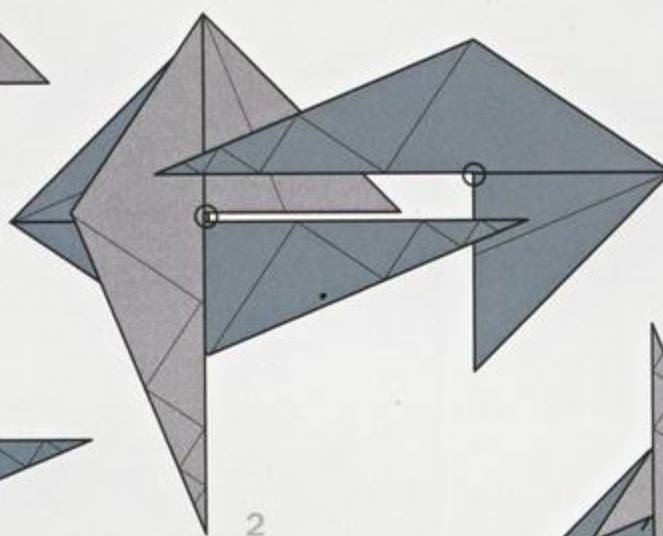
2x

2x

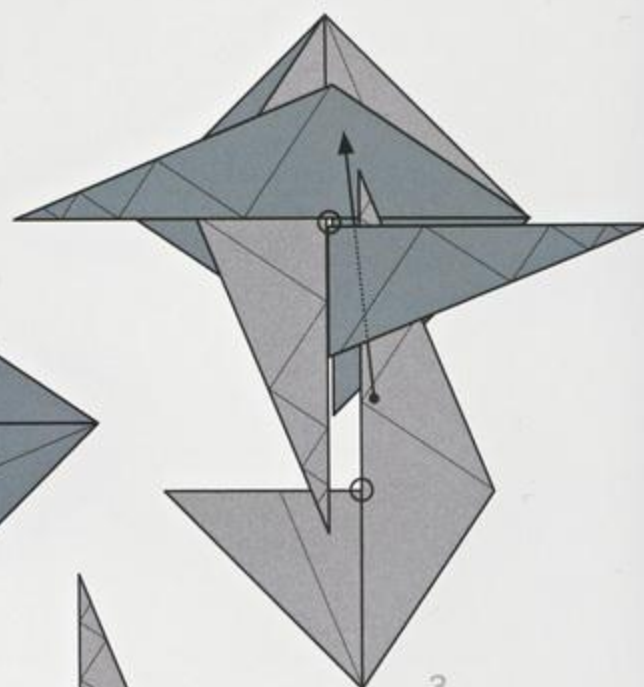
ASSEMBLY METHOD



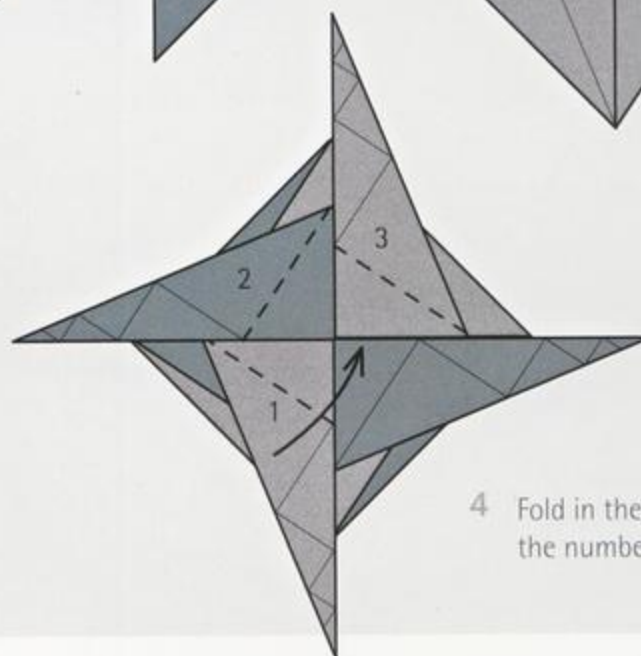
1 Align the point marks, stacking one unit on top of the previous one.



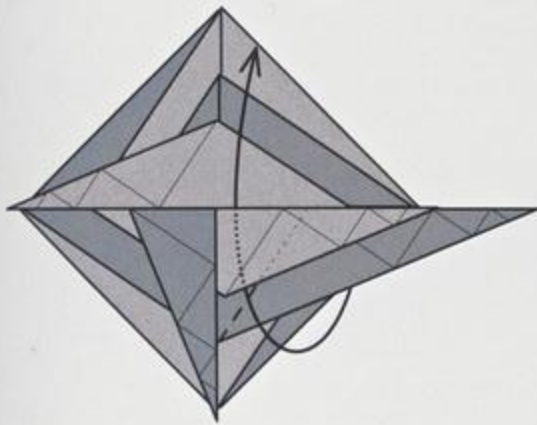
2



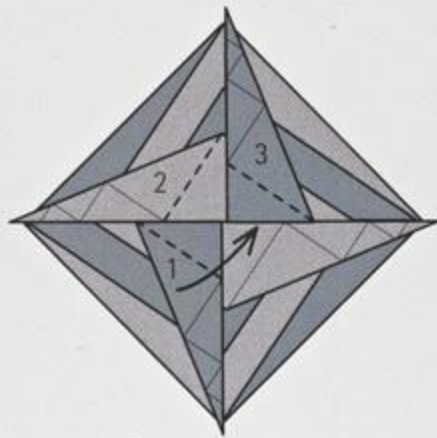
3



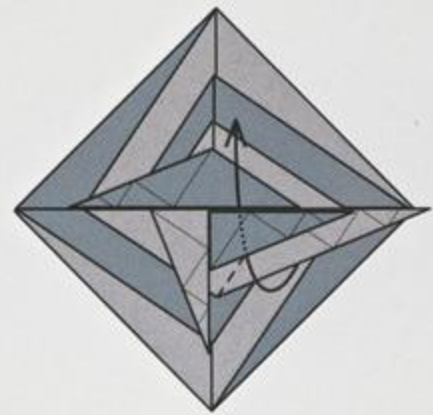
4 Fold in the order indicated by the numbers.



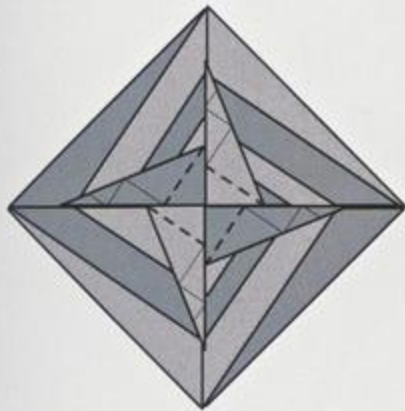
5 Fold no. 4 and pass under no. 1.



6



7

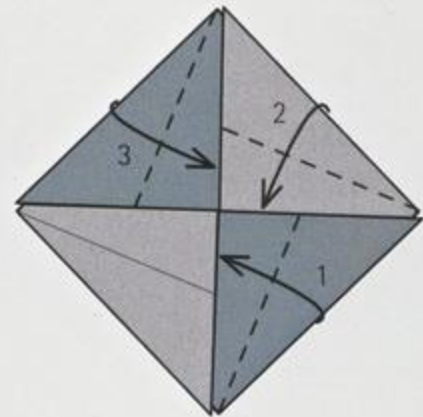


8

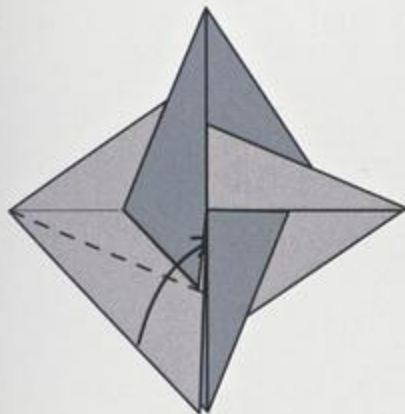
...



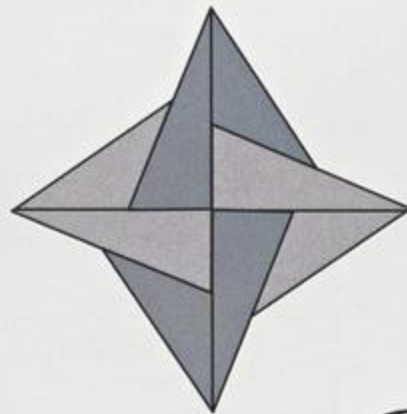
9 Finish by twirling the ends.



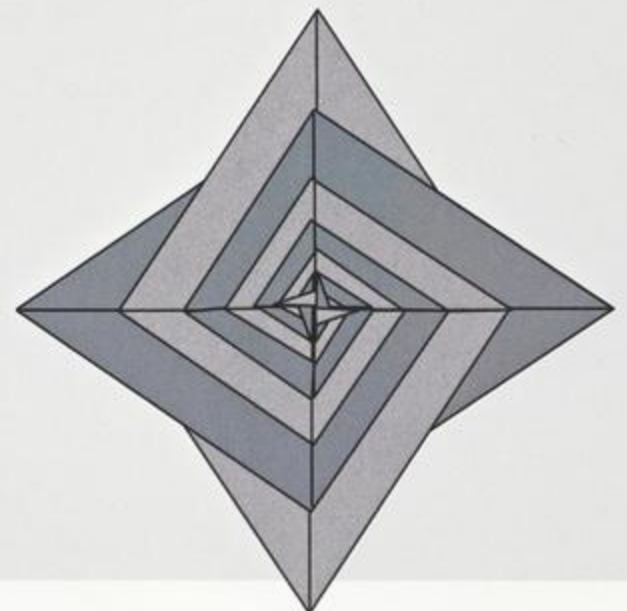
10

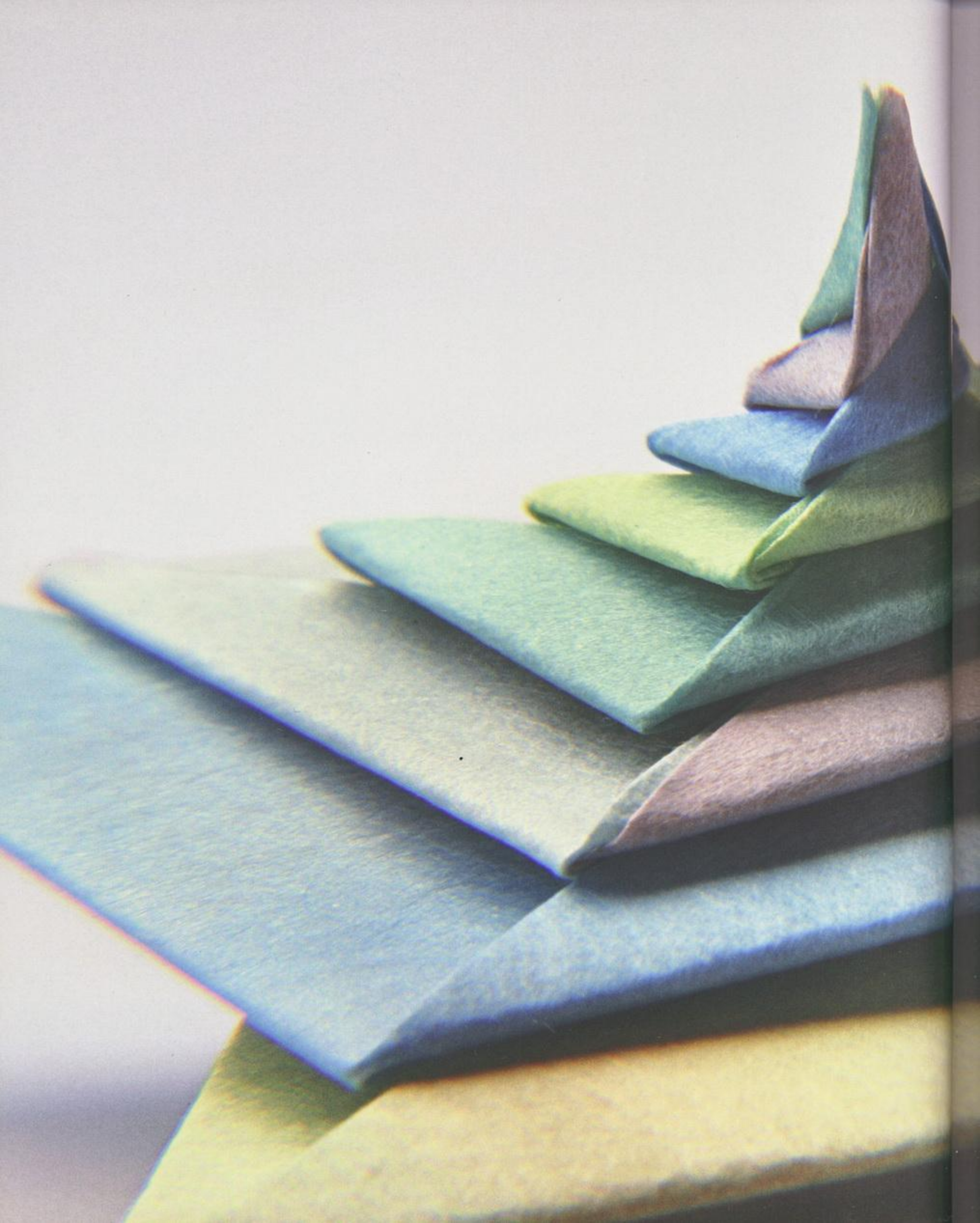


11 Fold and slip in.



12





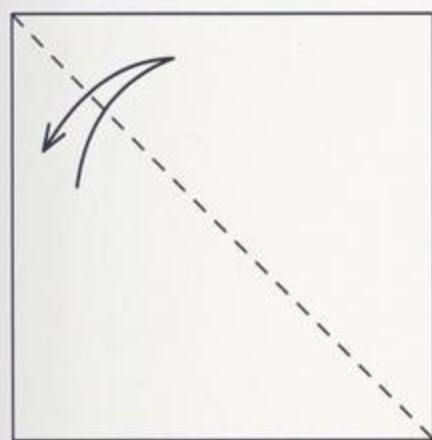


ユニット巻き貝

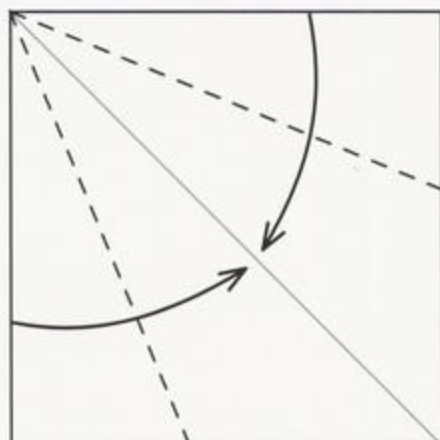


MODULAR SPIRAL SHELL

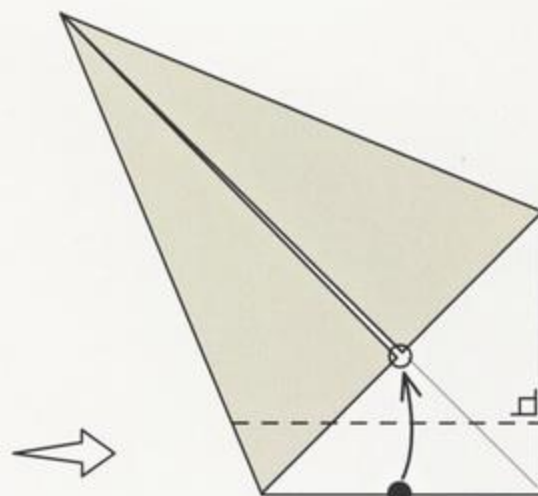
This shell is based on a model by Toshikazu Kawasaki made from a single sheet of paper.



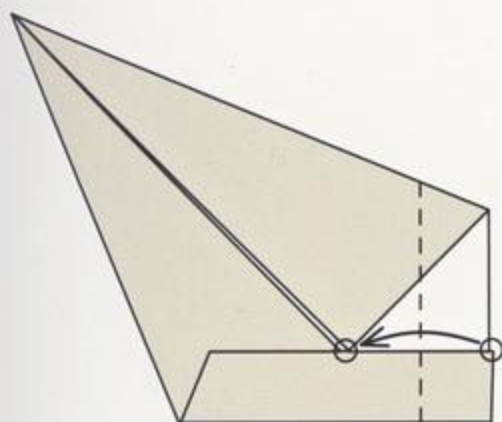
1



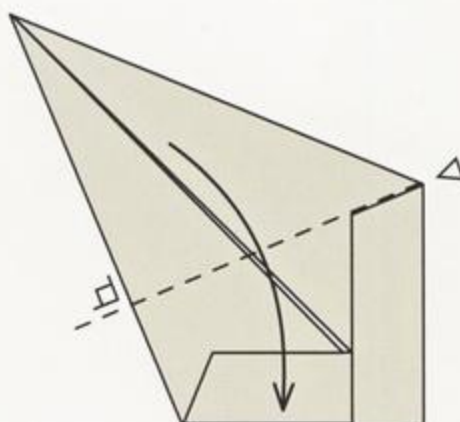
2



3



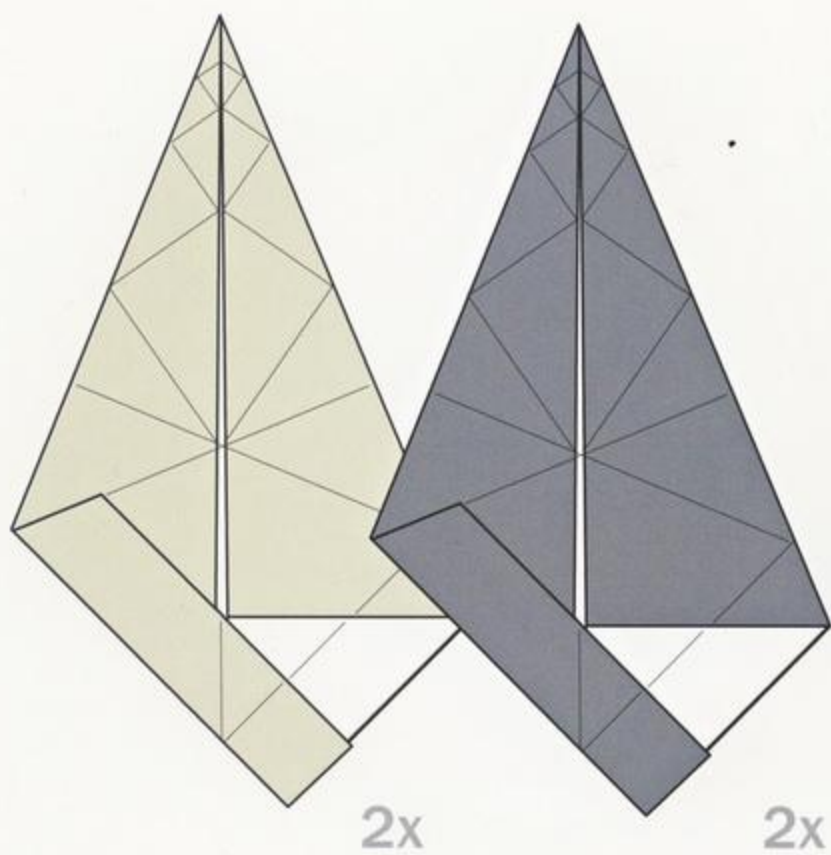
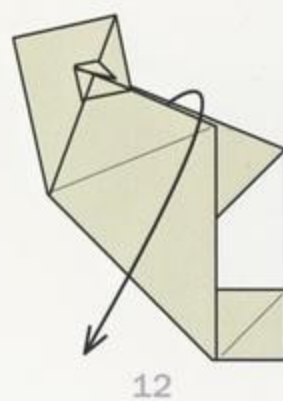
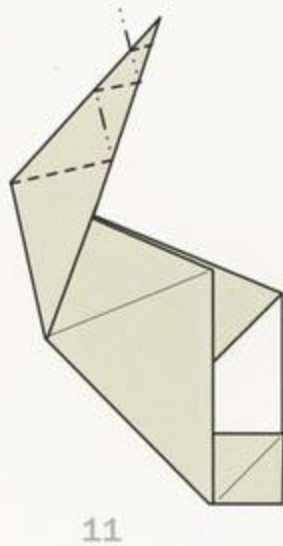
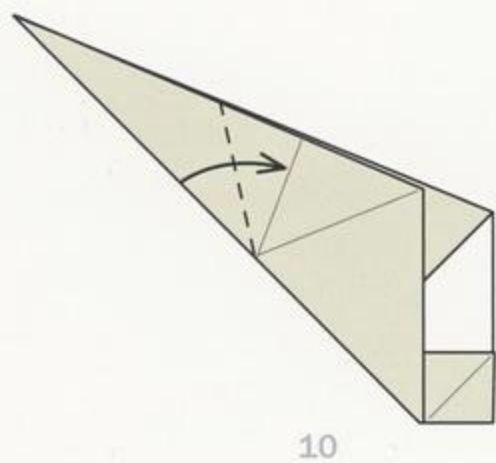
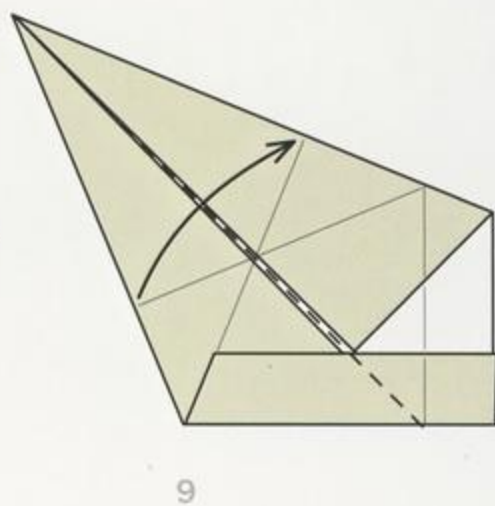
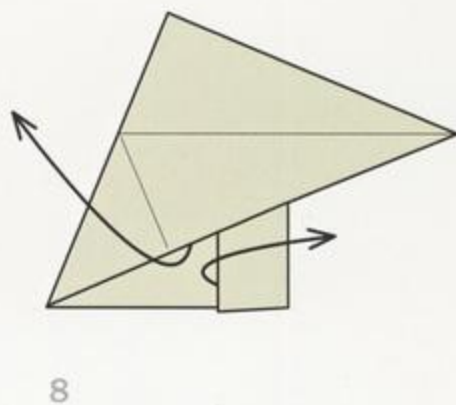
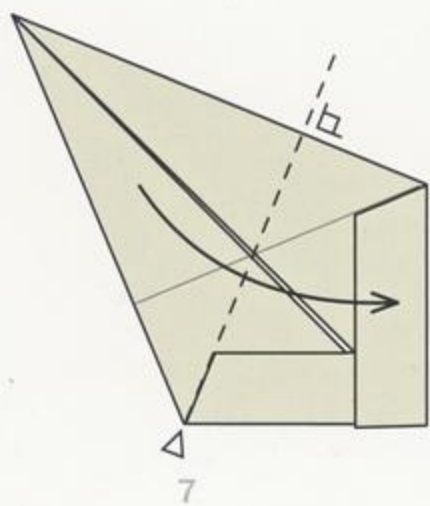
4



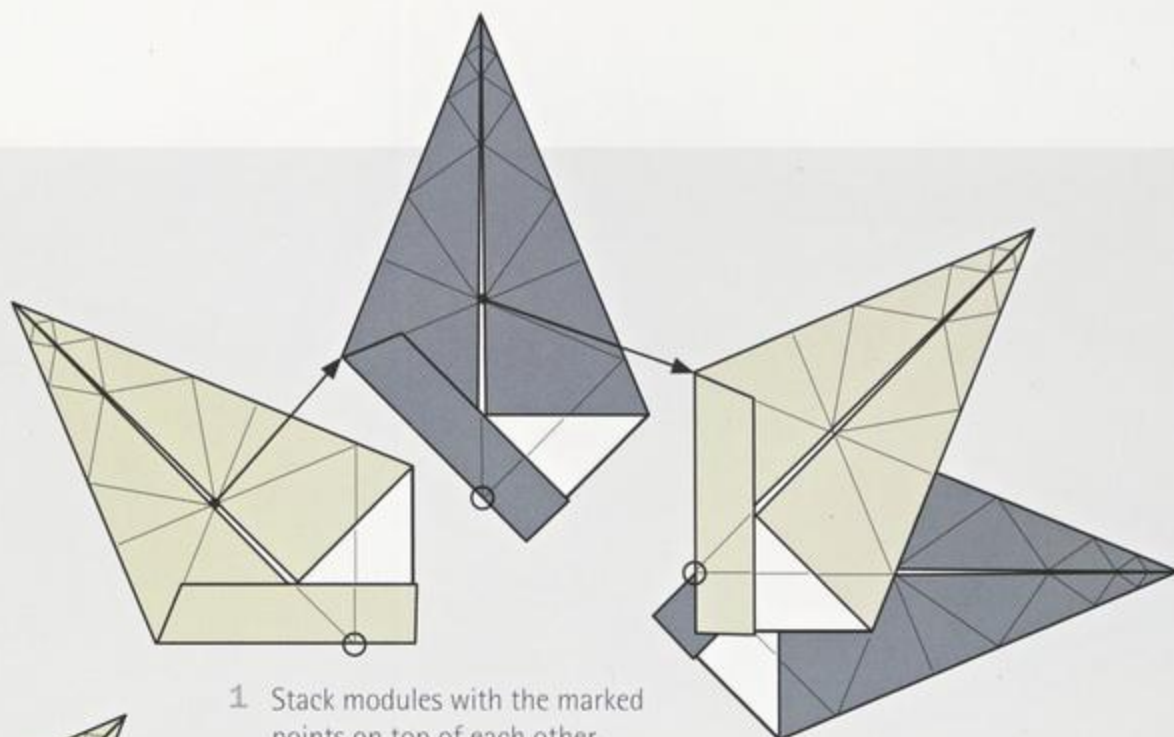
5



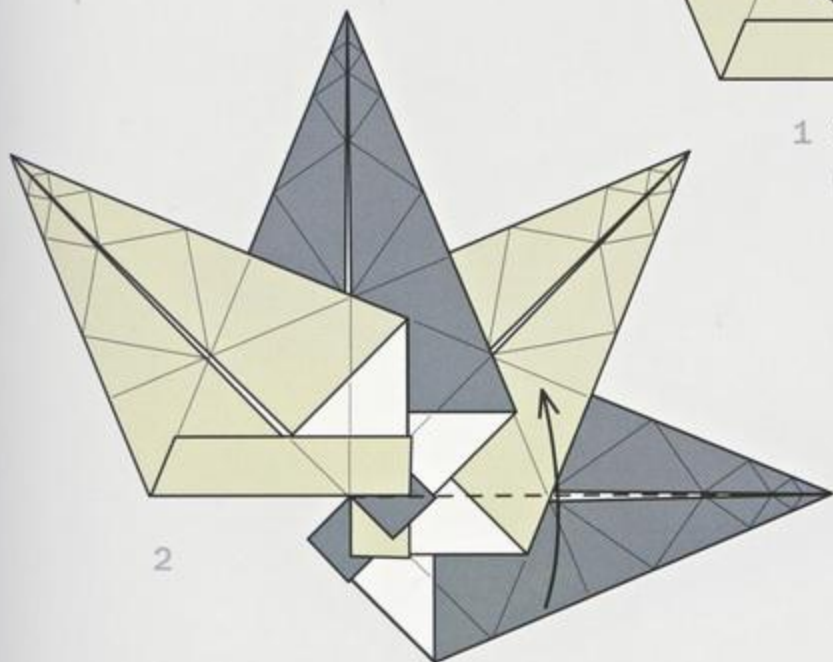
6



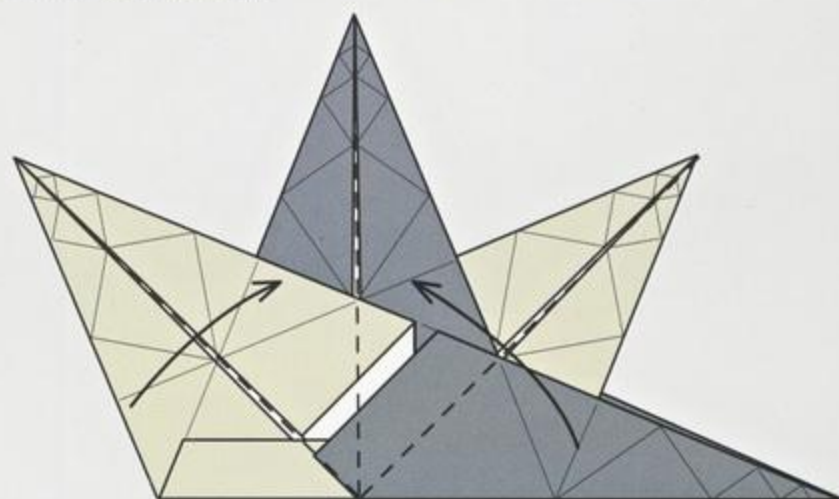
ASSEMBLY METHOD



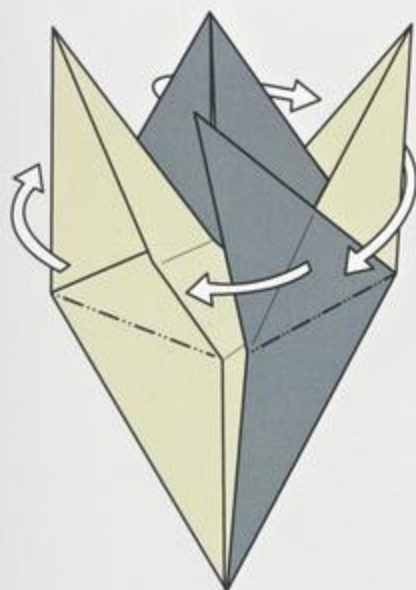
- 1 Stack modules with the marked points on top of each other.



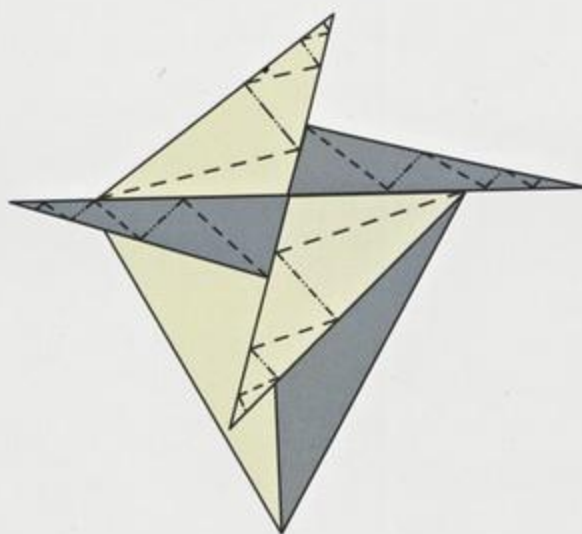
2



- 3 Make pyramid (upside down).



- 4 Twist, the pyramid base becomes flat.

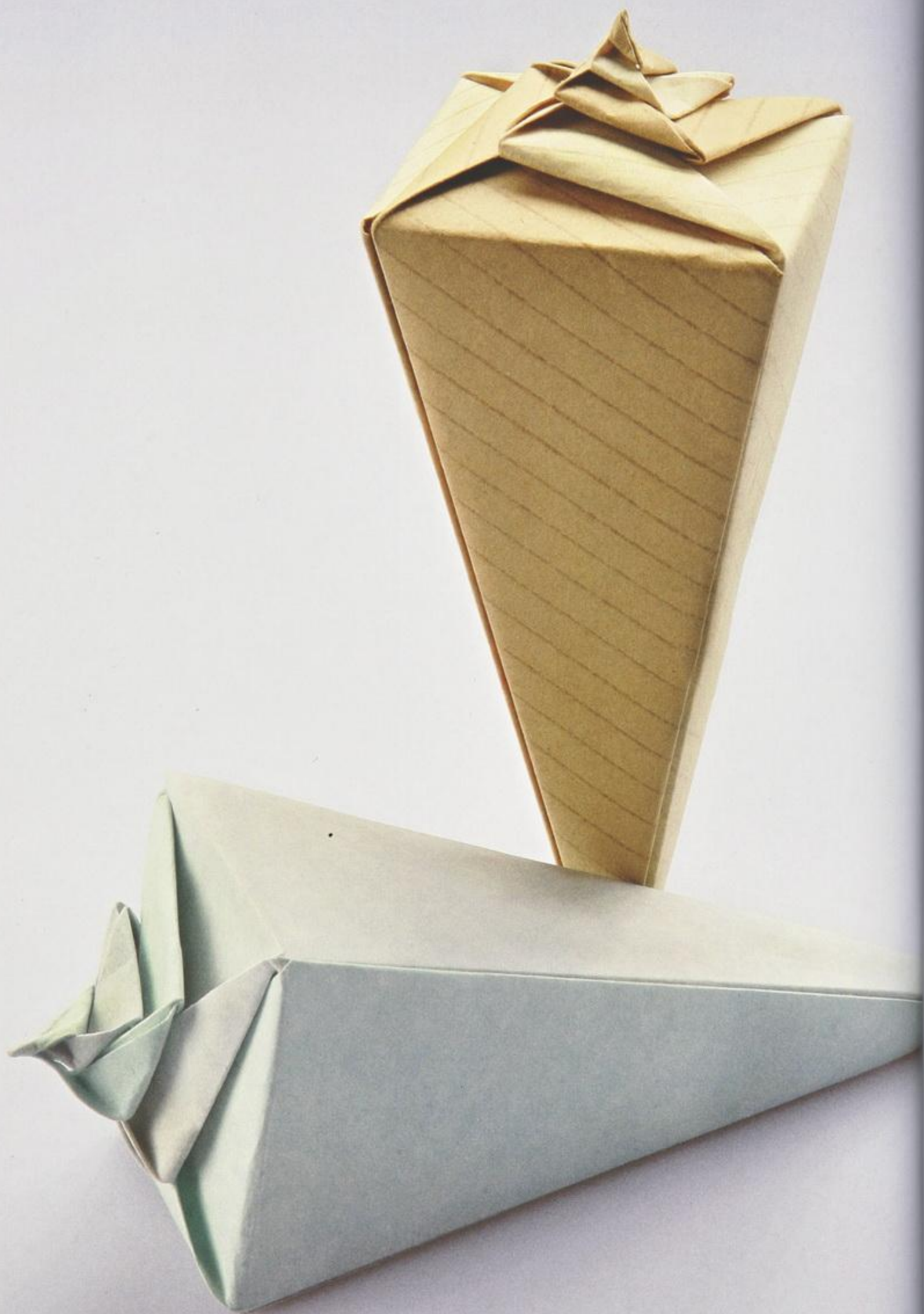


- 5 Spiral fold see «Decorative Right-angled Spiral» from step 4 on page 134.

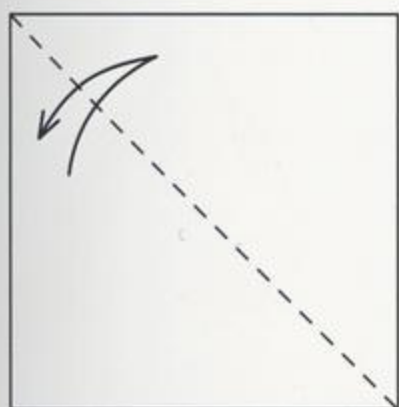


- 6 Fix the top with a firm twist. Adjust the shell's mouth.

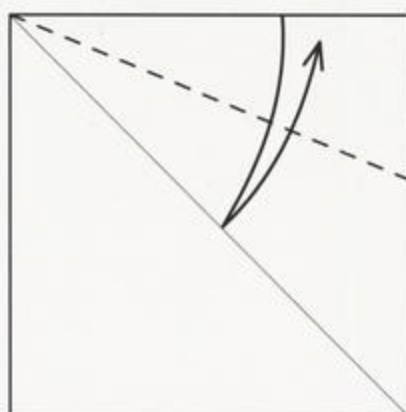
ユニット長巻き貝



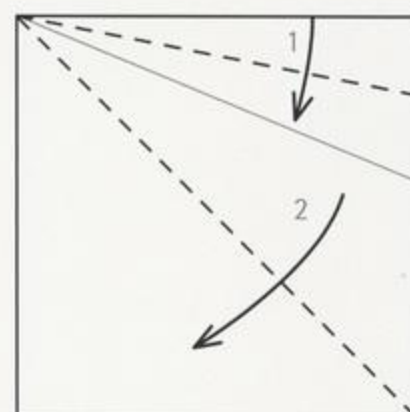
MODULAR SPIRAL SHELL LONG VERSION



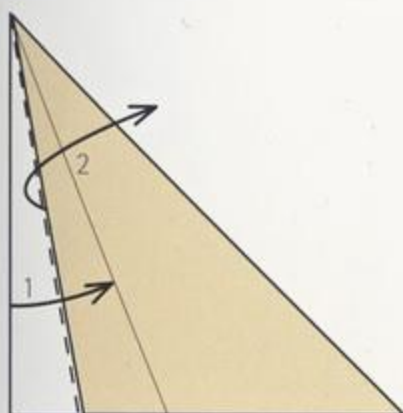
1



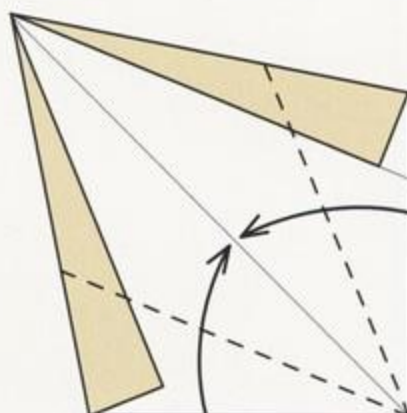
2



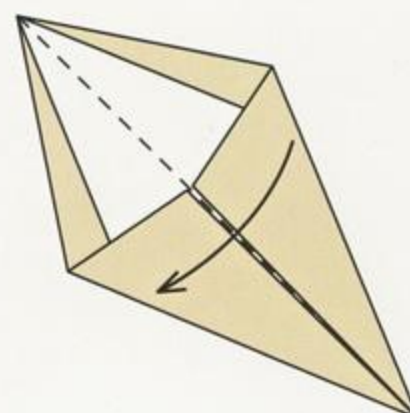
3 Fold in the order indicated by the numbers.



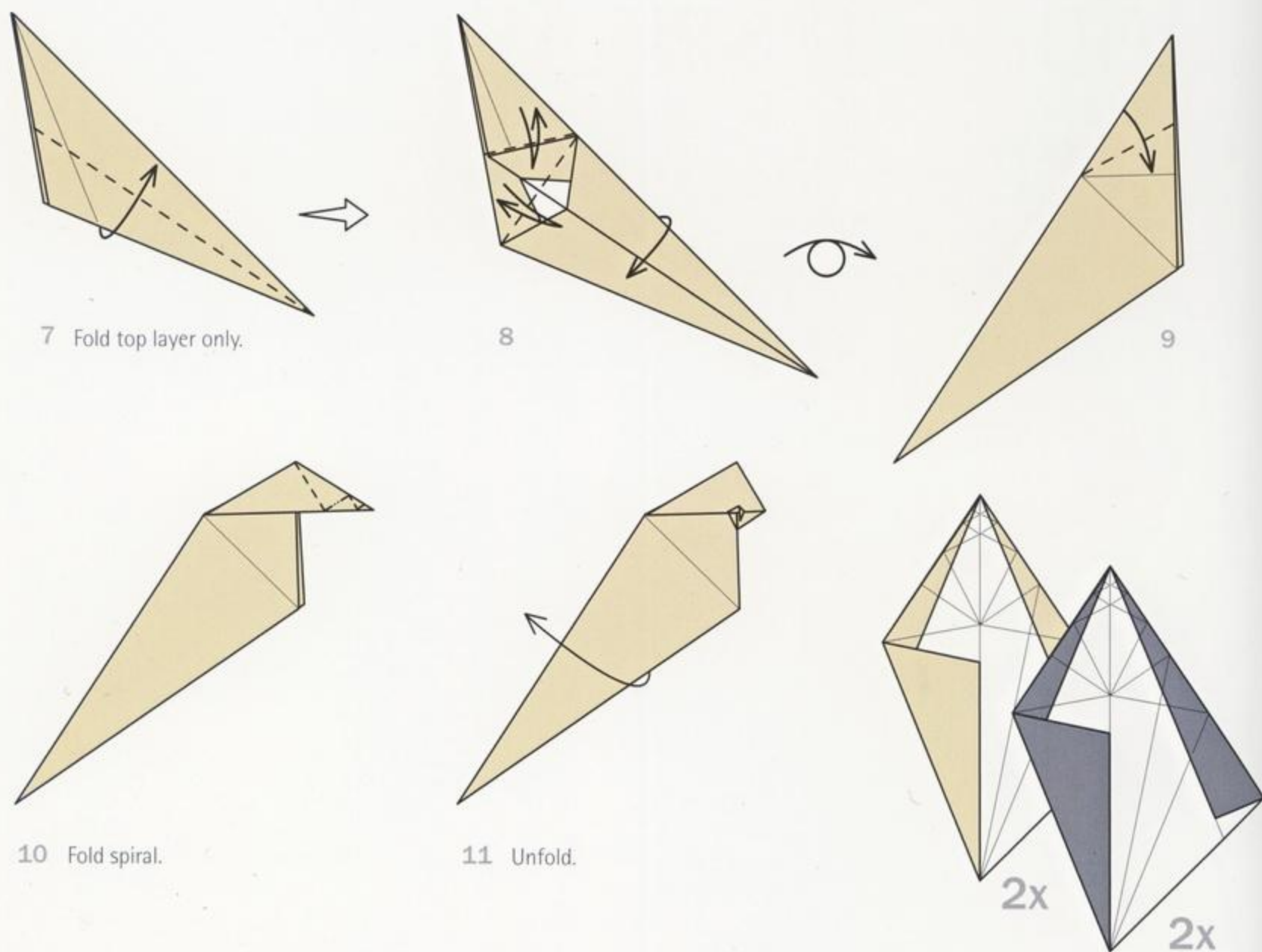
4



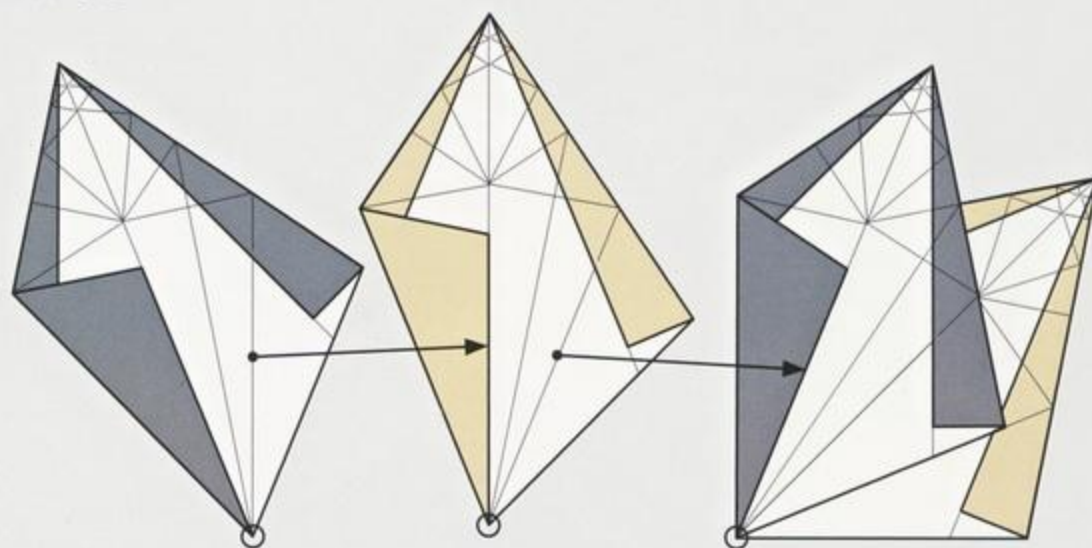
5



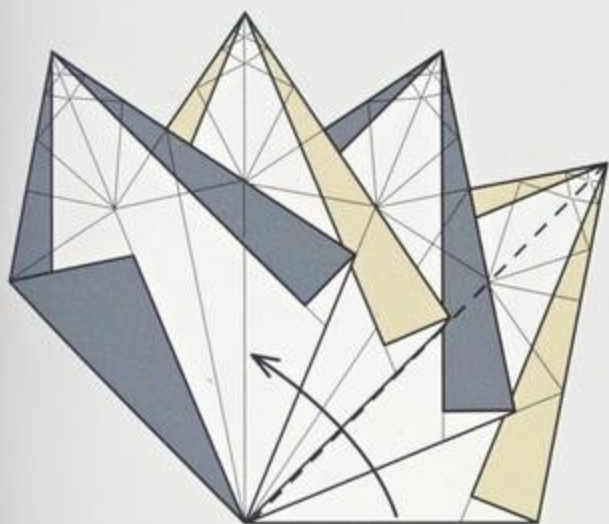
6



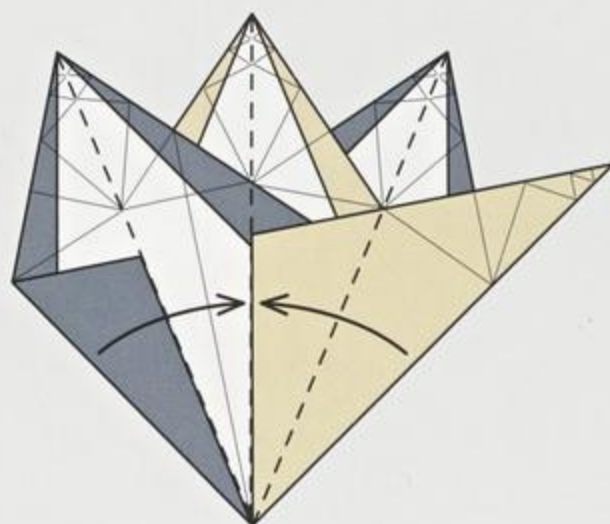
ASSEMBLY METHOD



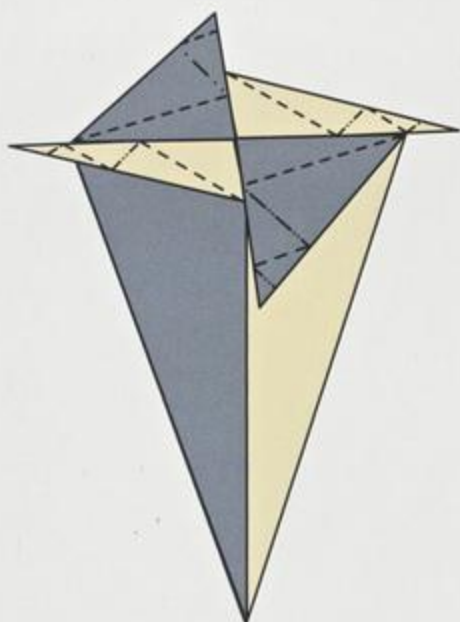
1 Stack modules with the marked points on top of each other.



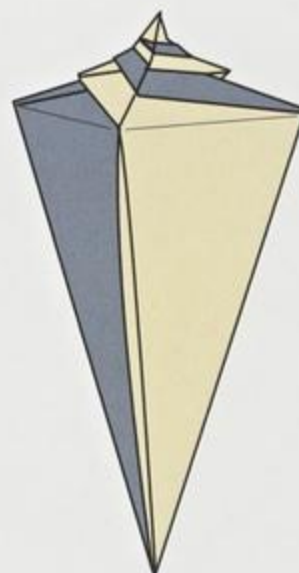
2



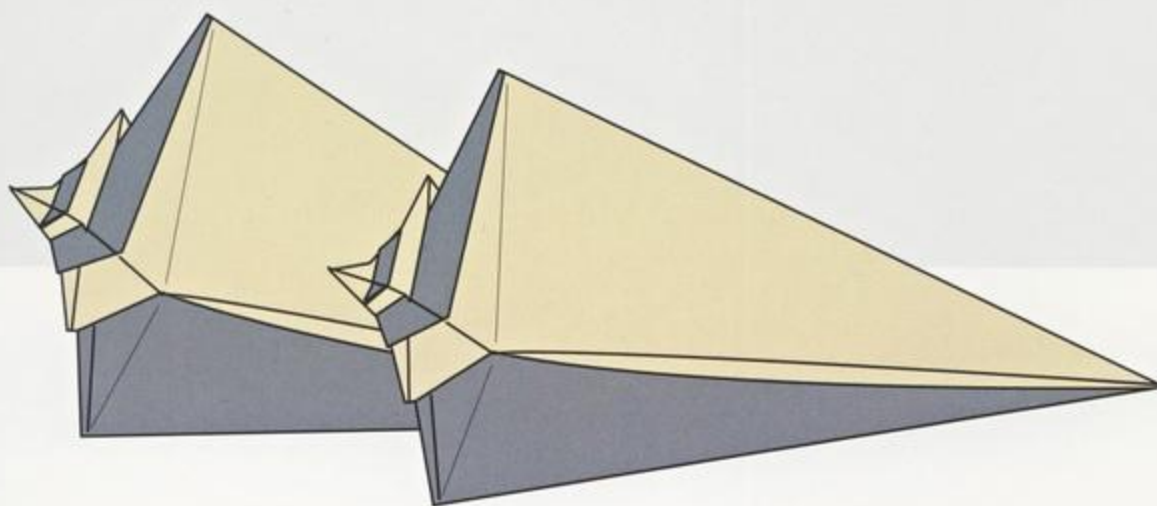
3 Make pyramid (upside down).



4 Twist, the pyramid base becomes flat.



5 Fold spiral, twirl the ends and arrange aperture.

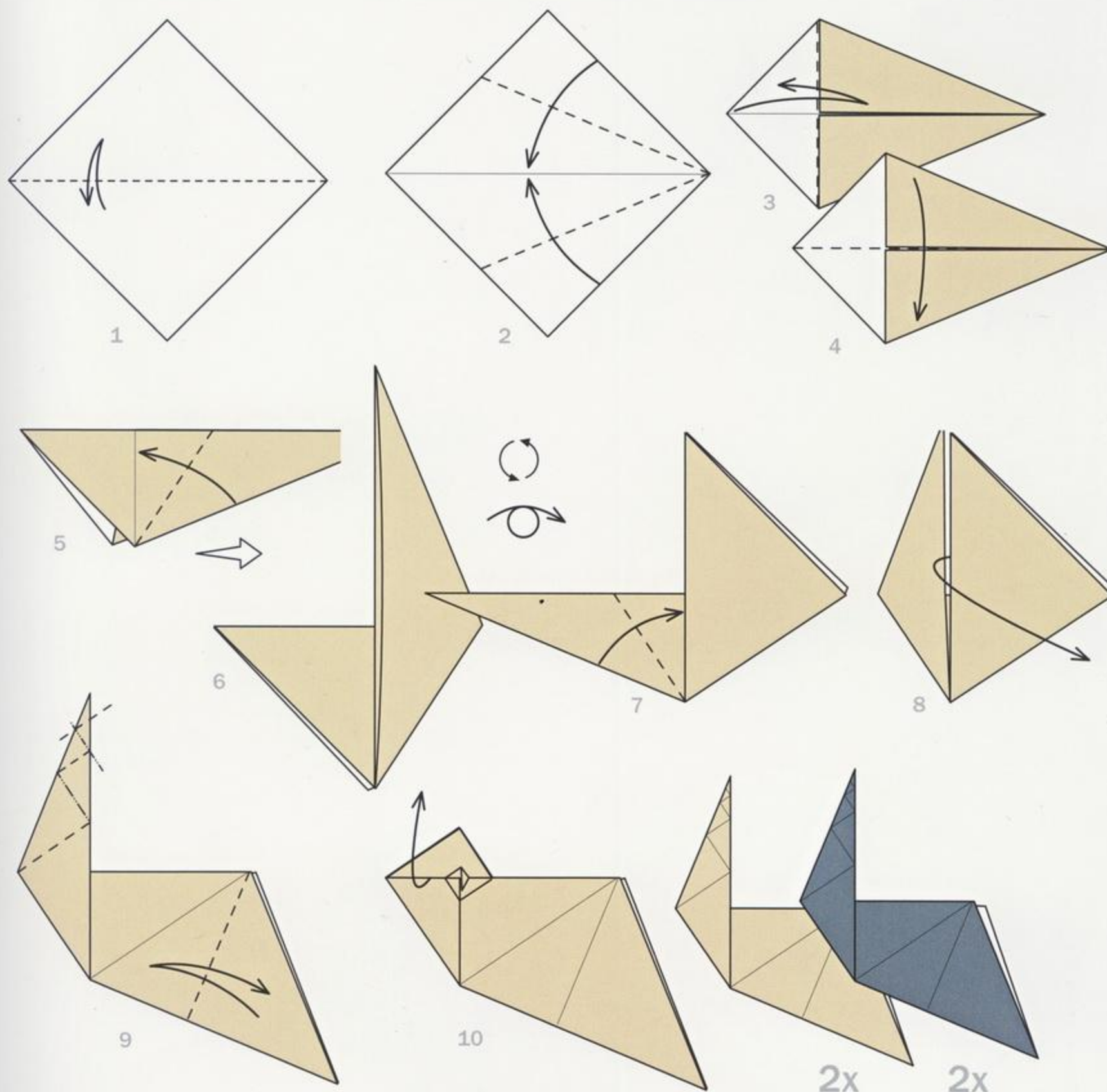


風化した貝

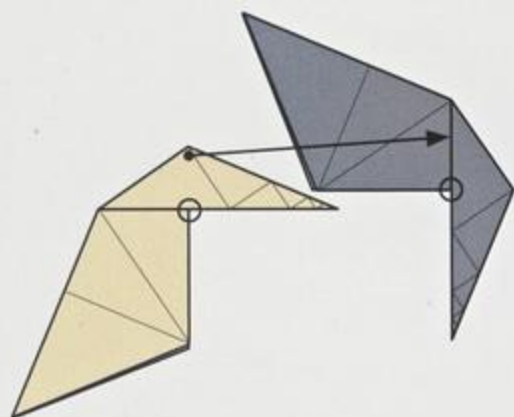


WEATHERED SHELL

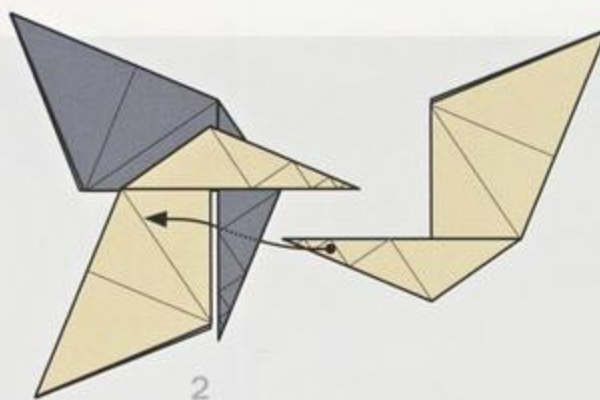
If exposed to the elements for some while the delicate parts of the shell can decay, leaving only the stronger parts; a weathered shell.



ASSEMBLY METHOD



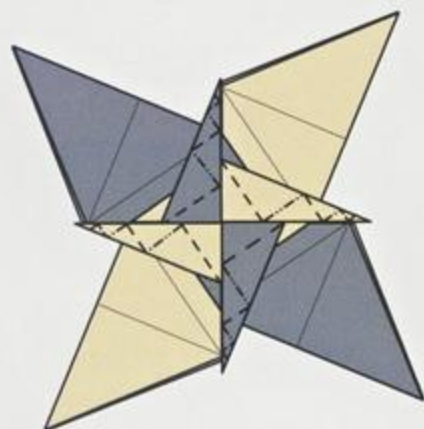
- 1 Stack modules with the marked points on top of each other.



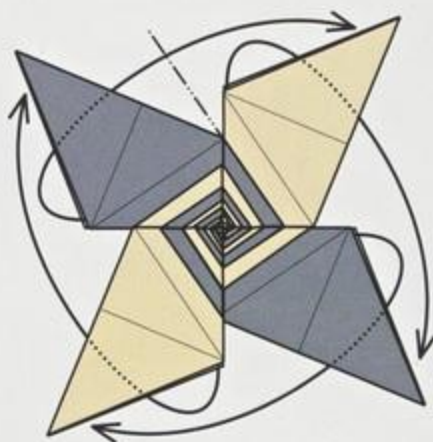
2



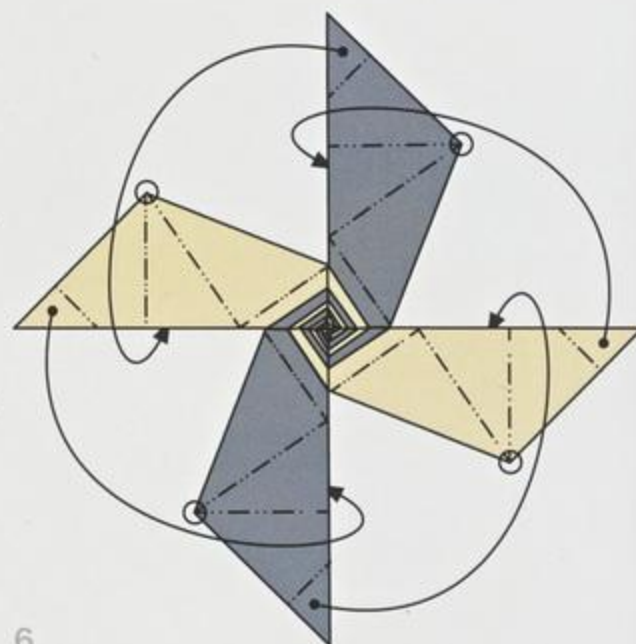
3



- 4 Fold spiral.

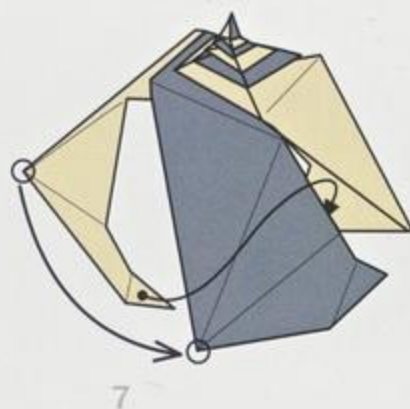


- 5 Unfold the outermost mountain fold of each of the four wings.



6

- Bring counterclockwise the marked corners over the mark of the next wing and bend the protruding tip around the edge. Steps 7 and 8 show more advanced stages of this process.

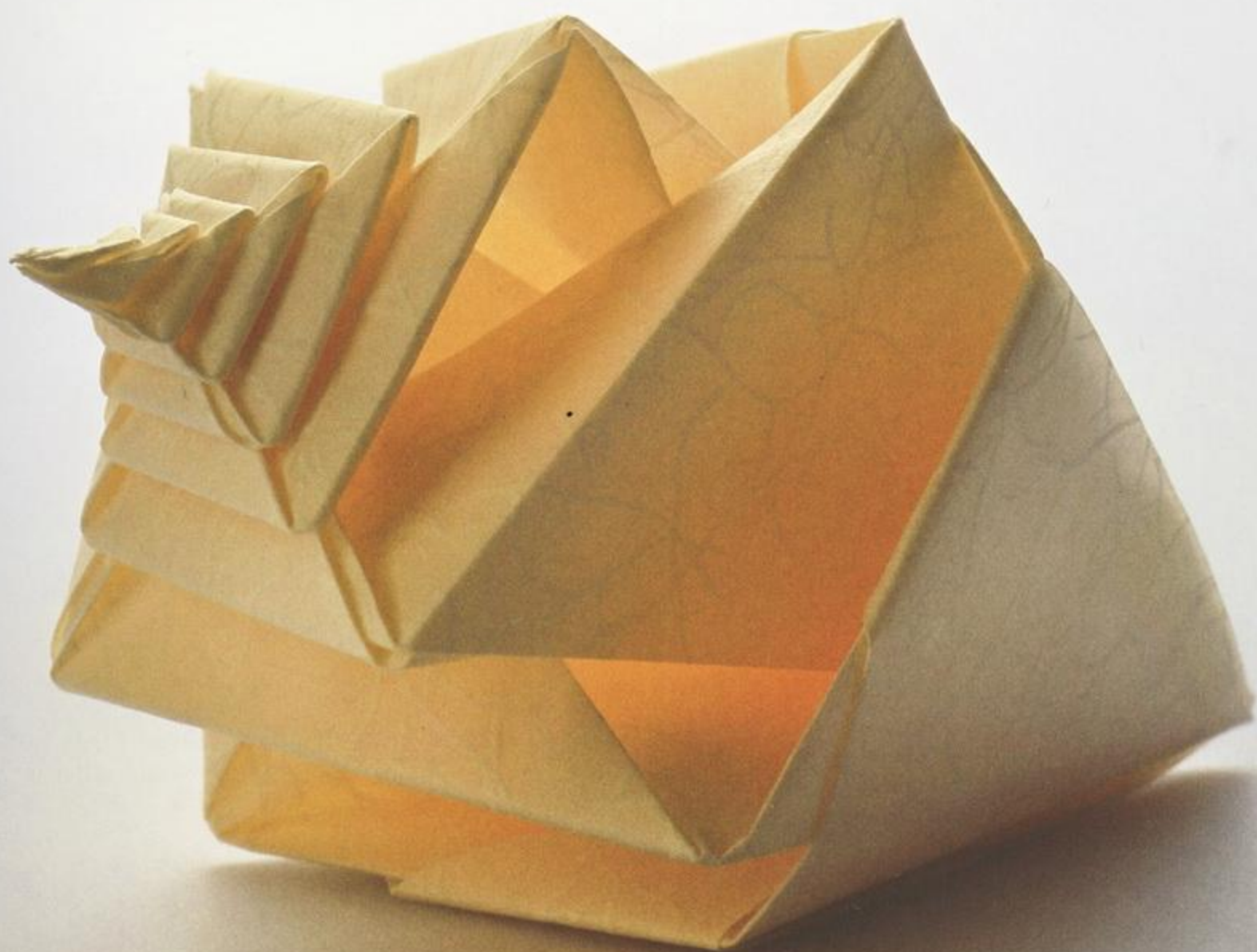


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WHIRLPOOL SPIRALS

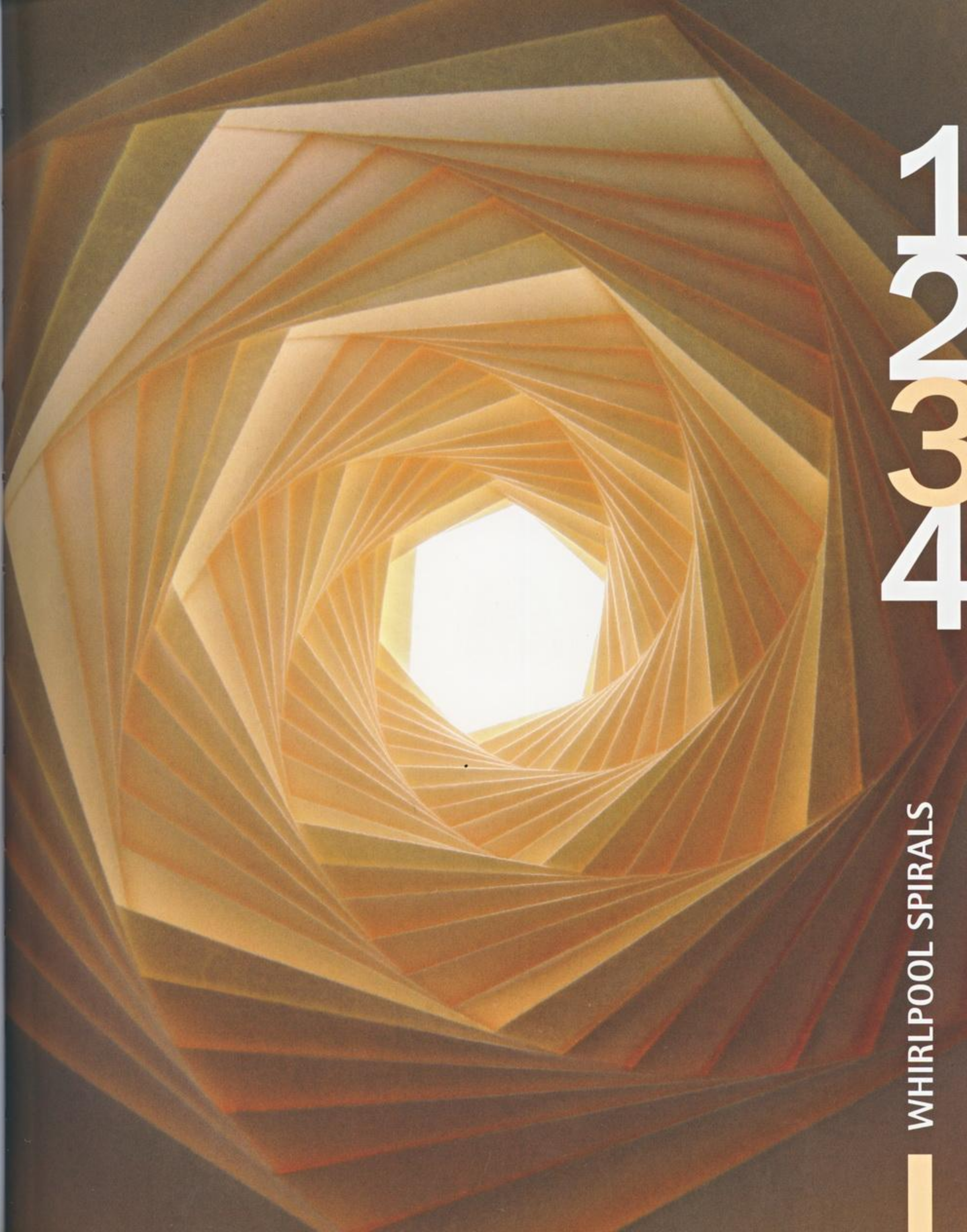
3

Origami is the simplest and most graceful way to understand the world. Tomoko Fuse's whirlpool spirals gently trace the structure of our galaxy, fold by fold. Turn these complex and yet so elementary objects in your hands, and observe the newly-formed space - everything around you will vanish. All that remains is acuteness of mind.

The subject of this chapter is to fold sheets of paper into what I call Whirlpool Spirals: regular polygons such as squares, pentagons, hexagons or other polygons of the same kind, are stacked one on top of another. The spirals are formed as each additional polygon layer reduces in size and rotates in a distinct way. All these spirals have some regularities in common, and that the polygons can be rotated freely in a certain range.

My aim here is to show the *artistic* aspects of these spiral ideas. Professor Taketoshi Nojima has independently developed very similar theories in an *engineering* context.

The concentric polygons, diminishing and rotating rhythmically in successive steps, can be rendered on a two-dimensional plane. When folded with real paper with some thickness, however, some will pile up into towers outlining beautiful spirals, some are akin to rosettes or overlapping leaves of plants, and some remind us of conches. The reverse sides also show beautiful scaled patterns.



WHIRLPOOL SPIRALS

4321

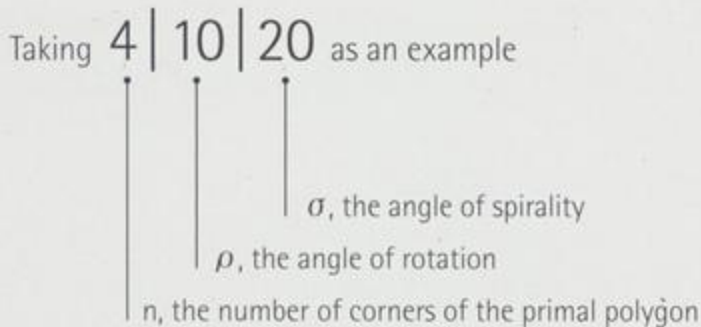
解説



EXPLANATION

OF THE NOTATION AND CONSTRUCTION OF CREASE PATTERNS

Each Whirlpool Spiral is named by a set of three numbers. The first one is the number of corners of a regular polygon called primal polygon. The second number is the angle of rotation ρ (Greek letter rho) and the third number is the angle of spirality σ (Greek letter sigma), let us call them primal angles.



The legend explains the respective meanings.

The crease patterns for the Whirlpool Spirals are constructed in three steps.

In step 1 we choose specific values for the primal angles: the angle of rotation ρ and the angle of spirality σ . The possible values of these angles depend on n , the number of corners of the primal polygon.

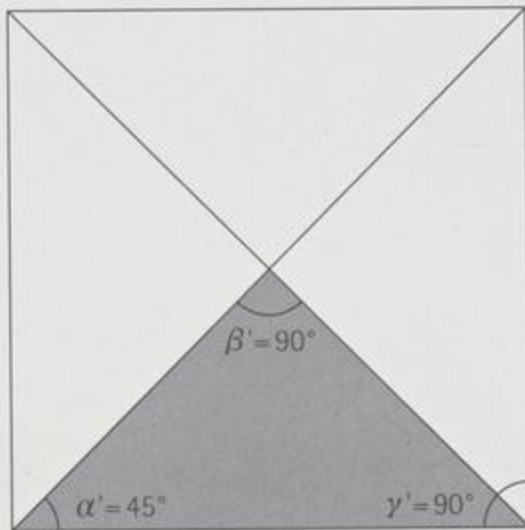
In step 2 we construct a basic triangle with two given angles. The first of these angles is the angle of rotation. The second angle is calculated from the primal angles ρ and σ and a secondary angle α' that is dependent on the primal polygon as shown on the following page.

In step 3 a primal number n (4 in case the primal polygon is a square) of basic triangles are aligned along their long sides while each is tilted at the rotation angle ρ towards the previous triangle. Then copies of the row of triangles are scaled down to fit into the gaps of their preceding row to get the complete crease pattern.

SQUARES

PRIMAL POLYGON AND PRIMAL TRIANGLE

$n=4$



$$\begin{aligned}\beta' &= 360^\circ/n \\ \alpha' &= (180^\circ - \beta')/2 \\ \gamma' &= 2\alpha'\end{aligned}$$

$$0^\circ < \rho \leq \frac{1}{2}\beta' = 45^\circ$$

$$0^\circ < \sigma \leq \alpha' = 45^\circ$$

1. Get the ranges of ρ and σ

The angle of rotation ρ and the angle of spirality σ can be chosen freely within a certain range. The figure shows the primal polygon (a square in this case) divided into the primal number n of isosceles triangles (4 in case of the square). The base and centre angles of these triangles are called α' and β' respectively. The corner angles of the primal polygon are called γ' . The ranges for the angle of rotation ρ and the angle of spirality σ are shown in the figure.

CALCULATE β



angle of rotation $\rho = 10^\circ$

$$\epsilon = 90^\circ + \rho/2 = 95^\circ$$

$$\beta = \epsilon - \alpha' = 95^\circ - 45^\circ = 50^\circ$$



angle of spirality

The basic triangle defines the crease pattern.

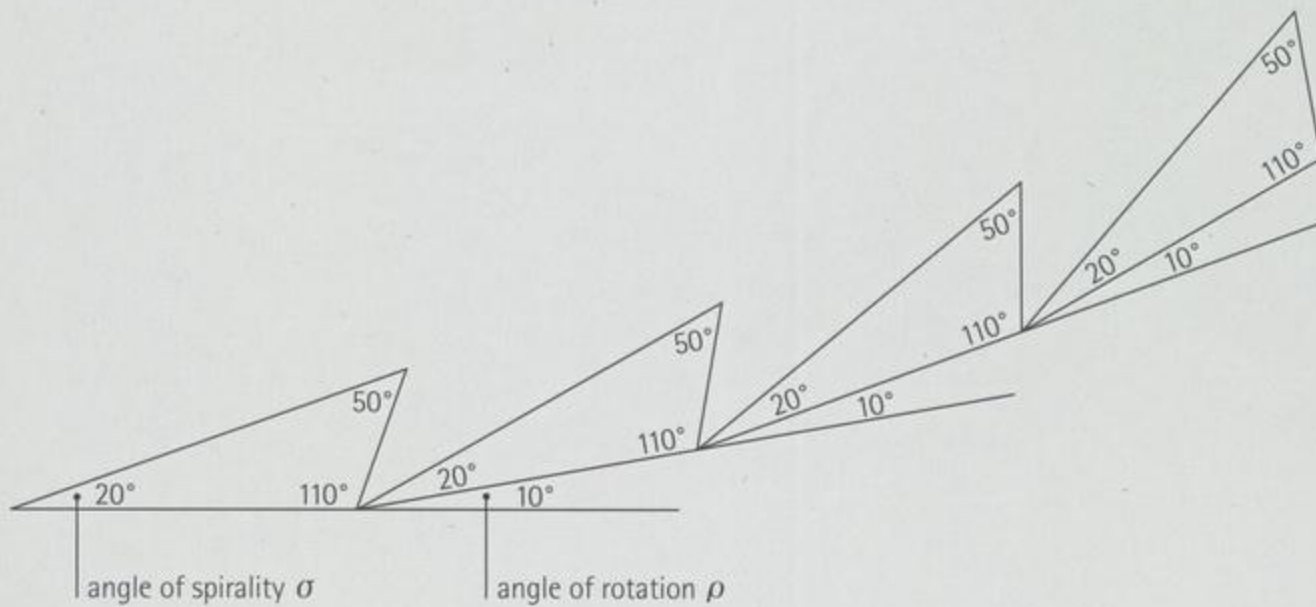
2. Construct the basic triangle

First, choose a value for the angle of rotation ρ . Then calculate the exterior base angle ϵ of an isosceles triangle whose apex angle is ρ .

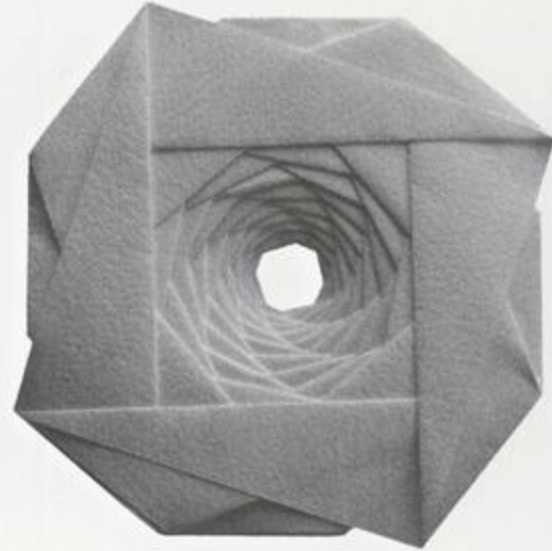
Choose an angle of spirality σ and set it as the first angle of the basic triangle. Get its second angle β by subtracting α' (45° in the squares case) from ϵ . Then its third angle will be $\gamma = 180^\circ - \sigma - \beta$.

3. Construct the crease pattern

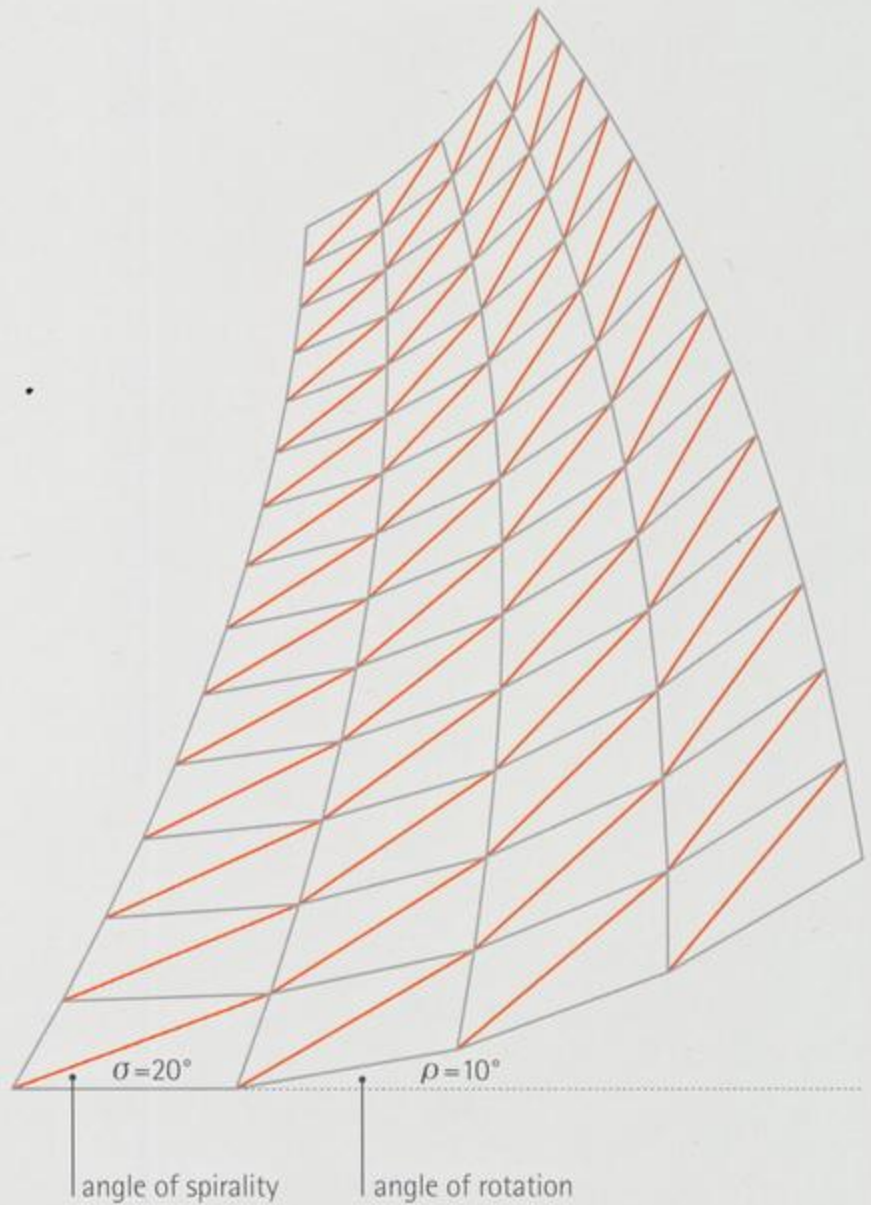
Align $n=4$ basic triangles in a row and tilt each at the angle of rotation ρ towards the previous triangle. Then stack a copy of the chain of triangles on the original row, simultaneously scaling it down and rotating it so that it fits properly on the original row. Repeat this process to get the complete crease pattern.



WHIRLPOOL SPIRAL 4|10|20

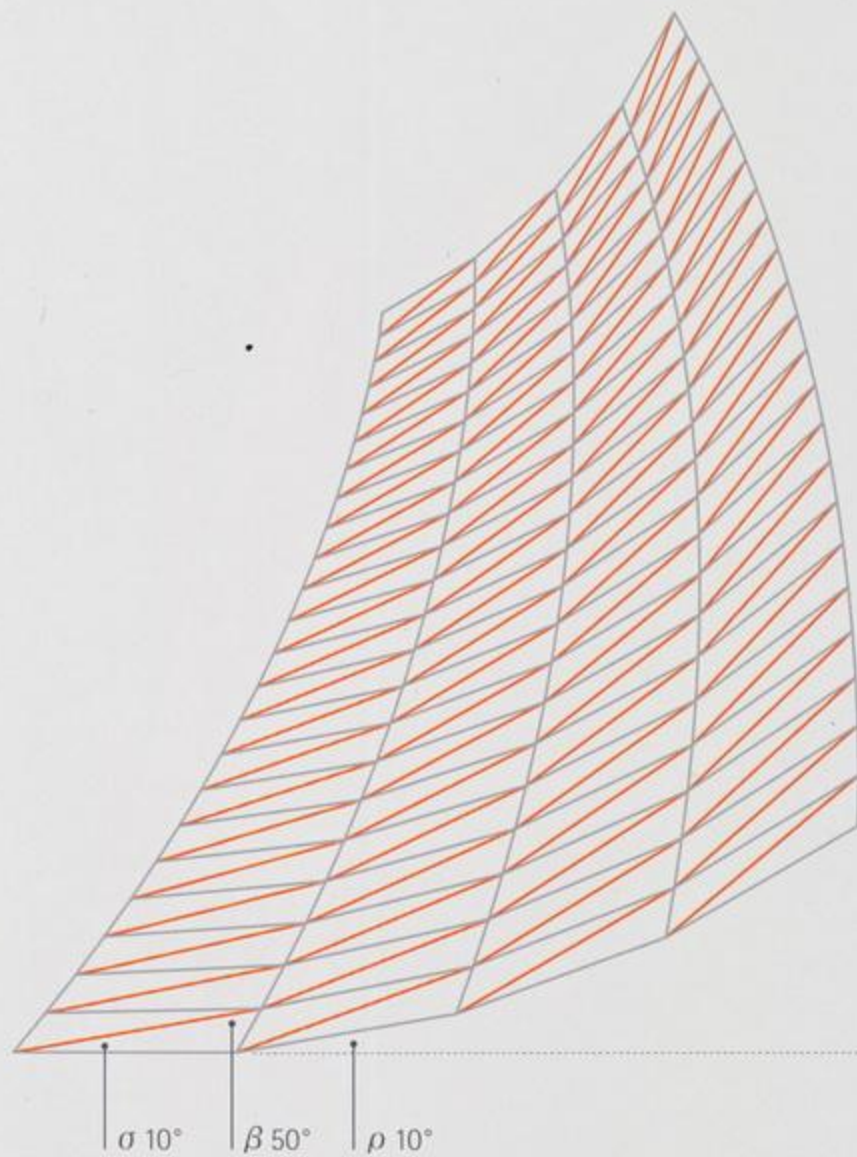


valley fold ———
mountain fold ———

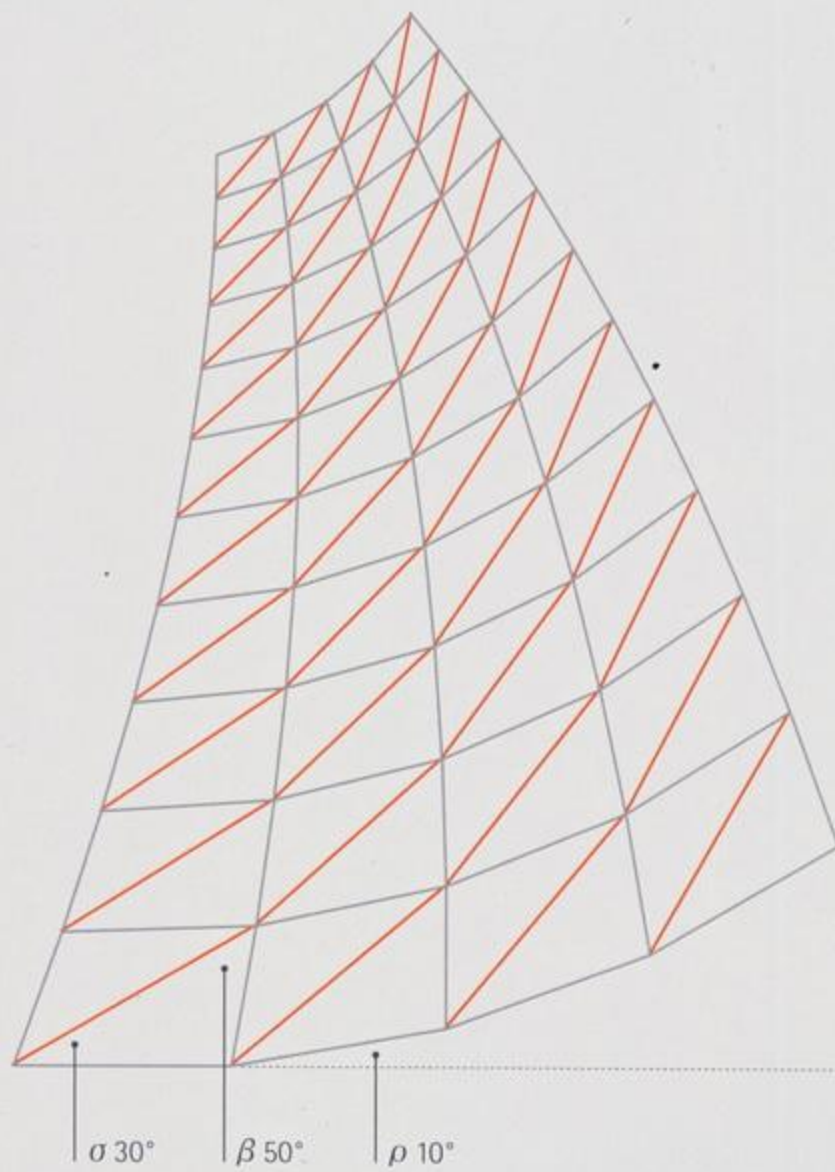
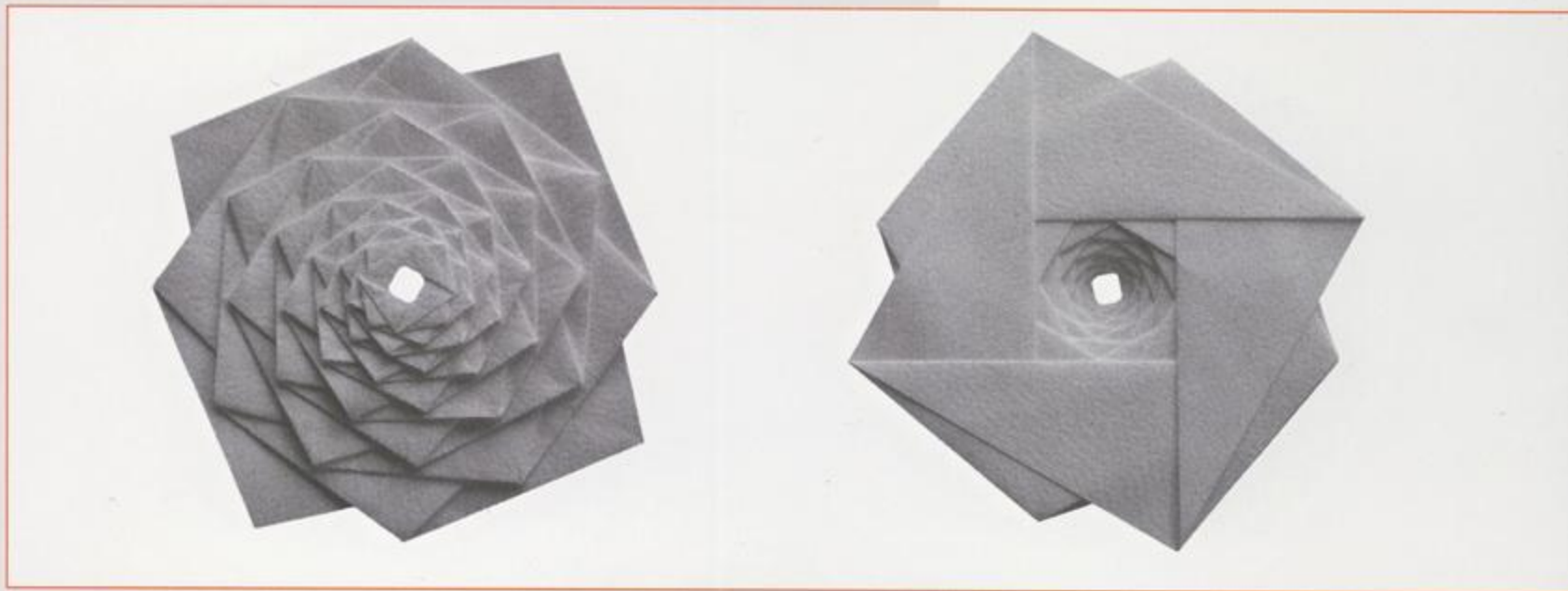




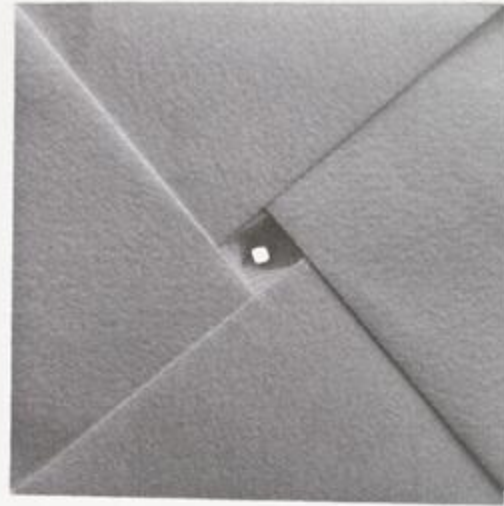
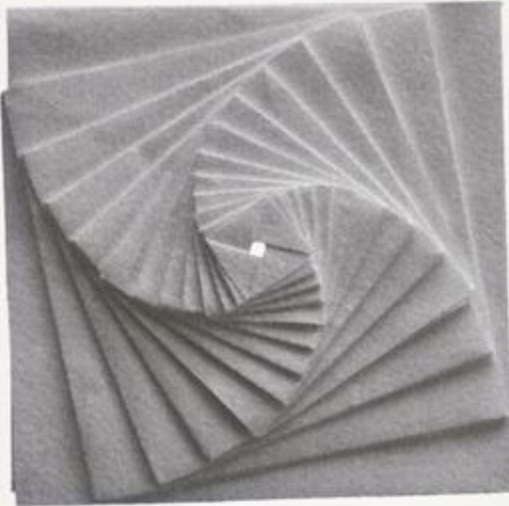
WHIRLPOOL SPIRAL 4|10|10



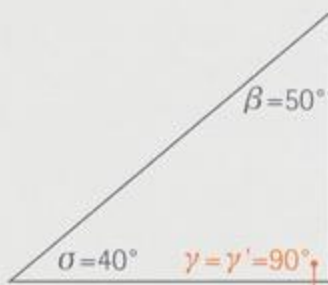
WHIRLPOOL SPIRAL 4|10|30



WHIRLPOOL SPIRAL 4|10|40

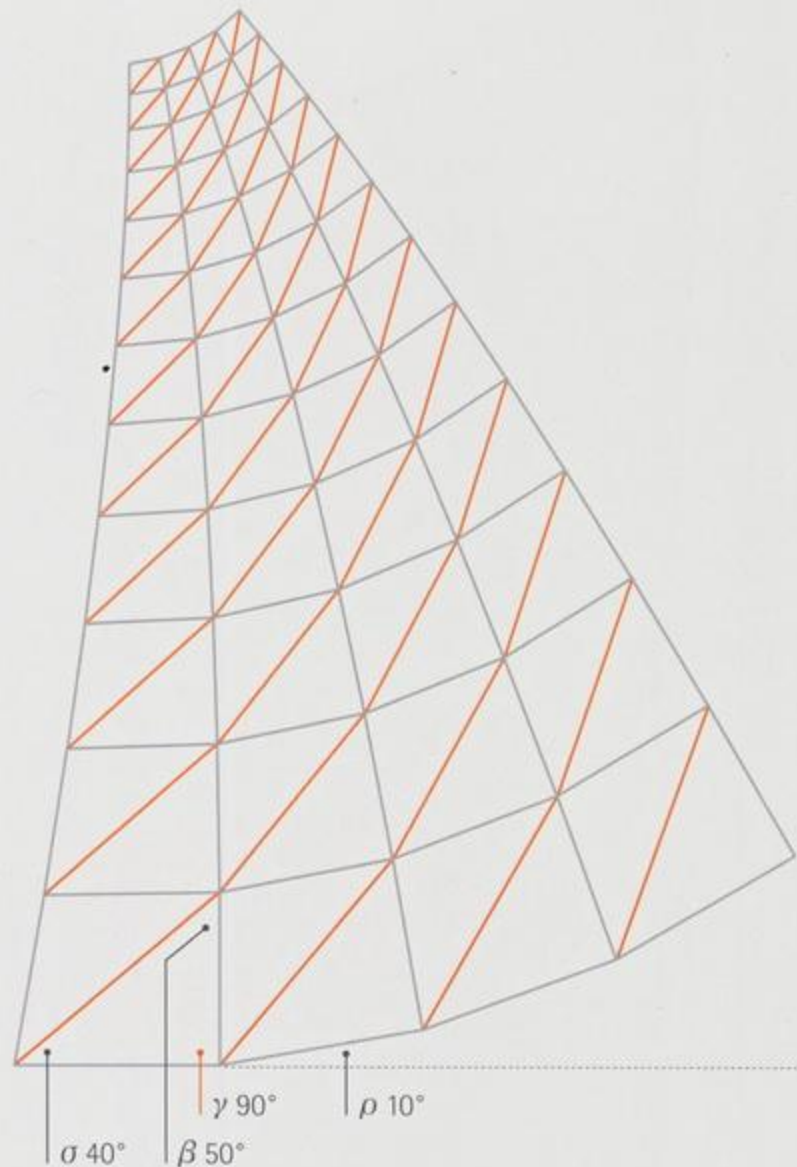


Special case 1

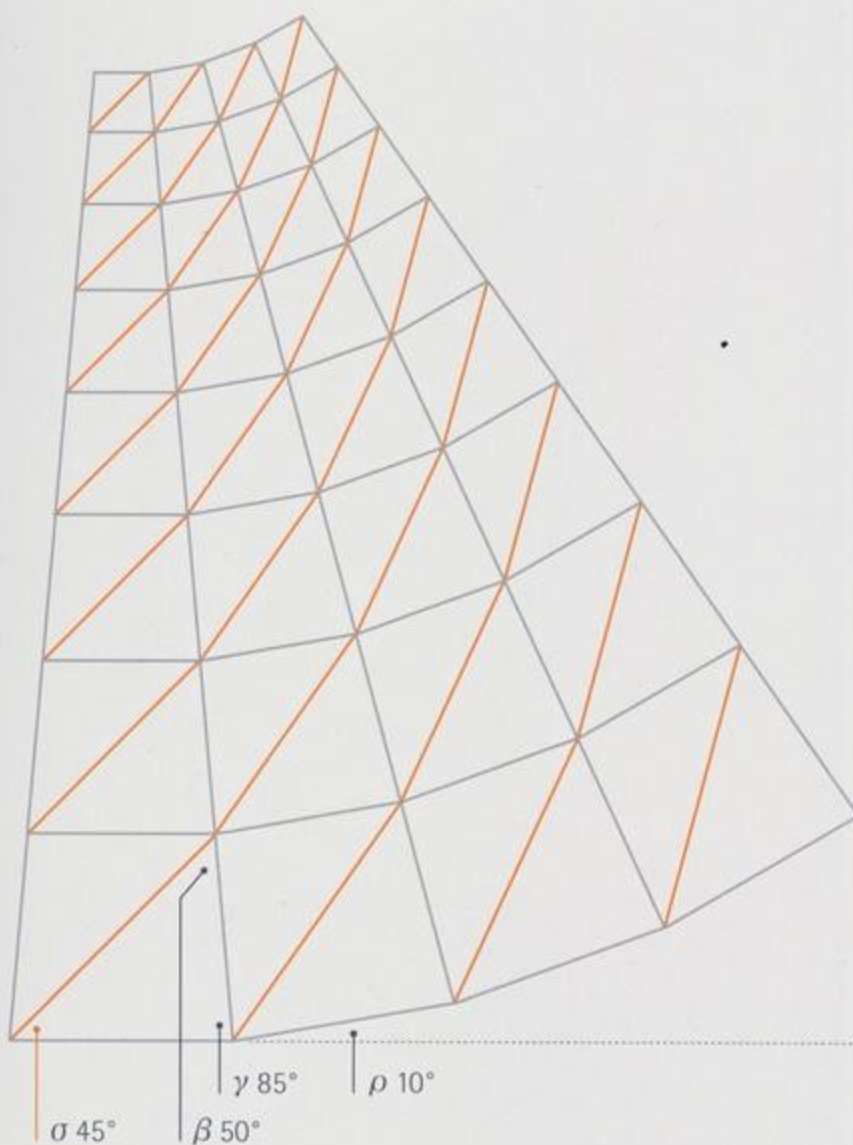


γ is the corner angle of a square

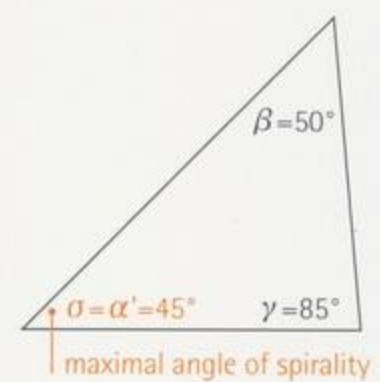
If γ is the corner angle of the primal polygon γ' ($\gamma' = 90^\circ$ in the case of $n = 4$), the corners of the rotating polygons (squares in the case of $n = 4$) align on the edges of the previous polygon (square).



WHIRLPOOL SPIRAL 4|10|45

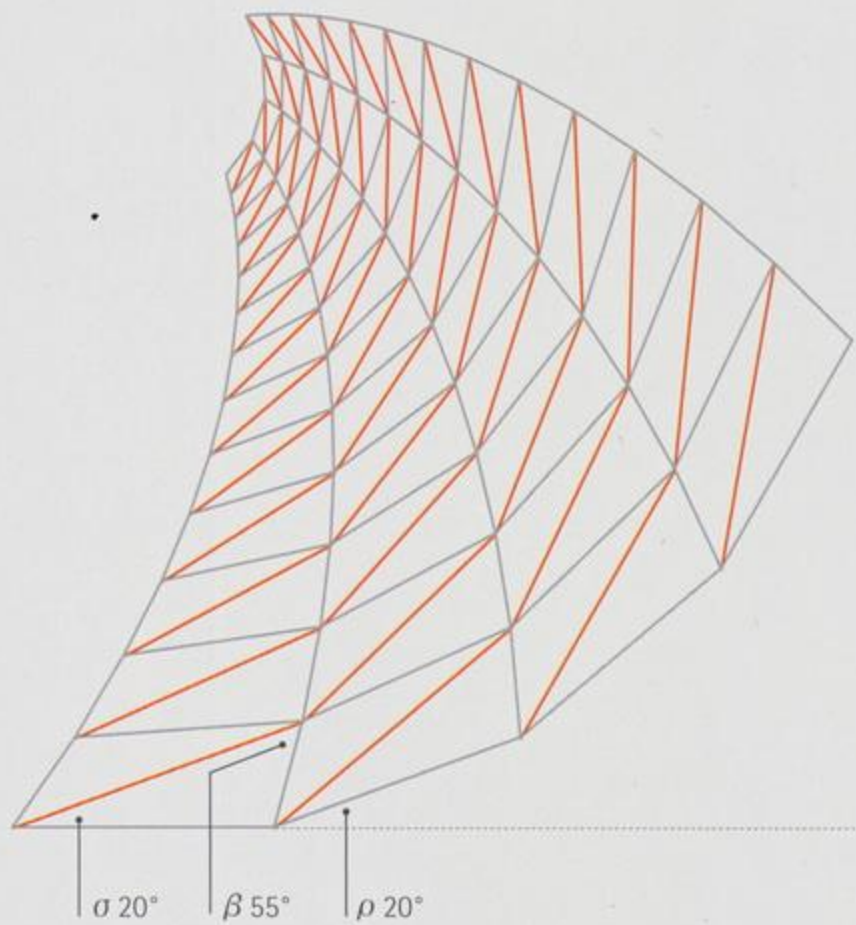
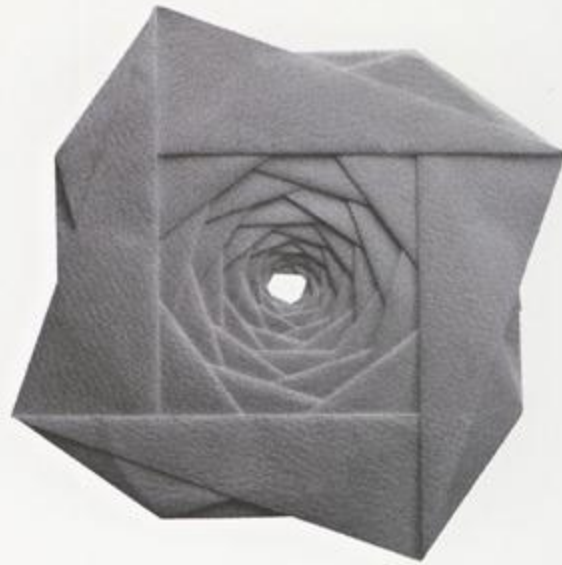


Special case 2

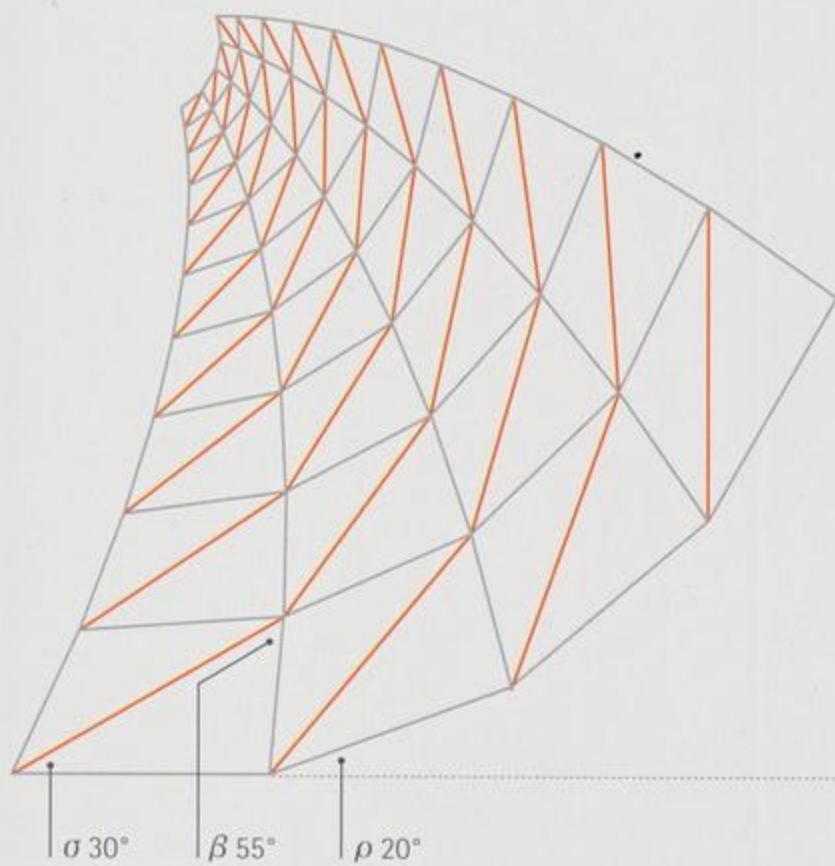
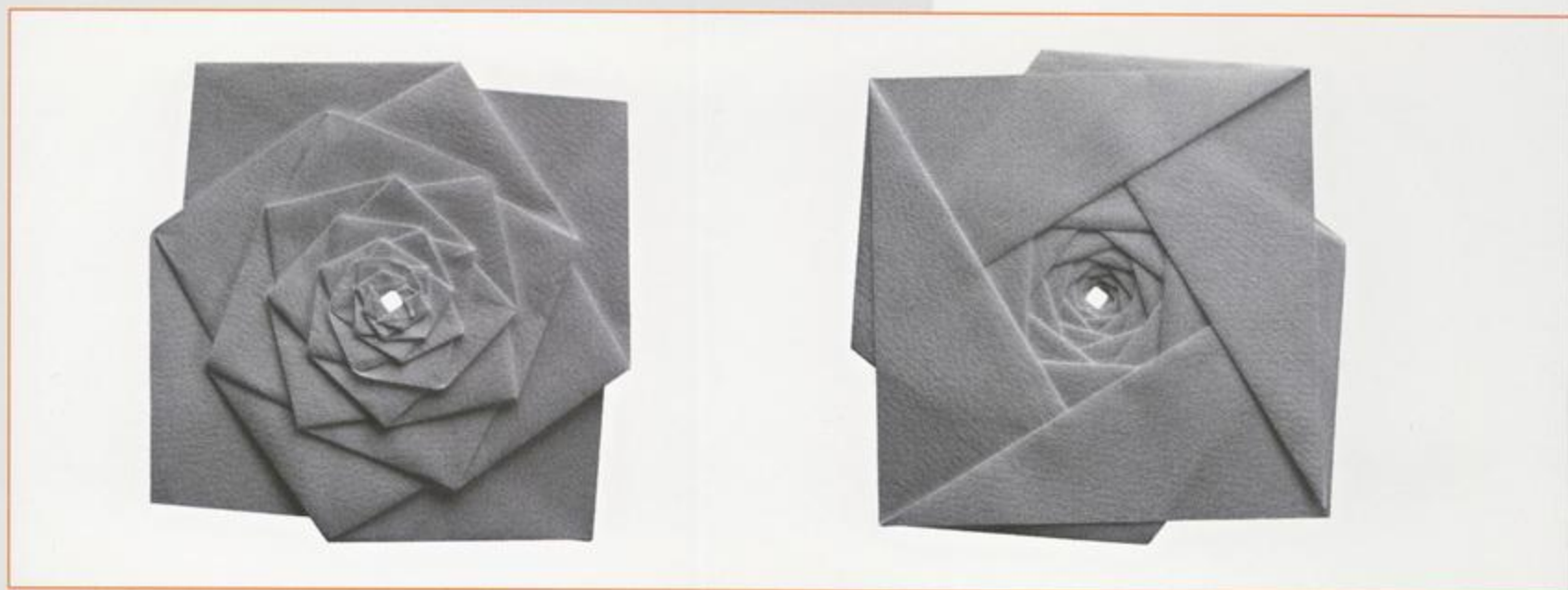


If the angle of spirality is maximal ($\alpha' = 45^\circ$ in the case of $n = 4$), the whirlpool spiral does not have a hole on the reverse side.

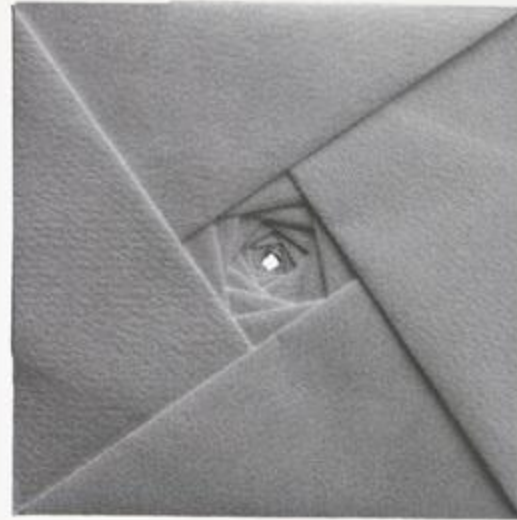
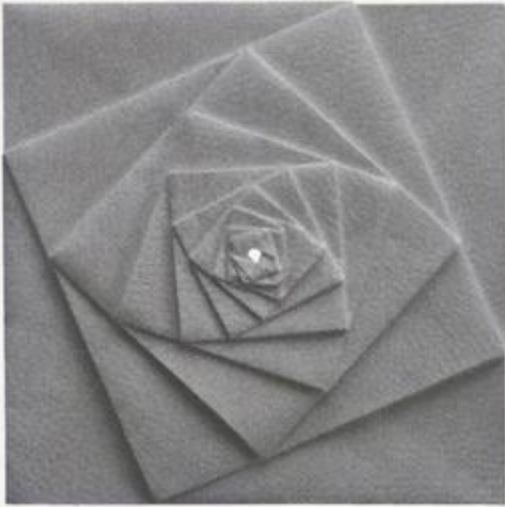
WHIRLPOOL SPIRAL 4|20|20



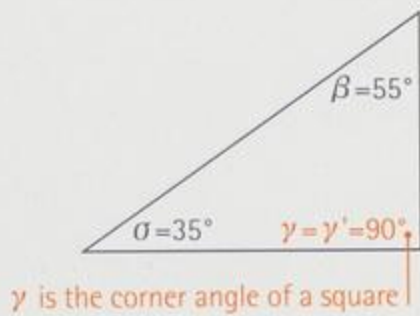
WHIRLPOOL SPIRAL 4|20|30



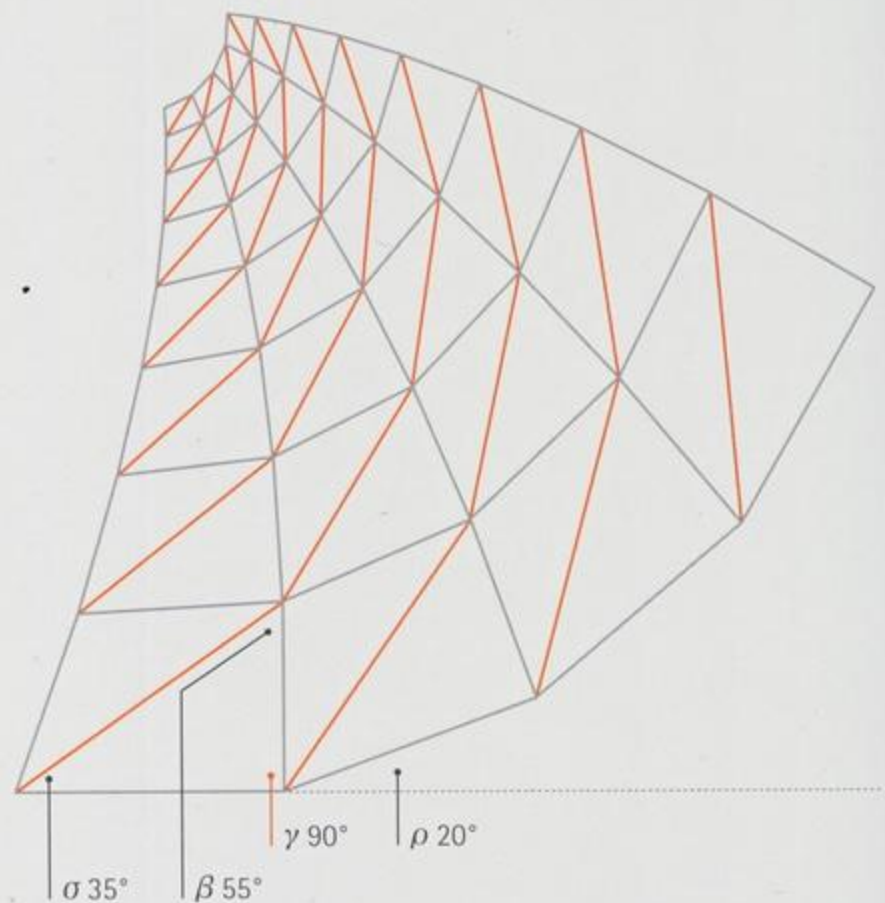
WHIRLPOOL SPIRAL 4|20|35



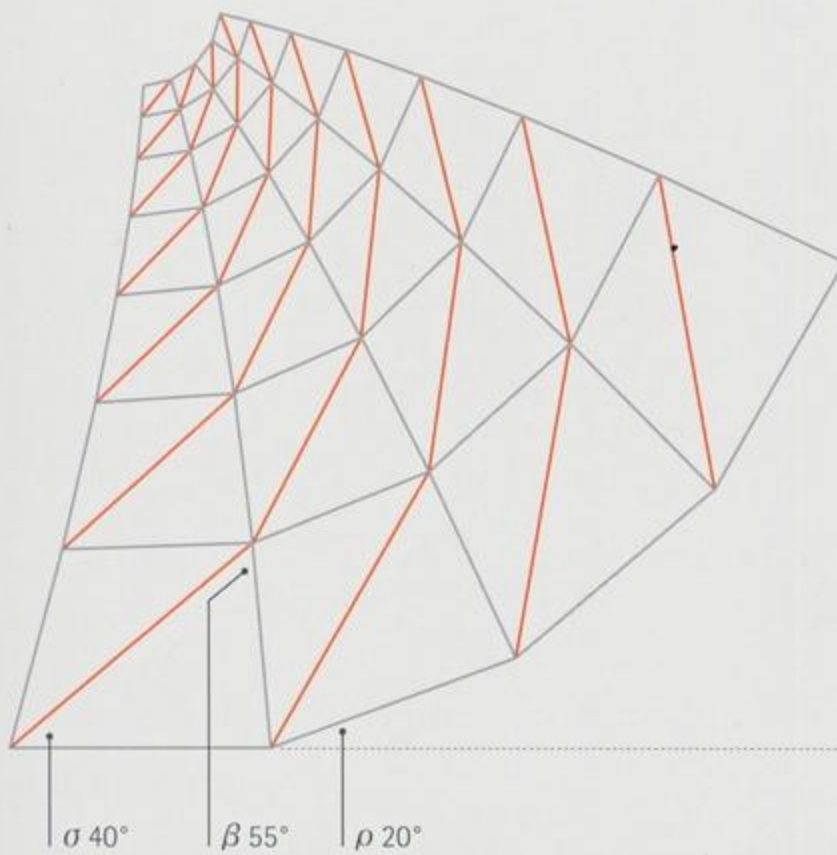
Special case 1



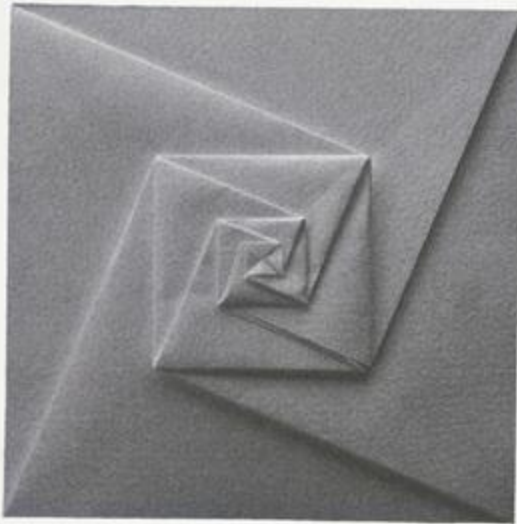
This is another example of special case 1 in the $4|x|x$ family.



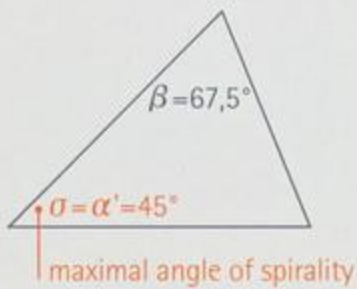
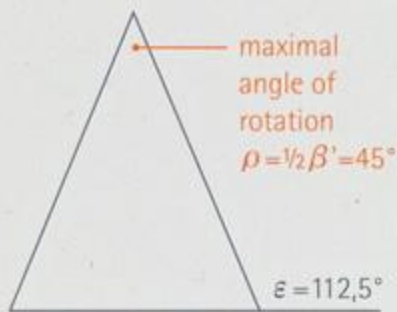
WHIRLPOOL SPIRAL 4|20|40



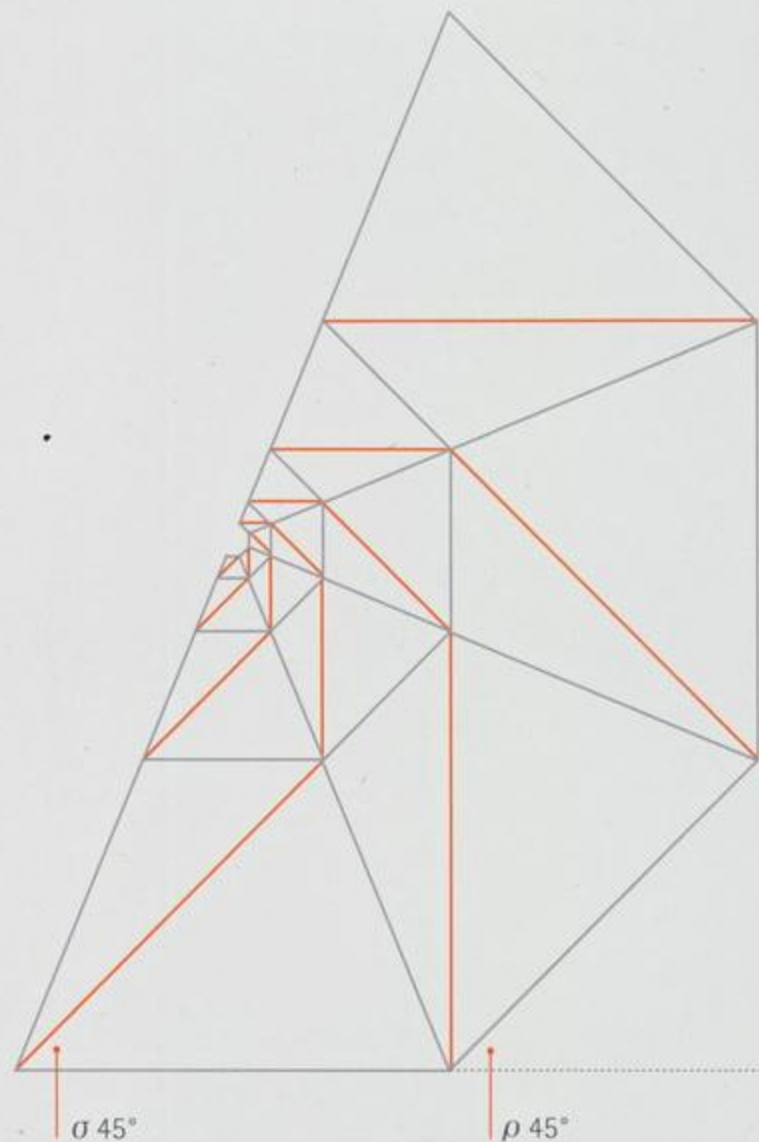
WHIRLPOOL SPIRAL 4|45|45

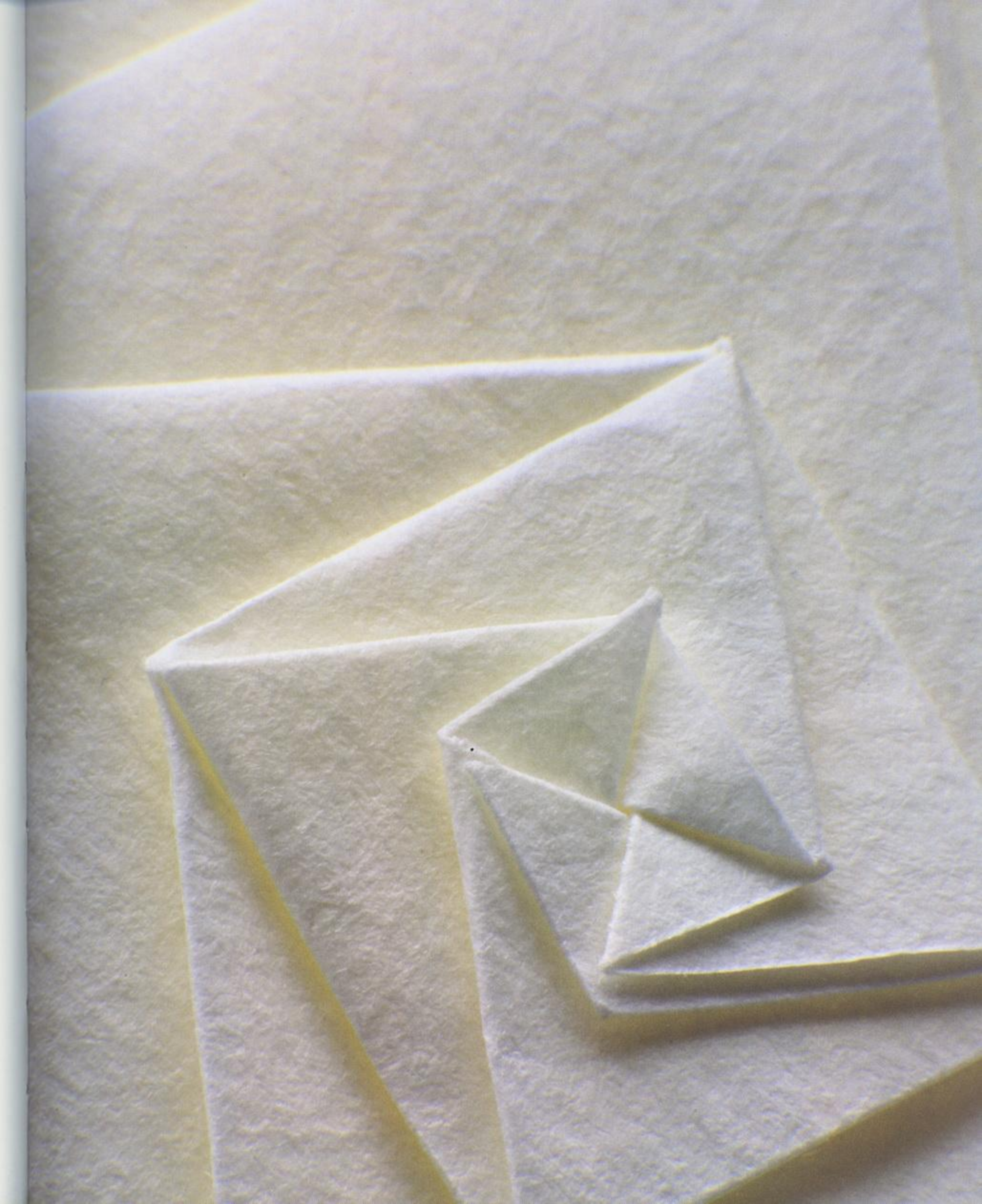


Special case 3



If both the angle of rotation ρ and the angle of spirality σ are maximal, the sides of the crease pattern are straight lines that form a 180° angle. Consecutive primal polygons (squares in the case of $n=4$) also rotate 180° .

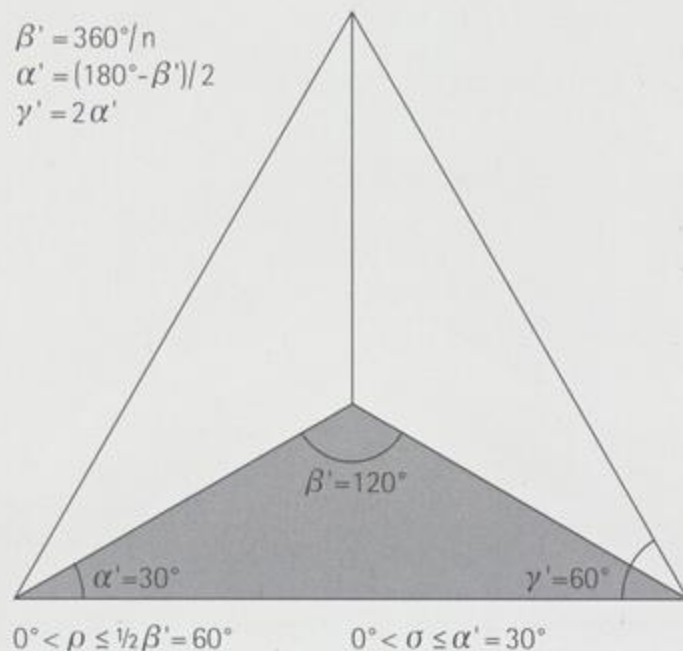




PRIMAL POLYGON AND PRIMAL TRIANGLE

$n=3$

$$\begin{aligned}\beta' &= 360^\circ/n \\ \alpha' &= (180^\circ - \beta')/2 \\ \gamma' &= 2\alpha'\end{aligned}$$



TRIANGLES

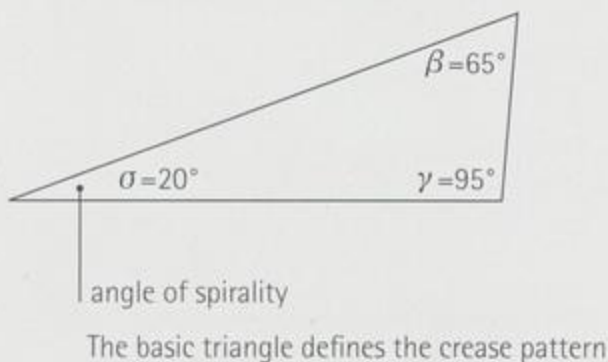
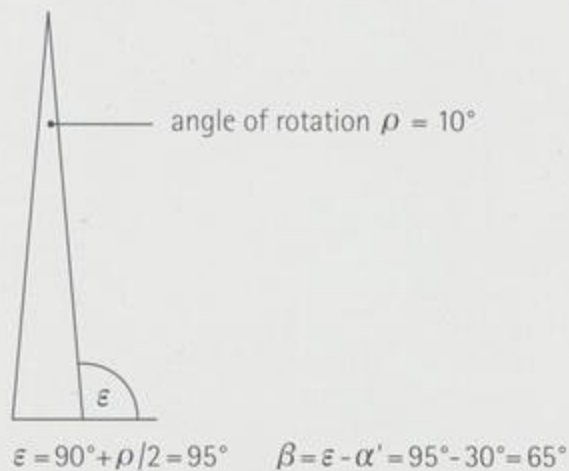
1. Get the ranges of ρ and σ

The figure shows the primal polygon for the $n=3$ case and the angles α' , β' and γ' derived from it. The ranges for ρ , the angle of rotation and σ , the angle of spirality are also shown.

2. Construct the basic triangle

Choose a value for ρ and calculate β by subtracting $\alpha' = 30^\circ$ from the exterior angle $\epsilon = 95^\circ$ of the base of an isosceles triangle whose apex angle is ρ . Set the angle of spirality σ as the first and β as the second angle of the basic triangle.

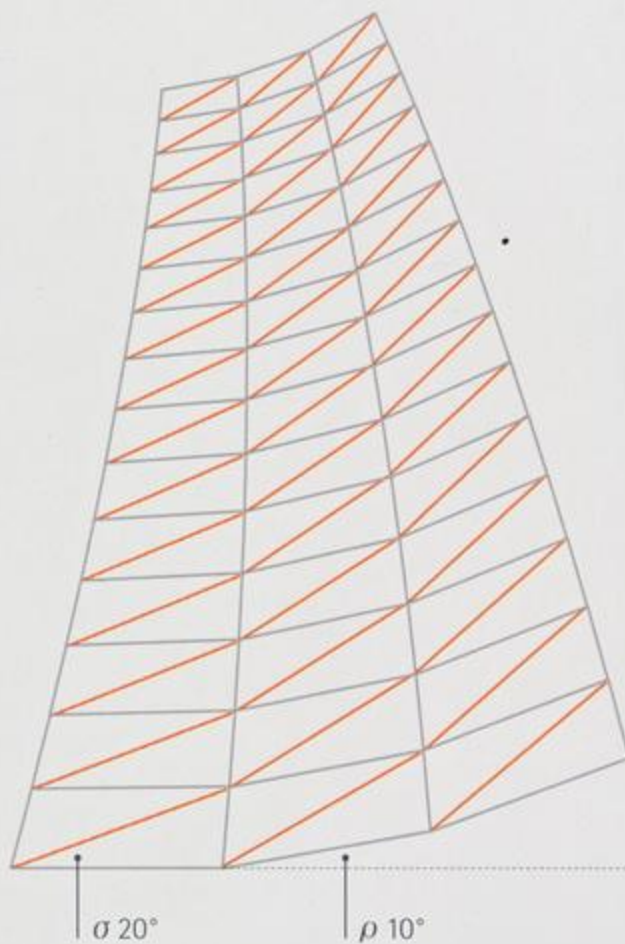
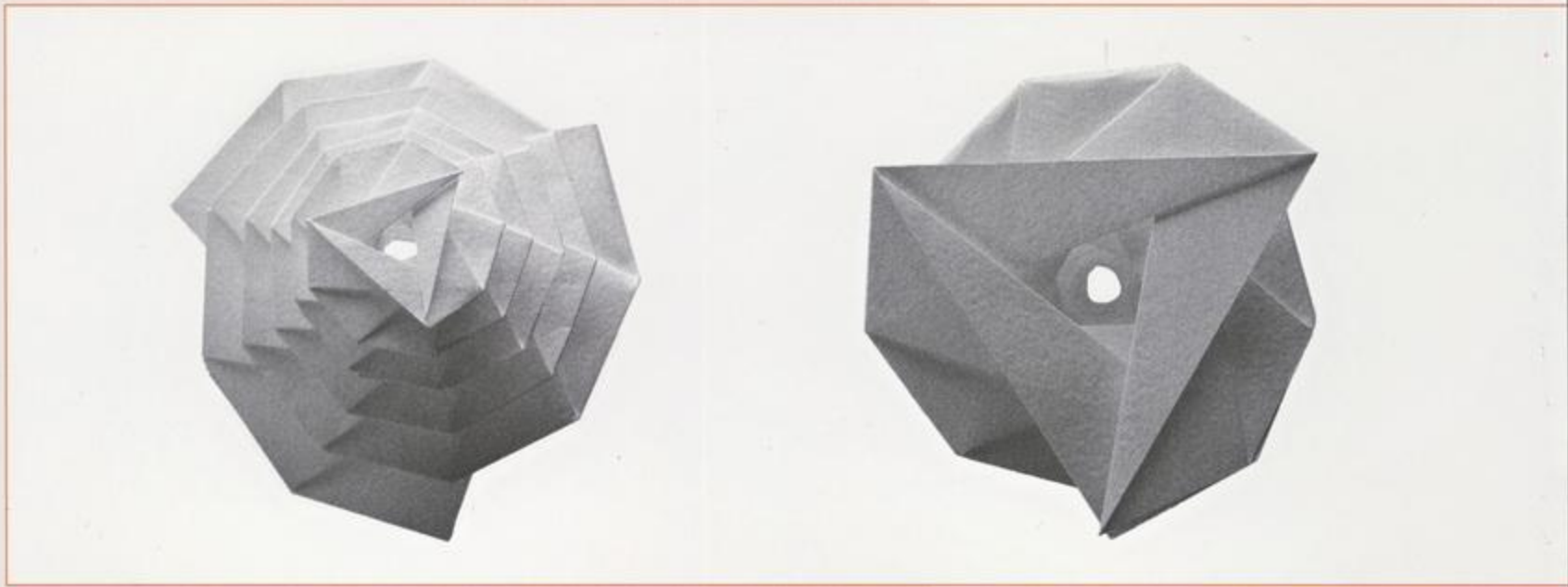
CALCULATE β



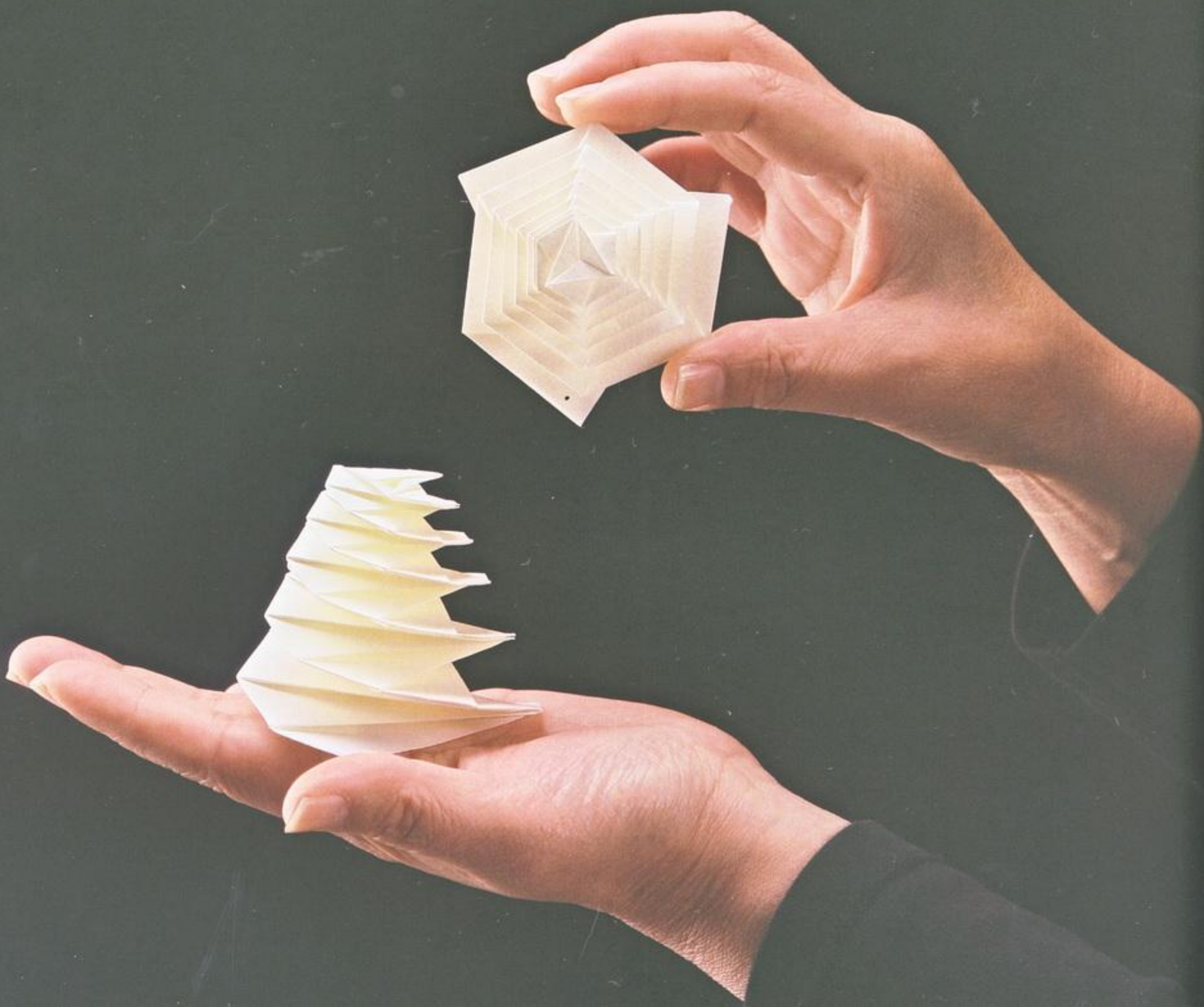
3. Construct the crease pattern

Align $n=3$ basic triangles in a row and tilt each at the angle of rotation ρ towards the previous triangle. Then scale down the chain of triangles and stack it on the original row. Repeat the process of scaling down and stacking to get the complete crease pattern.

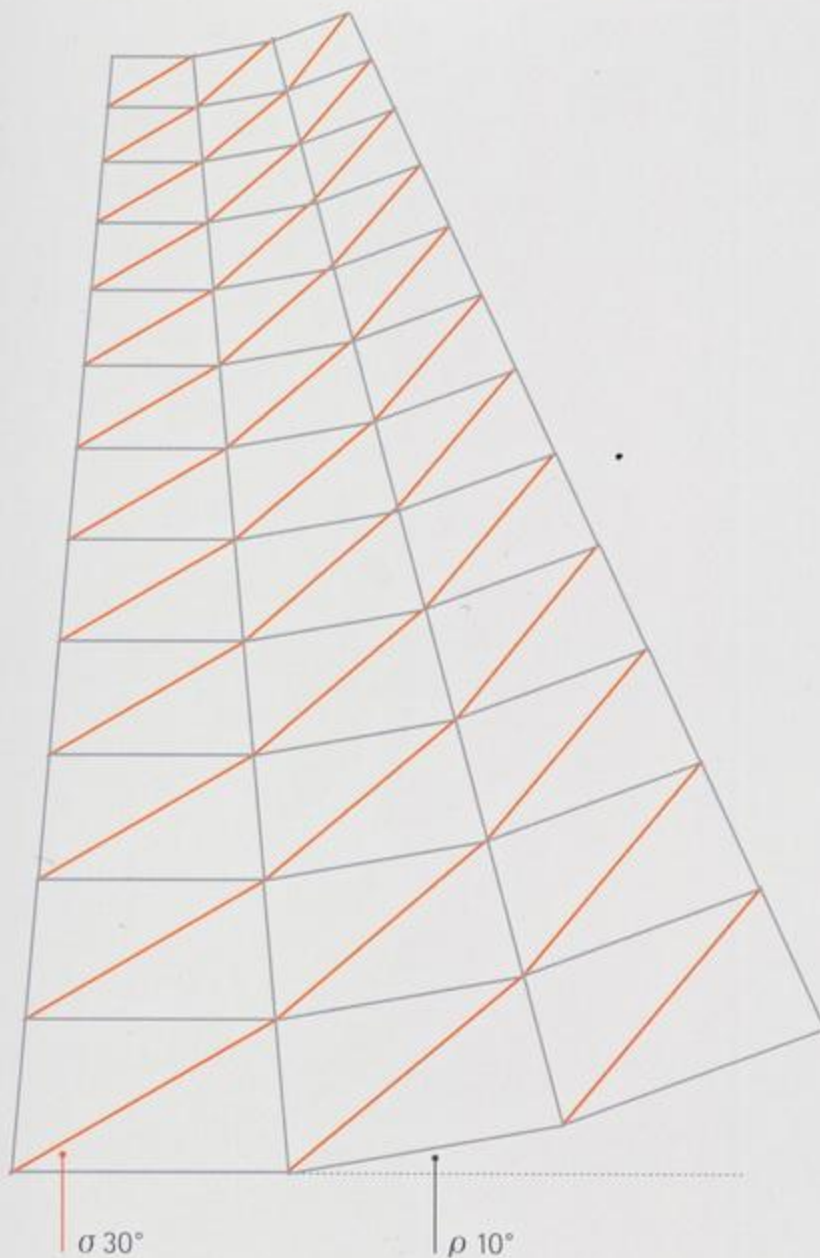
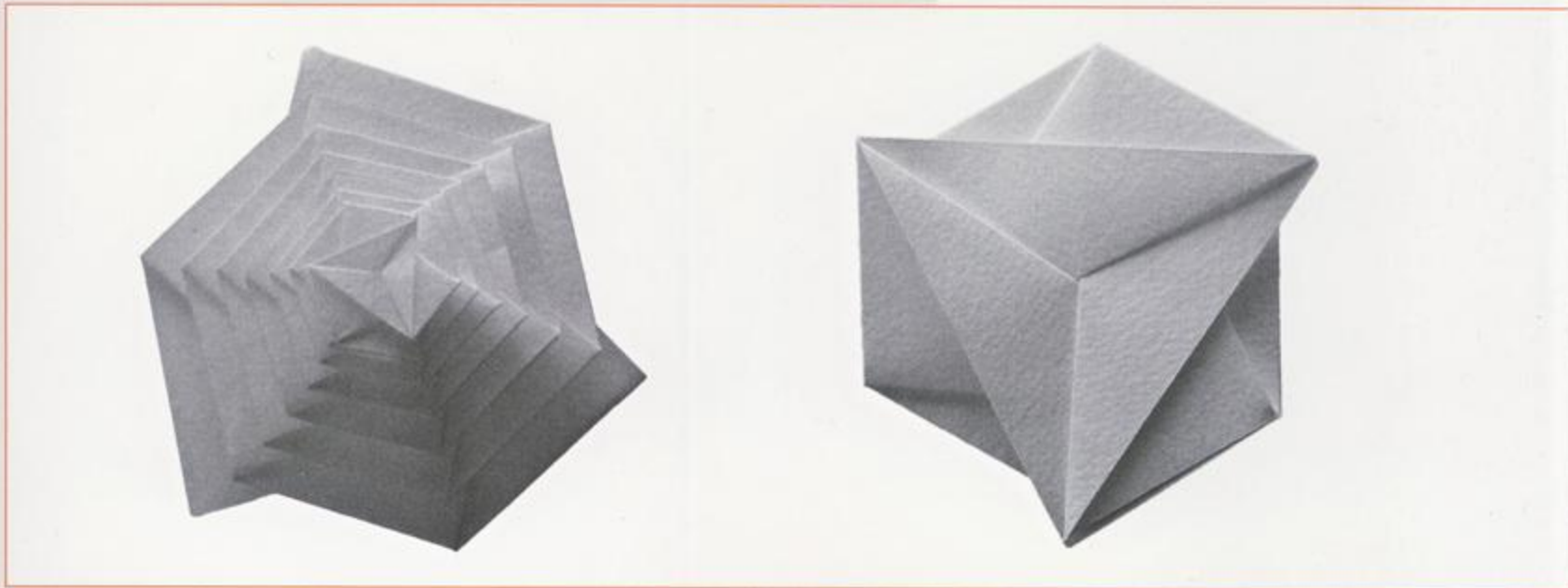
WHIRLPOOL SPIRAL 3|10|20



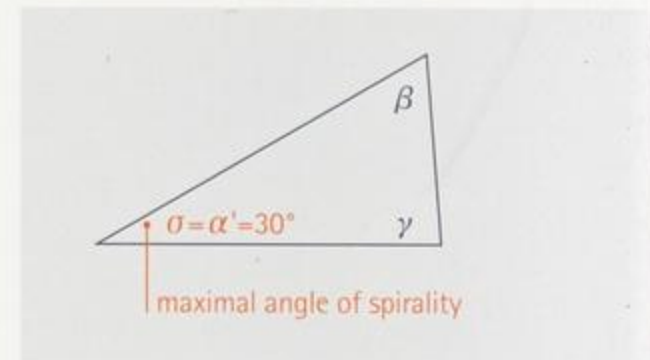
valley fold ———
mountain fold ———



WHIRLPOOL SPIRAL 3|10|30

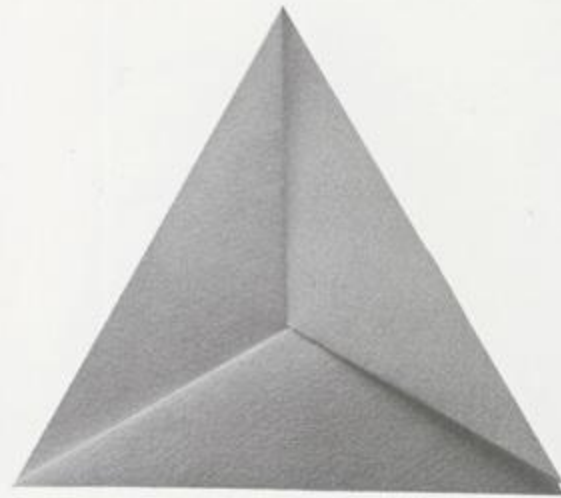
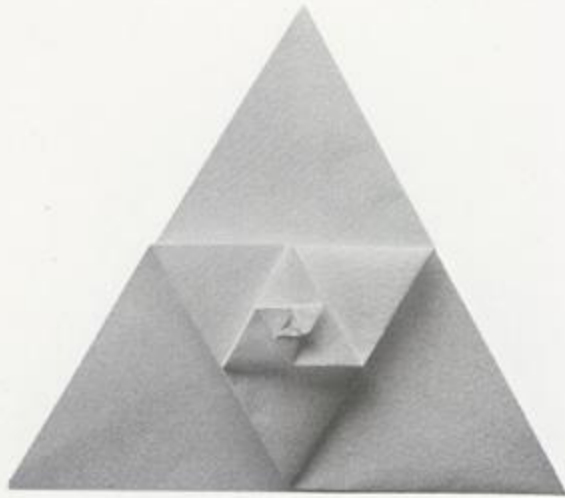


Special case 2

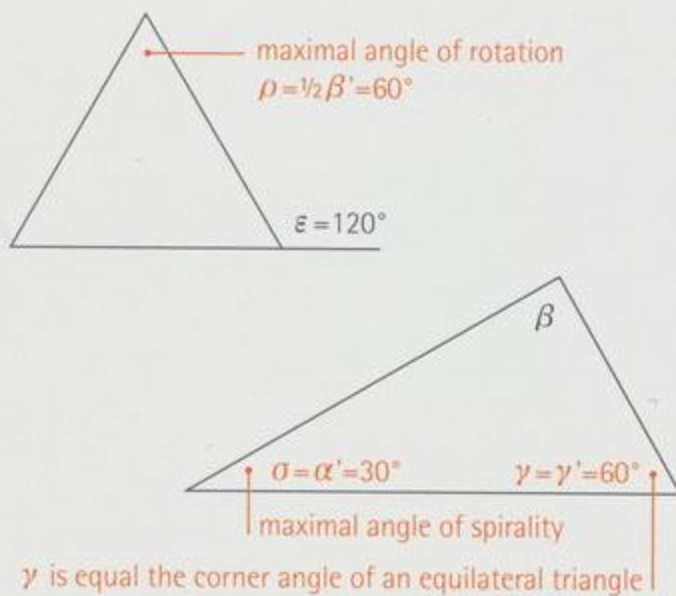


If the angle of spirality is maximal ($\alpha' = 30^\circ$ in the case of $n=3$), the whirlpool spiral does not have a hole on the reverse side.

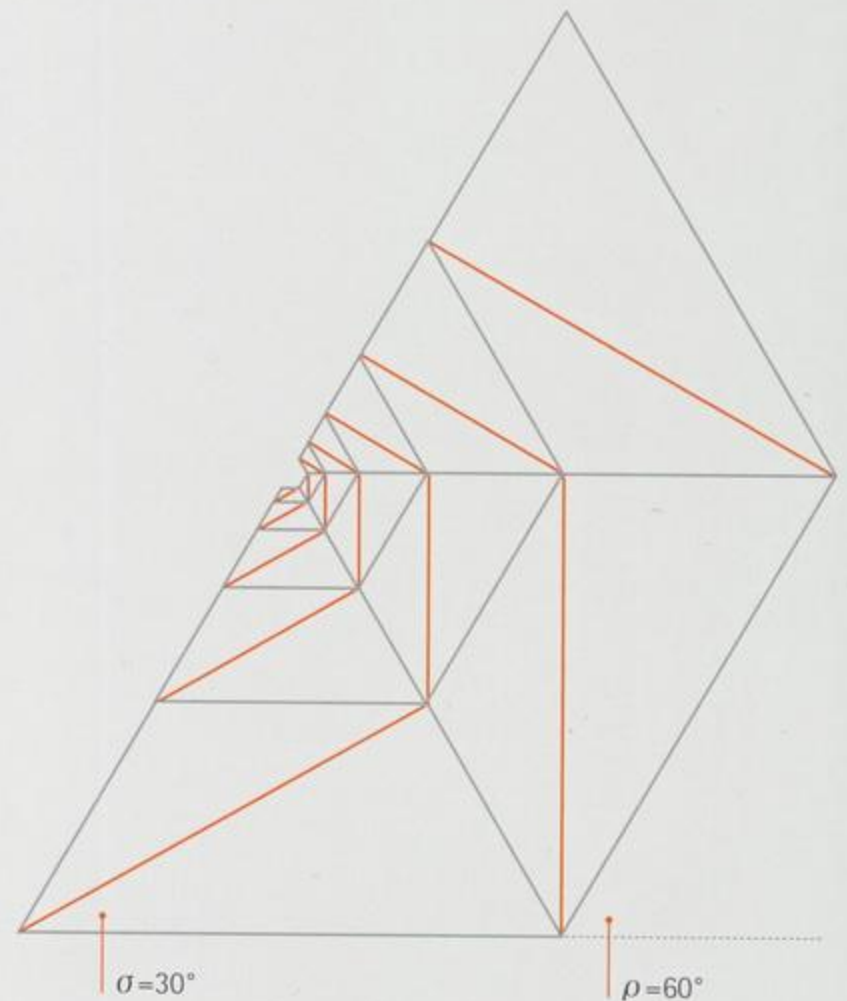
WHIRLPOOL SPIRAL 3|60|30

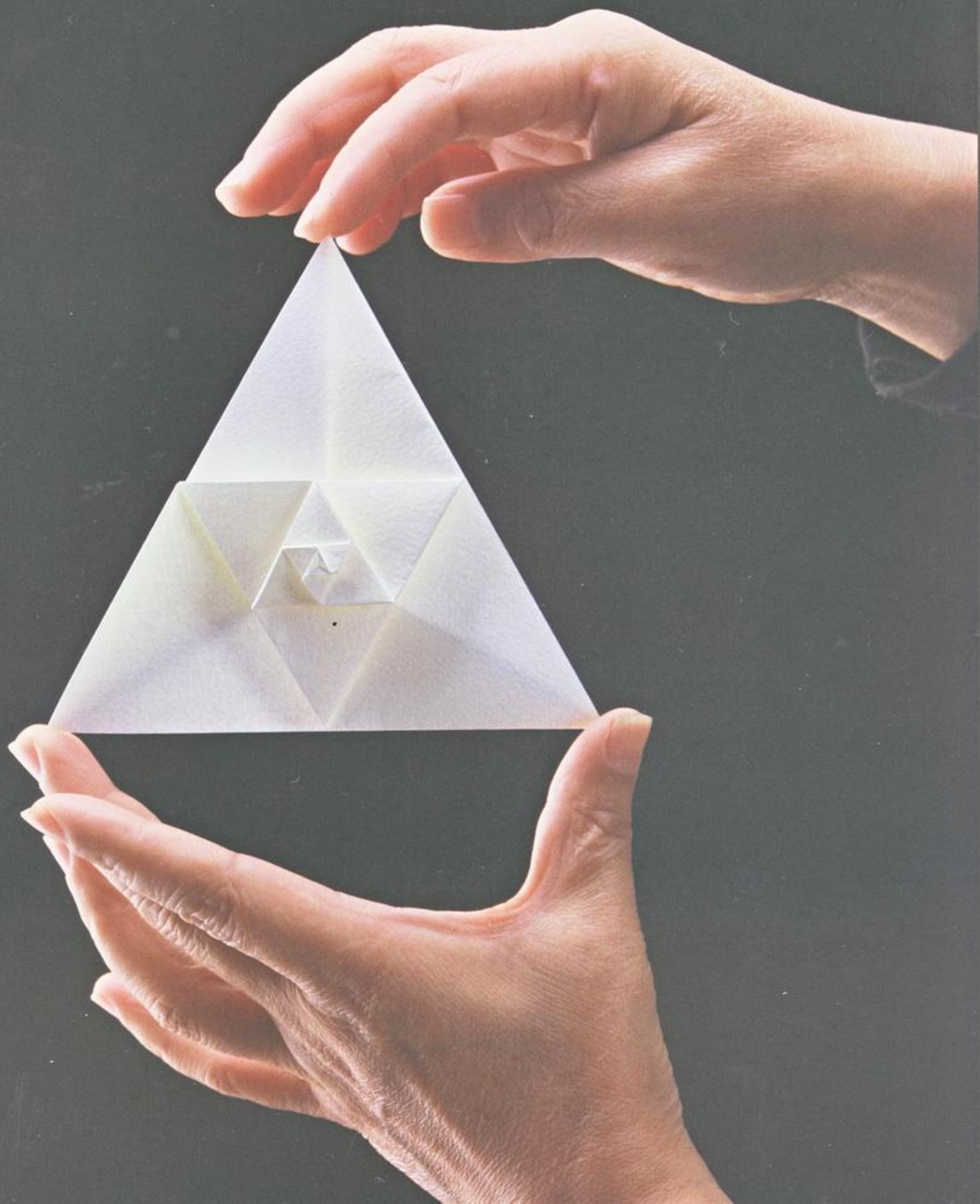


Special case 1,2,3

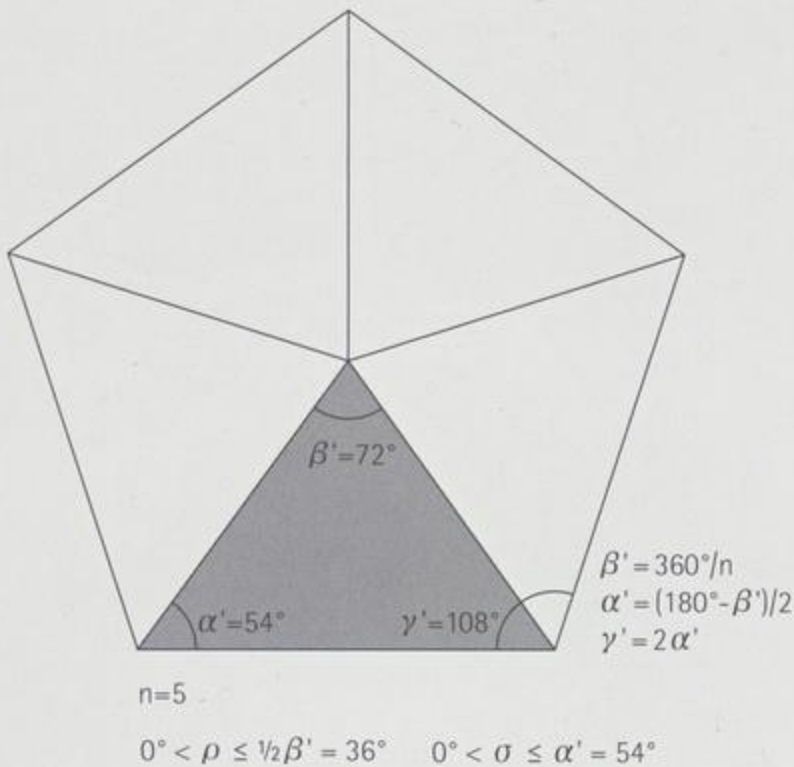


As $\gamma = \gamma'$, the spiralling triangles align on the edges of the previous triangle (SC1). Because $\sigma = \alpha'$ there is no hole at the reverse side (SC2). Because σ and ρ are maximal, the sides of the crease pattern are straight lines that form a 180° angle. Consecutive triangles also rotate 180° (SC3).





PENTAGONS



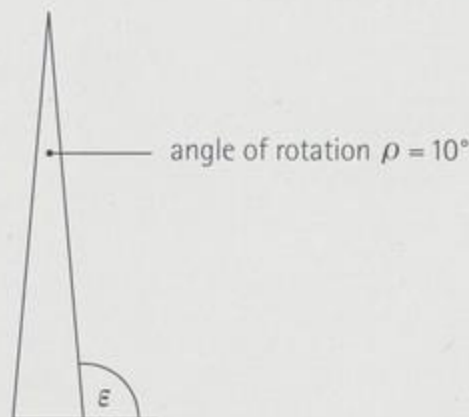
1. Get the ranges of ρ and σ

The figure shows the ranges for ρ , the angle of rotation and σ , the angle of spirality as well as the underlying angles α' , β' and γ' derived from the primal polygon for the $n=5$ cases.

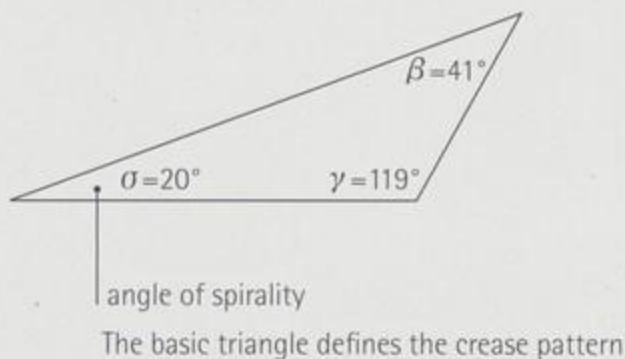
2. Construct the basic triangle

Choose a value for ρ , the angle of rotation and calculate β by subtracting $\alpha' = 54^\circ$ from the exterior angle $\varepsilon = 95^\circ$ of the base of an isosceles triangle whose apex angle is ρ . Set the angle of spirality σ as the first and β as the second angle of the basic triangle.

CALCULATE β



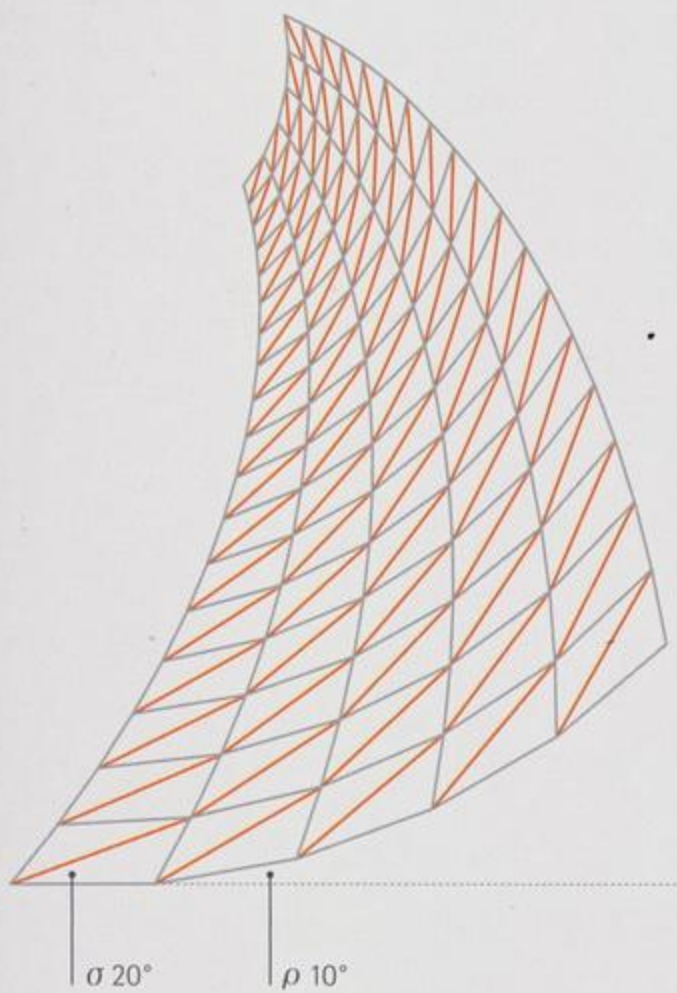
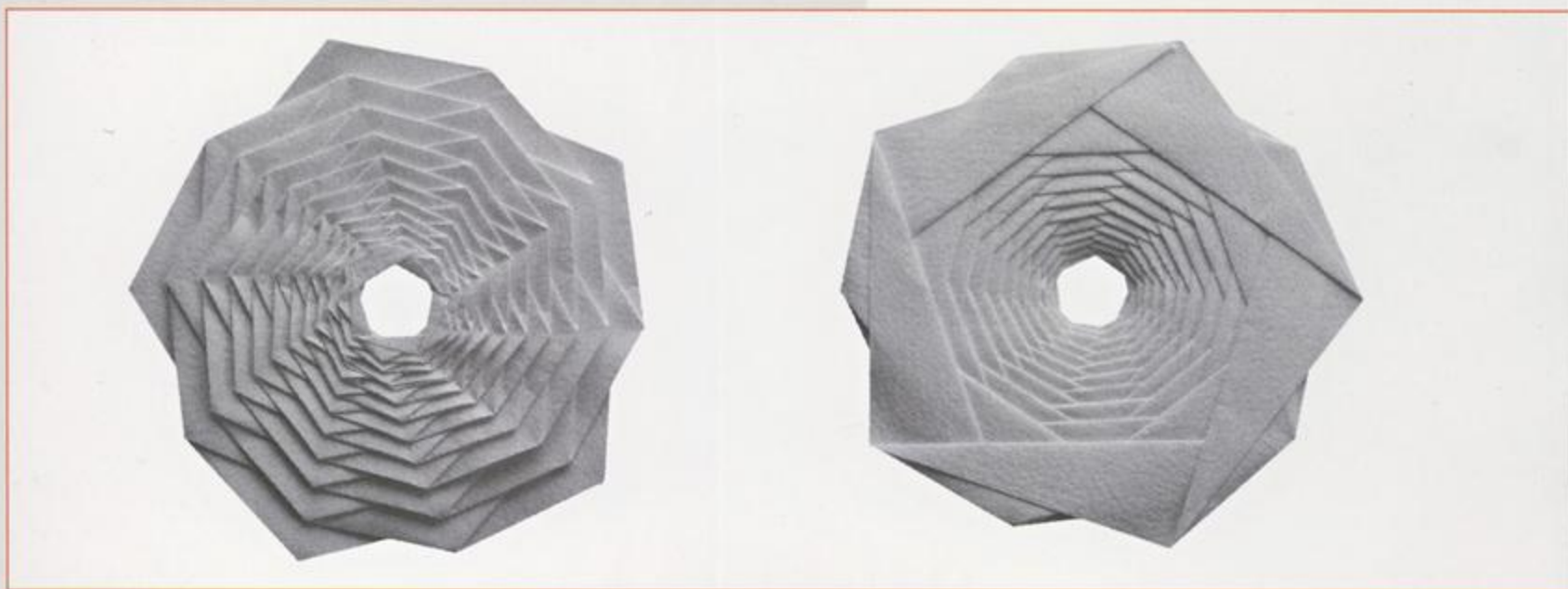
$$\varepsilon = 90^\circ + \rho/2 = 95^\circ \quad \beta = \varepsilon - \alpha' = 95^\circ - 54^\circ = 41^\circ$$



3. Construct the crease pattern

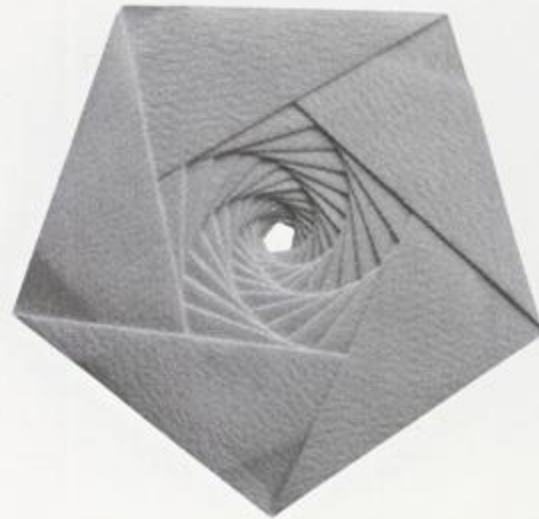
Align $n=5$ basic triangles in a row and tilt each at the angle of rotation ρ towards the previous triangle. Then scale down the chain of triangles and stack it on the original row. Repeat the process of scaling down and stacking to get the complete crease pattern.

WHIRLPOOL SPIRAL 5|10|20

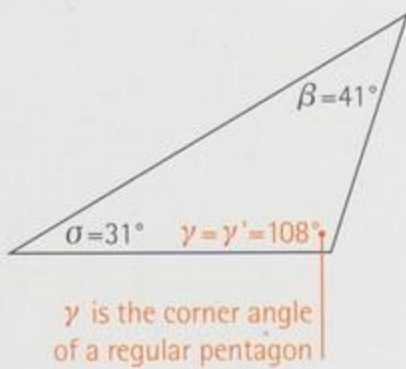


valley fold ———
mountain fold ———

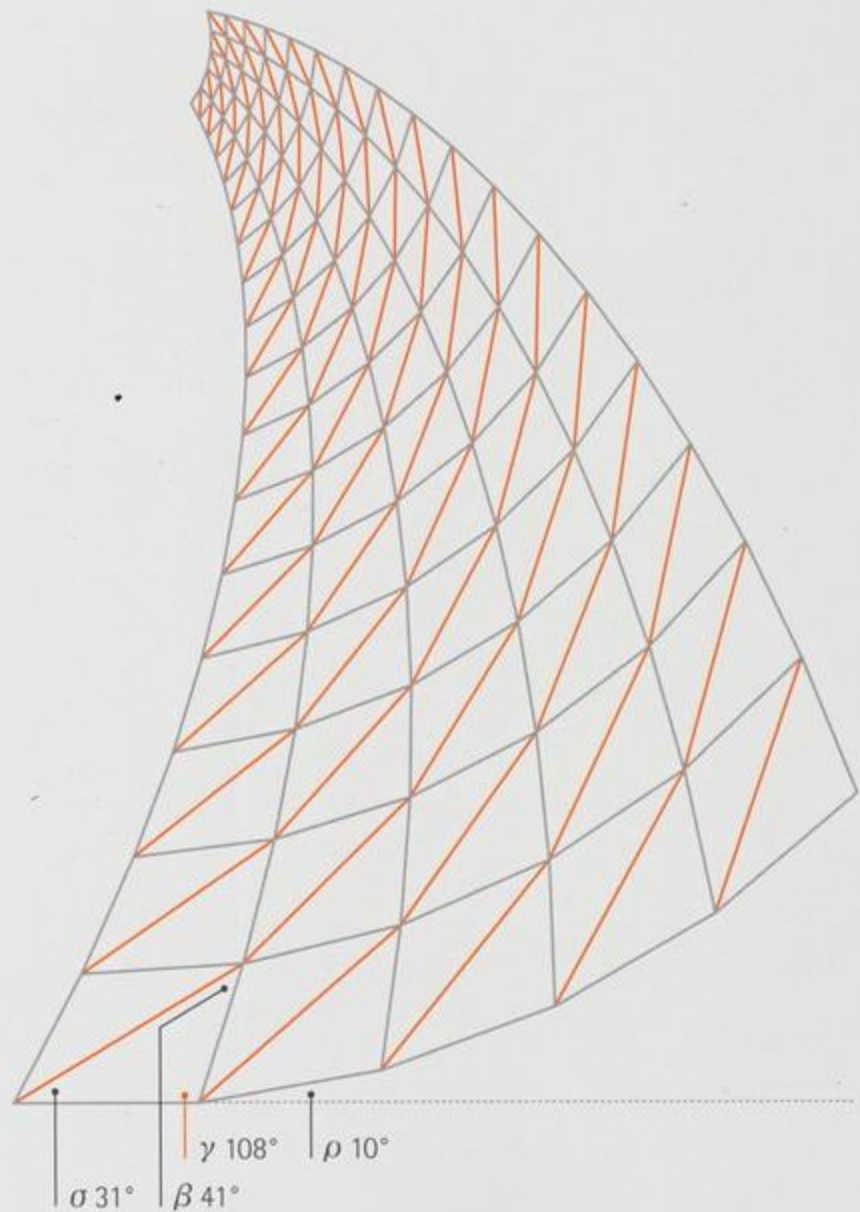
WHIRLPOOL SPIRAL 5|10|31



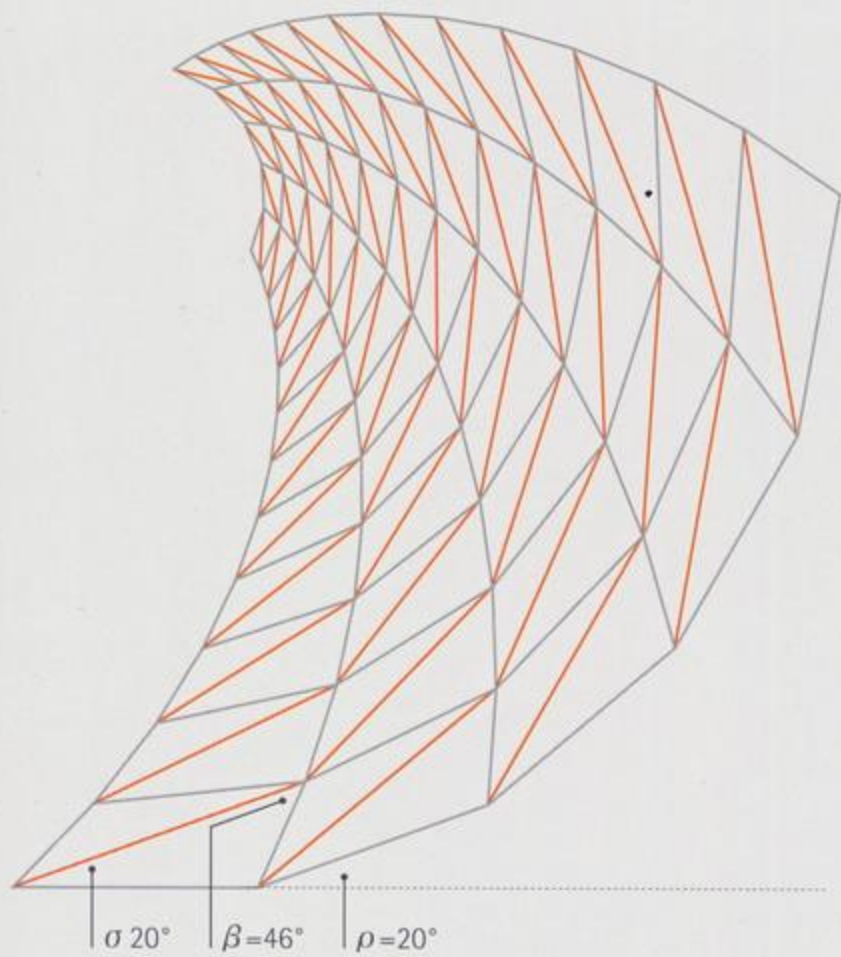
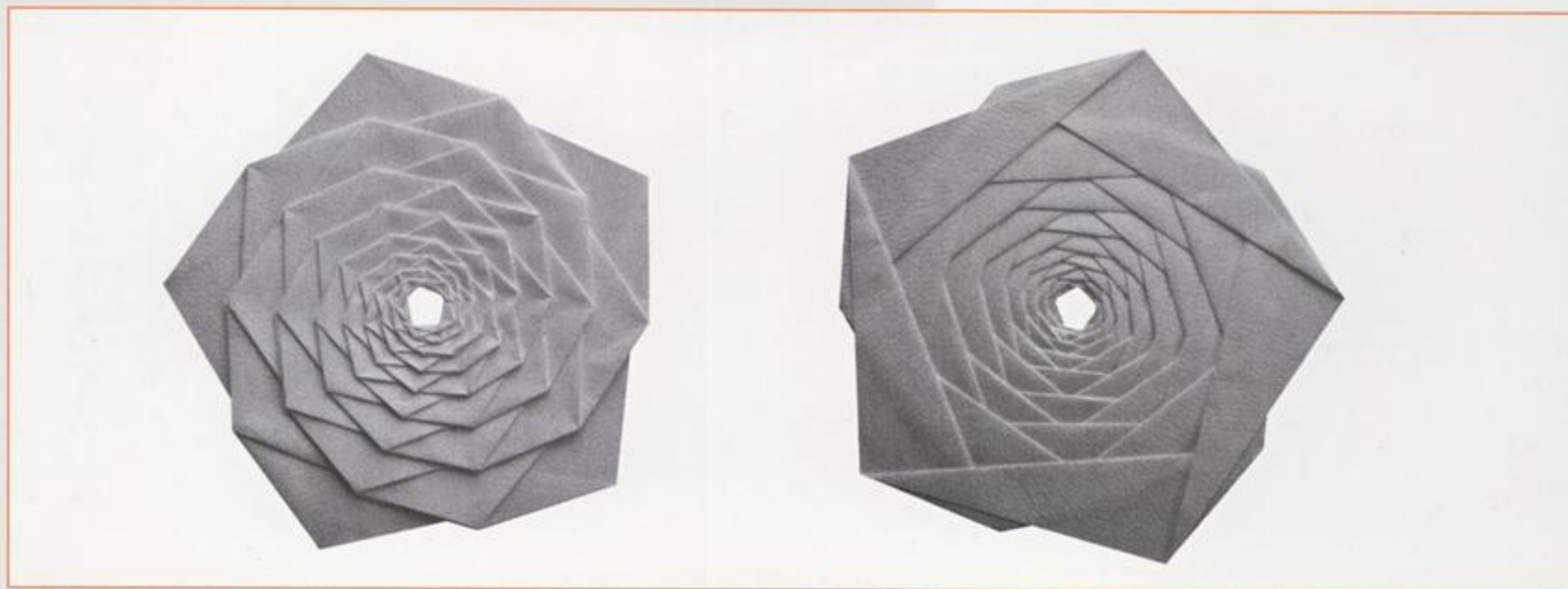
Special case 1



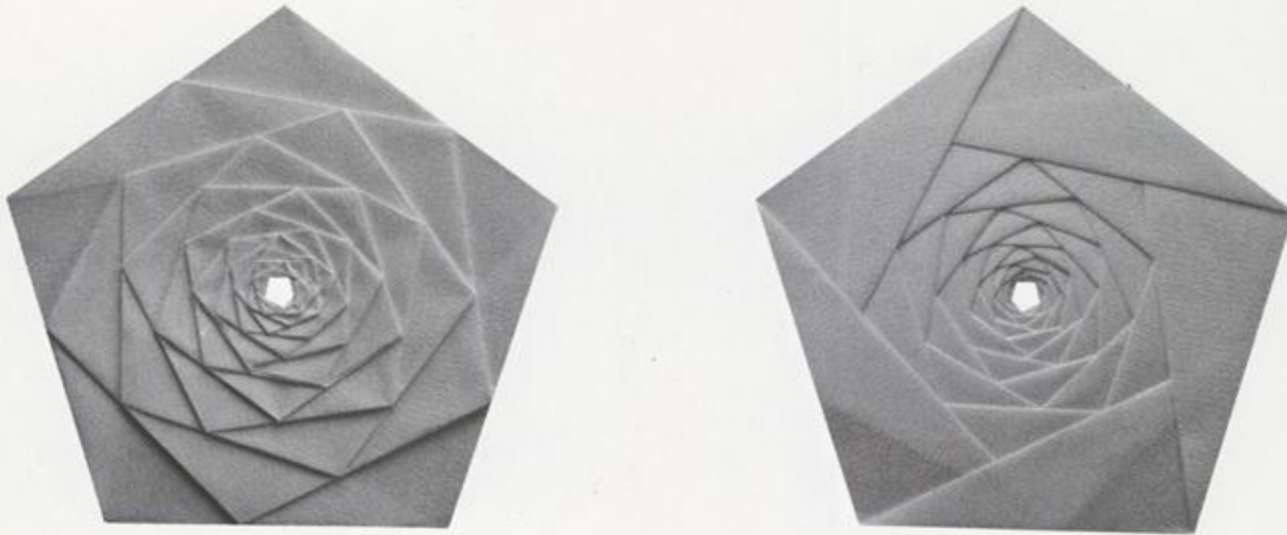
If γ is the corner angle of the primal polygon γ' ($\gamma' = 108^\circ$ in the case of $n=5$), the corners of the rotating pentagons align on the edges of the previous pentagon.



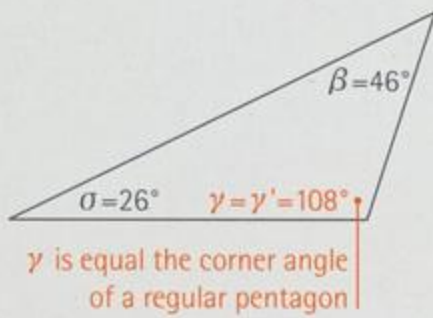
WHIRLPOOL SPIRAL 5|20|20



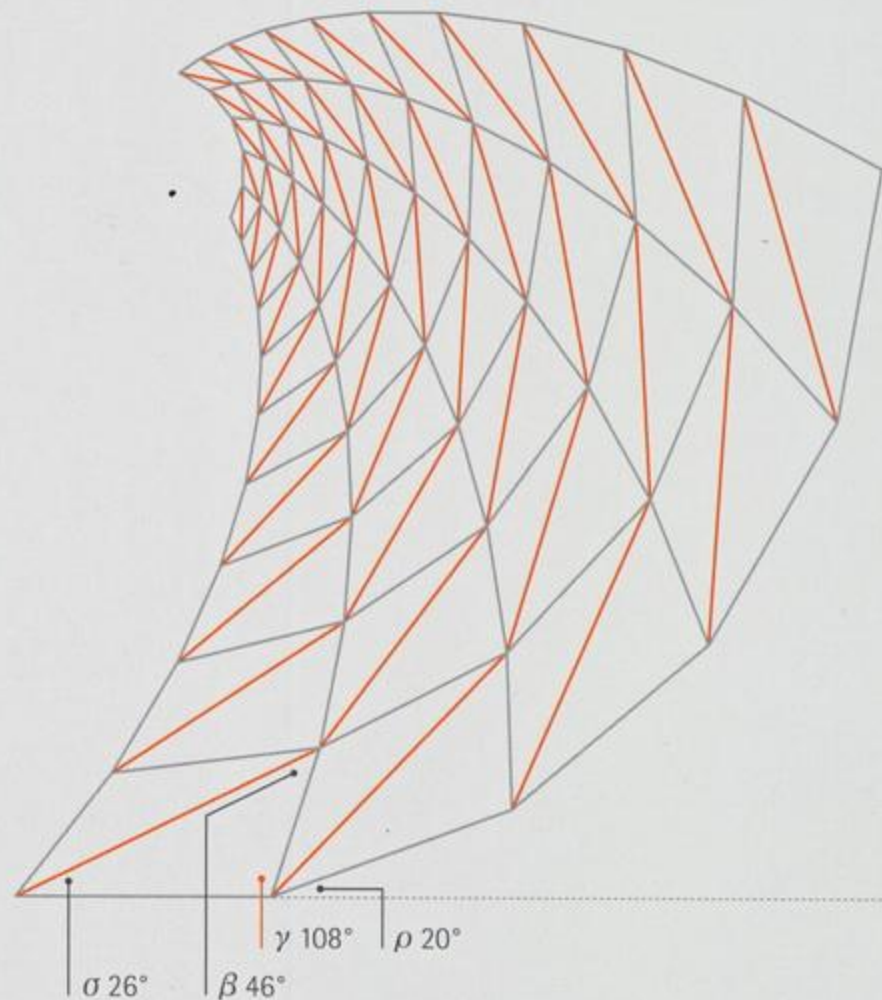
WHIRLPOOL SPIRAL 5|20|26



Special case 1

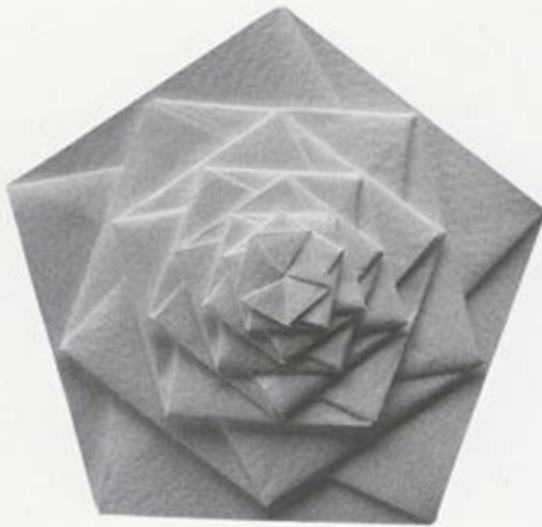


This is another example of special case 1 in the 5|x|x family.

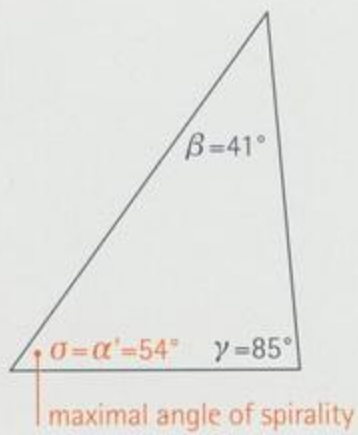




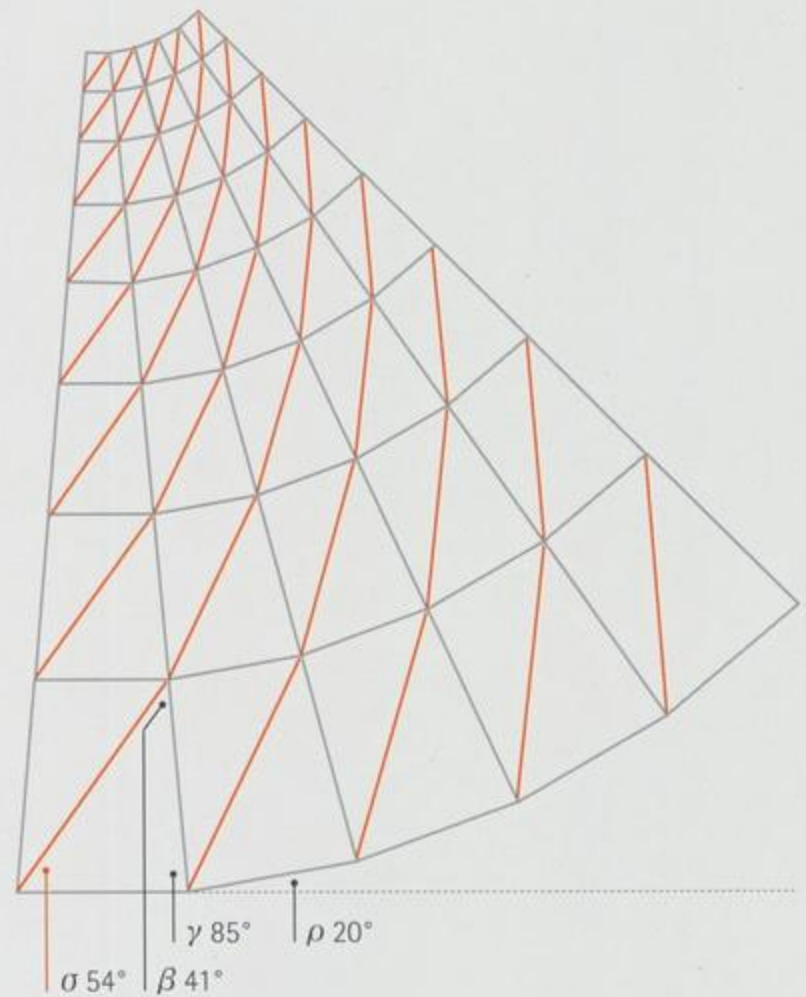
WHIRLPOOL SPIRAL 5|10|54



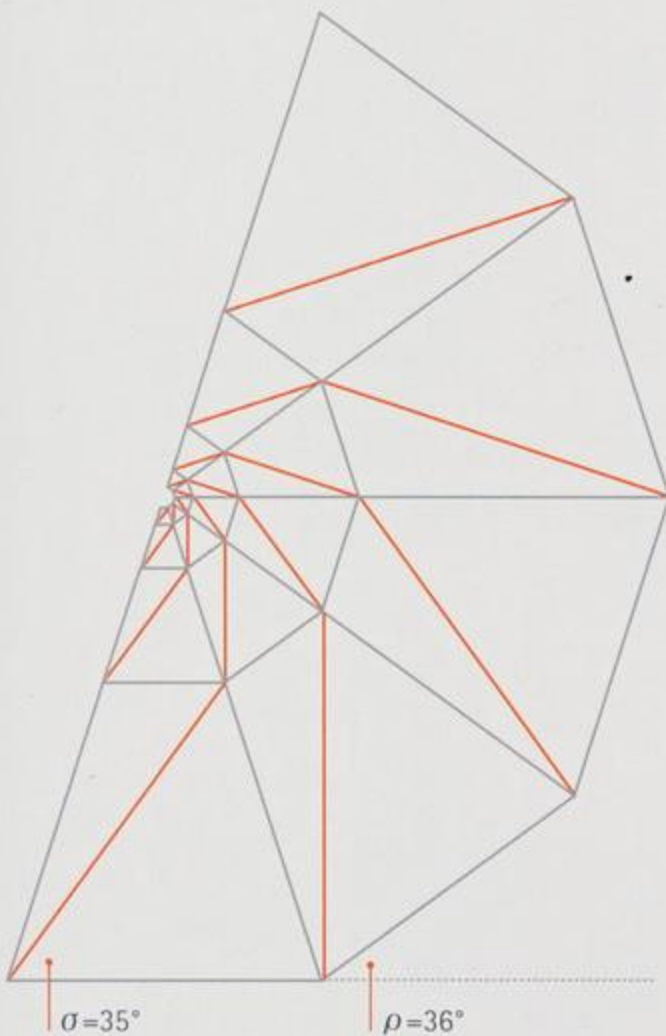
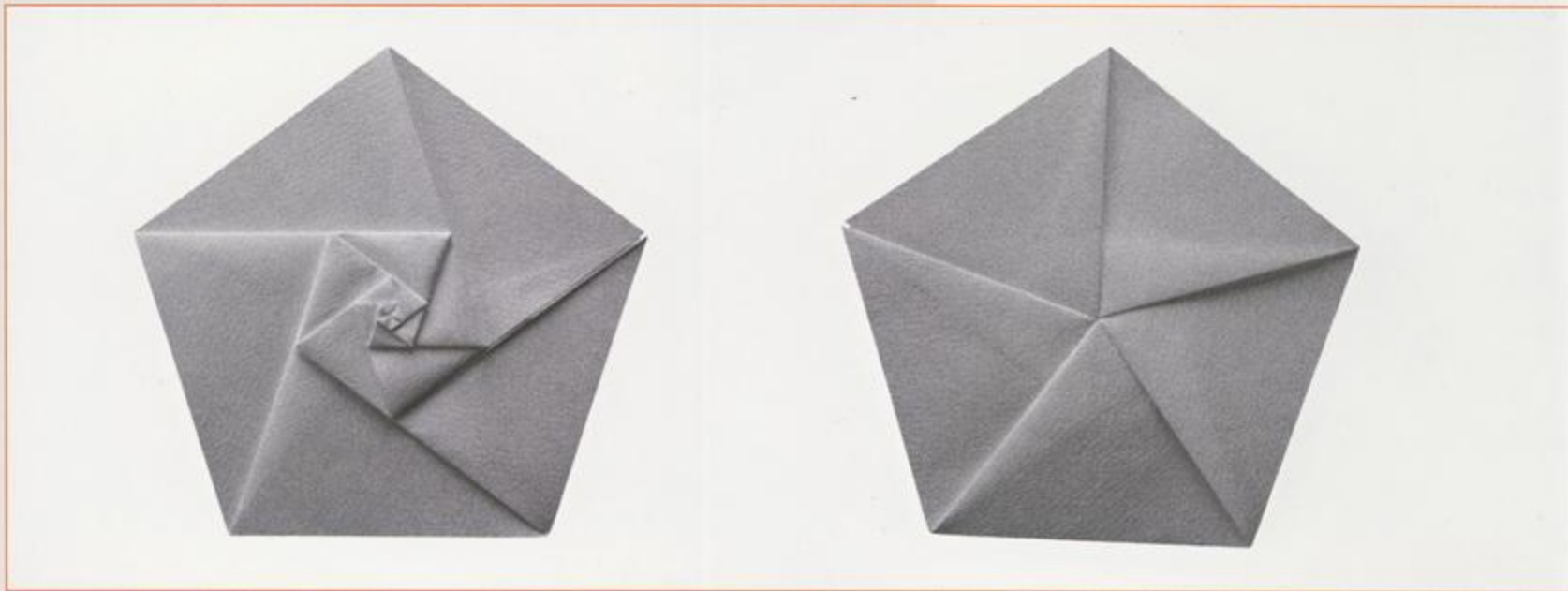
Special case 2



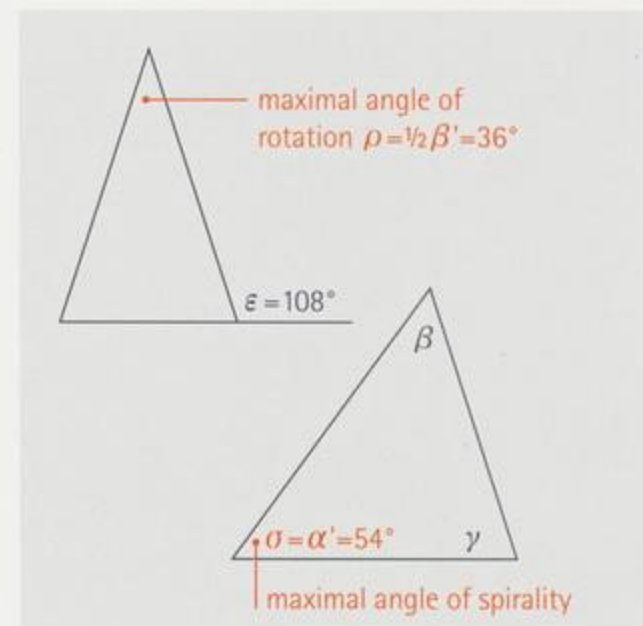
If the angle of spirality is maximal ($\alpha' = 54^\circ$ in the case of $n=5$), the whirlpool spiral does not have a hole on the reverse side.



WHIRLPOOL SPIRAL 5|36|54



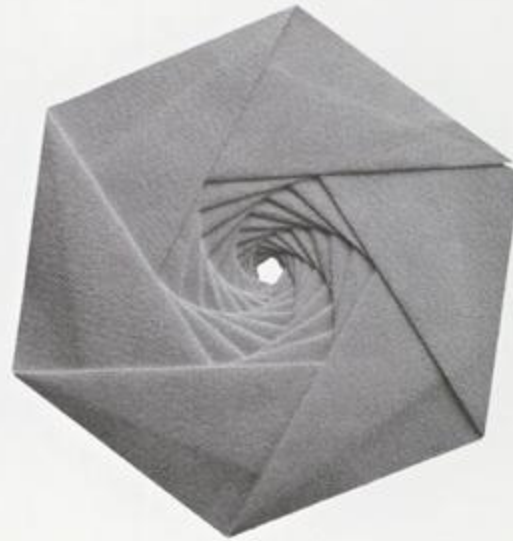
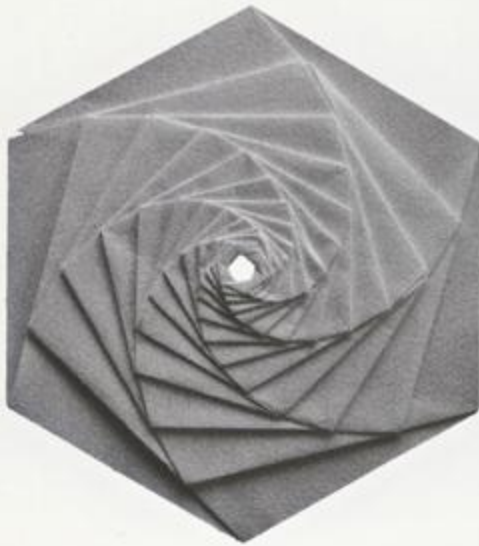
Special case 3



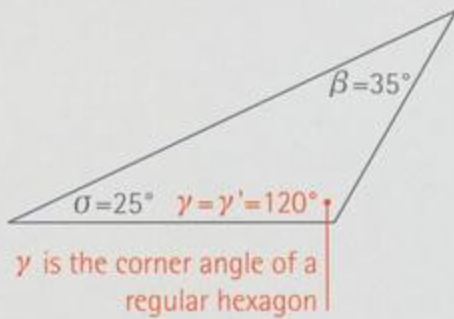
If both the angle of rotation ρ and the angle of spirality σ are maximal, the sides of the crease pattern are straight lines that form a 180° angle. Consecutive pentagons also rotate 180° .

OTHER POLYGONS

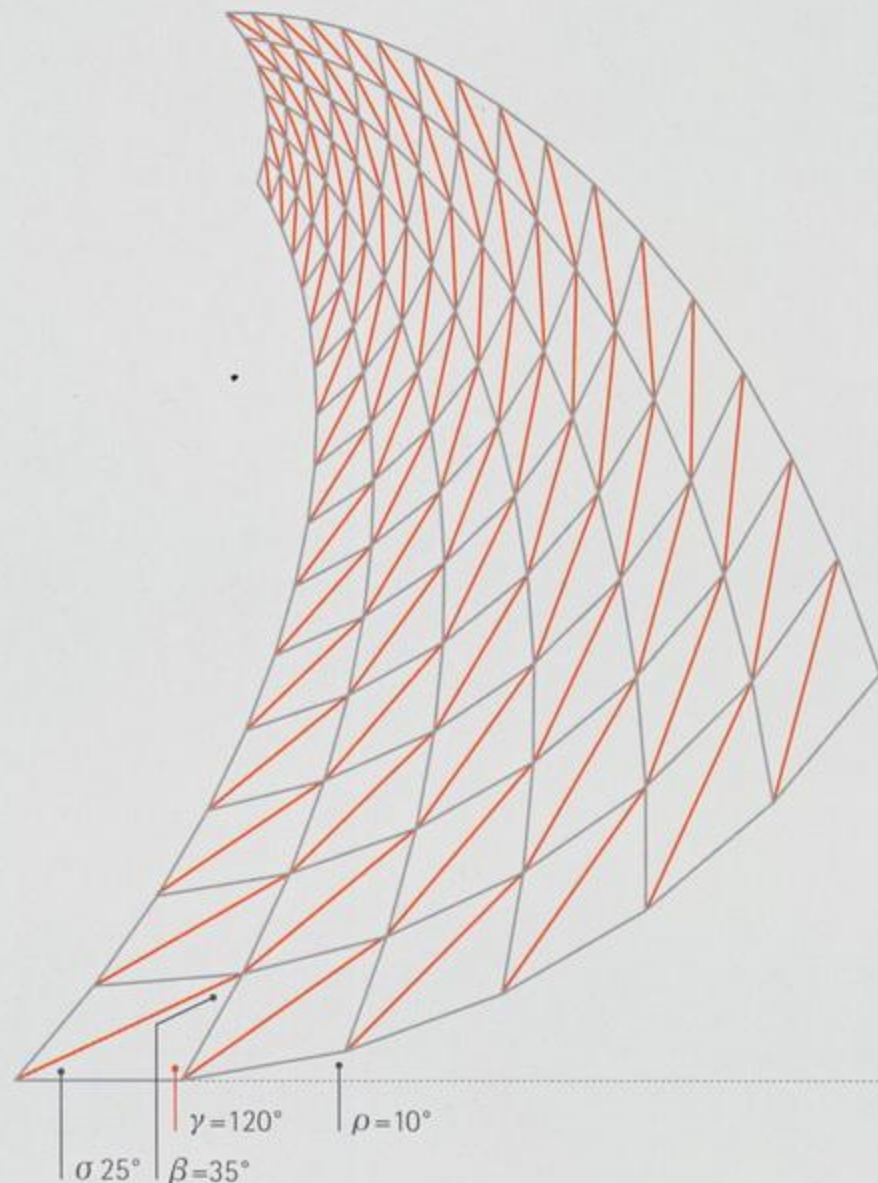
WHIRLPOOL SPIRAL 6|10|25



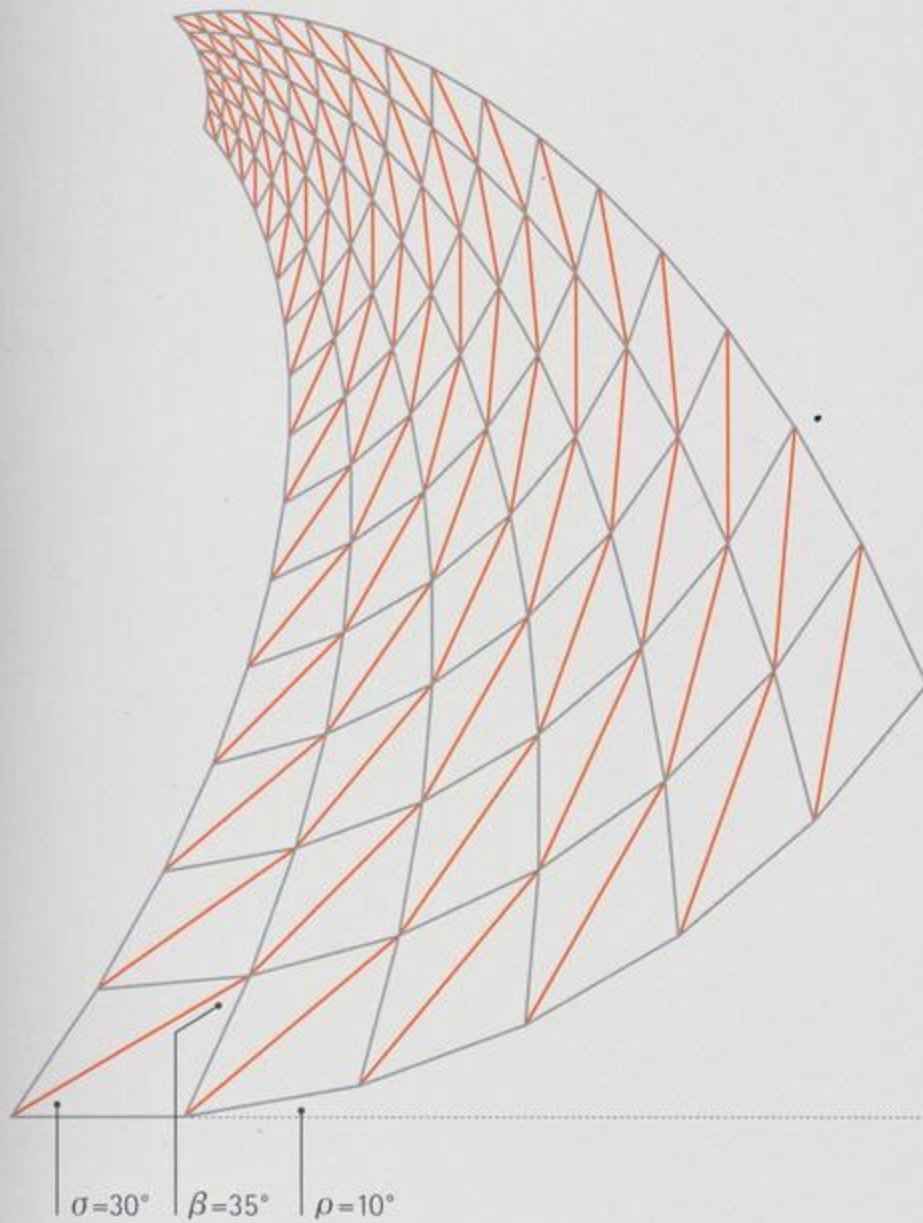
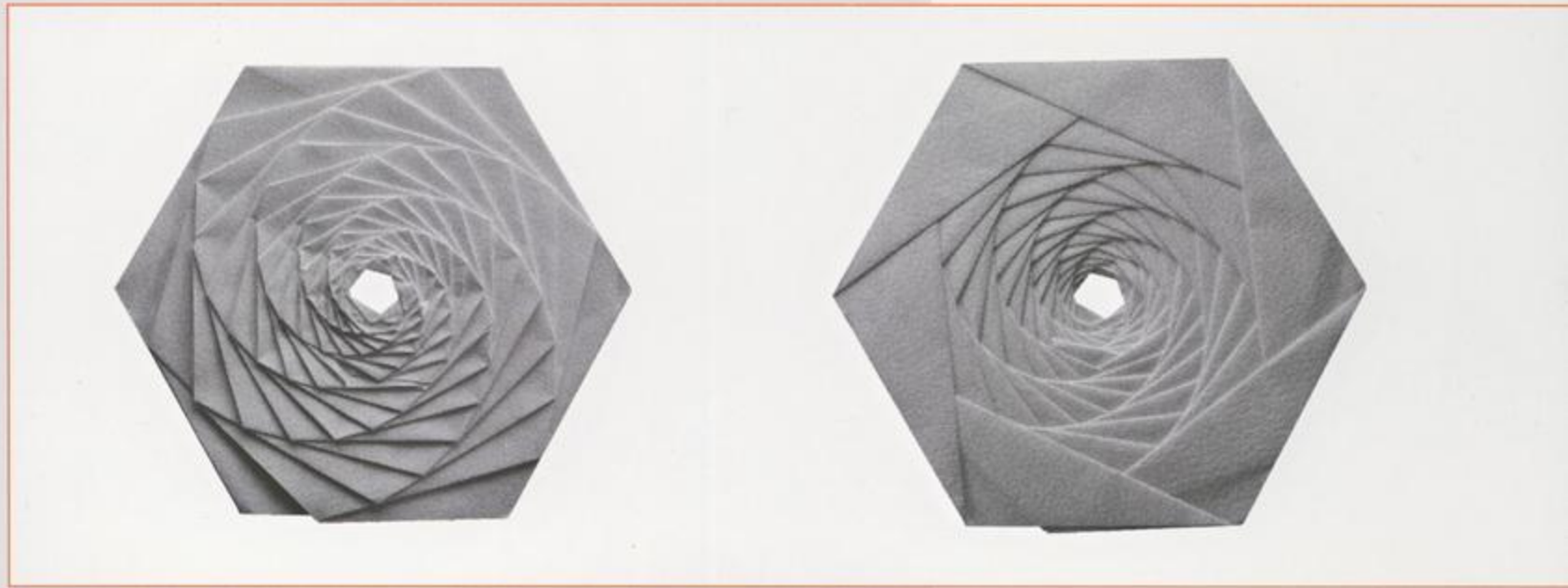
Special case 1



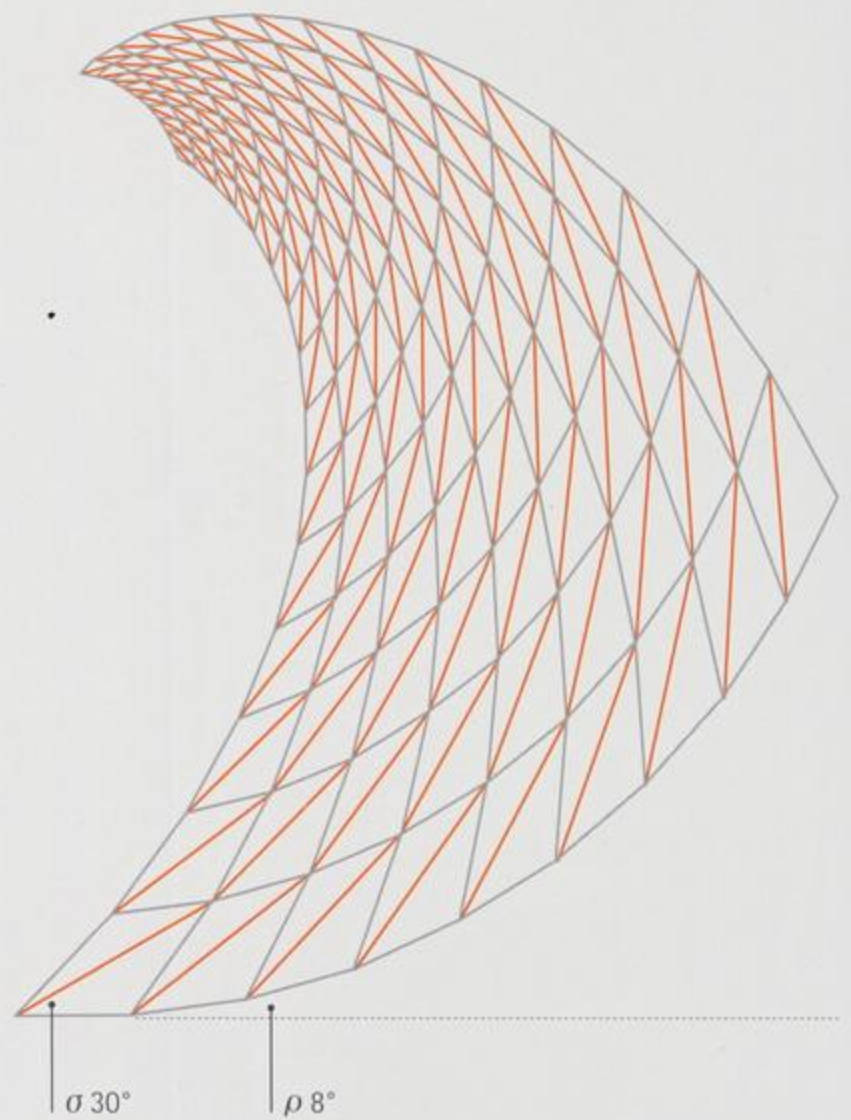
This is an example of special case 1 in the $6|x|x$ family.



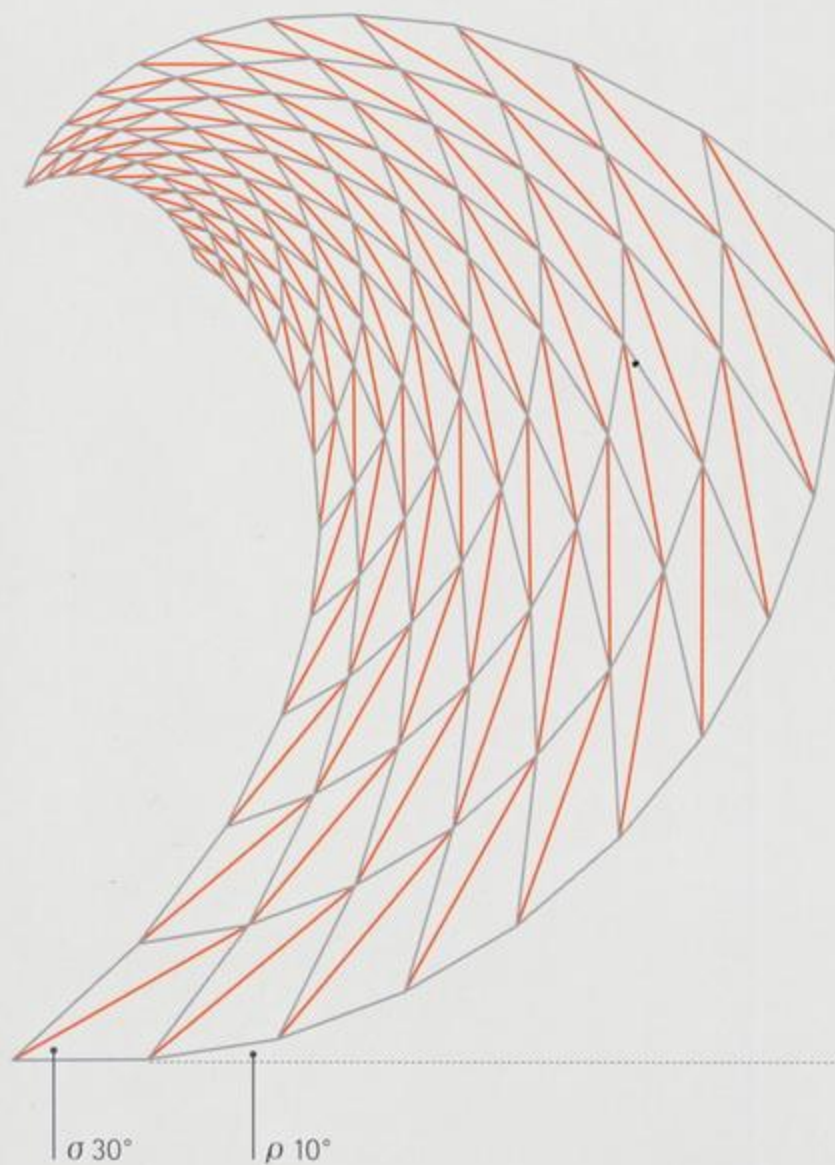
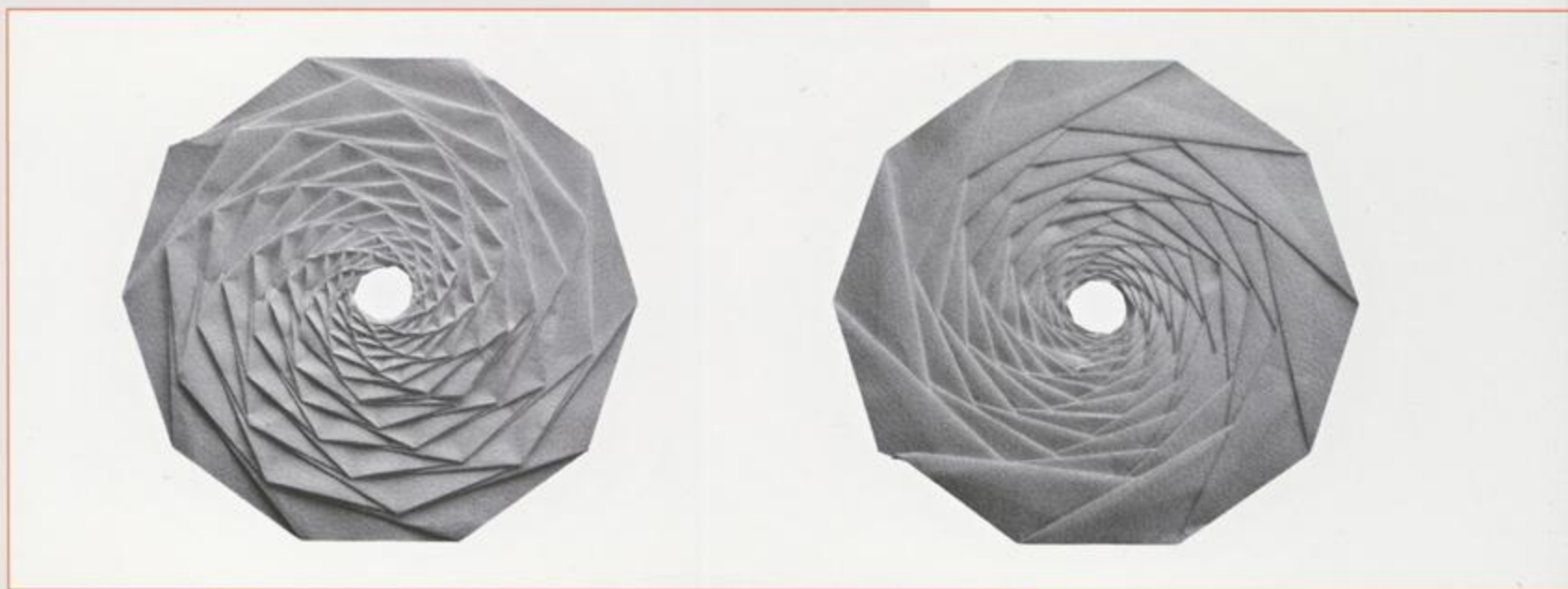
WHIRLPOOL SPIRAL 6|10|30



WHIRLPOOL SPIRAL 9|8|30



WHIRLPOOL SPIRAL 10|10|30



ランプシェード



LAMPSHADES

You can use the *Whirlpool Spirals-technique* to produce beautiful lampshades. Some more elements are added to the crease pattern to build the base and the top of the lampshade, and for gluing.

The shaded parts in the crease patterns on the following pages are used for gluing to fix the form of the lampshade and to attach it to the lampshade's mounting.

The notation used for the Whirlpool Spirals is also used for the lampshades. You will notice that the value of the angle of rotation is also used as centre angle of the lampshade's top. This gives the whole lampshade a harmonious form.

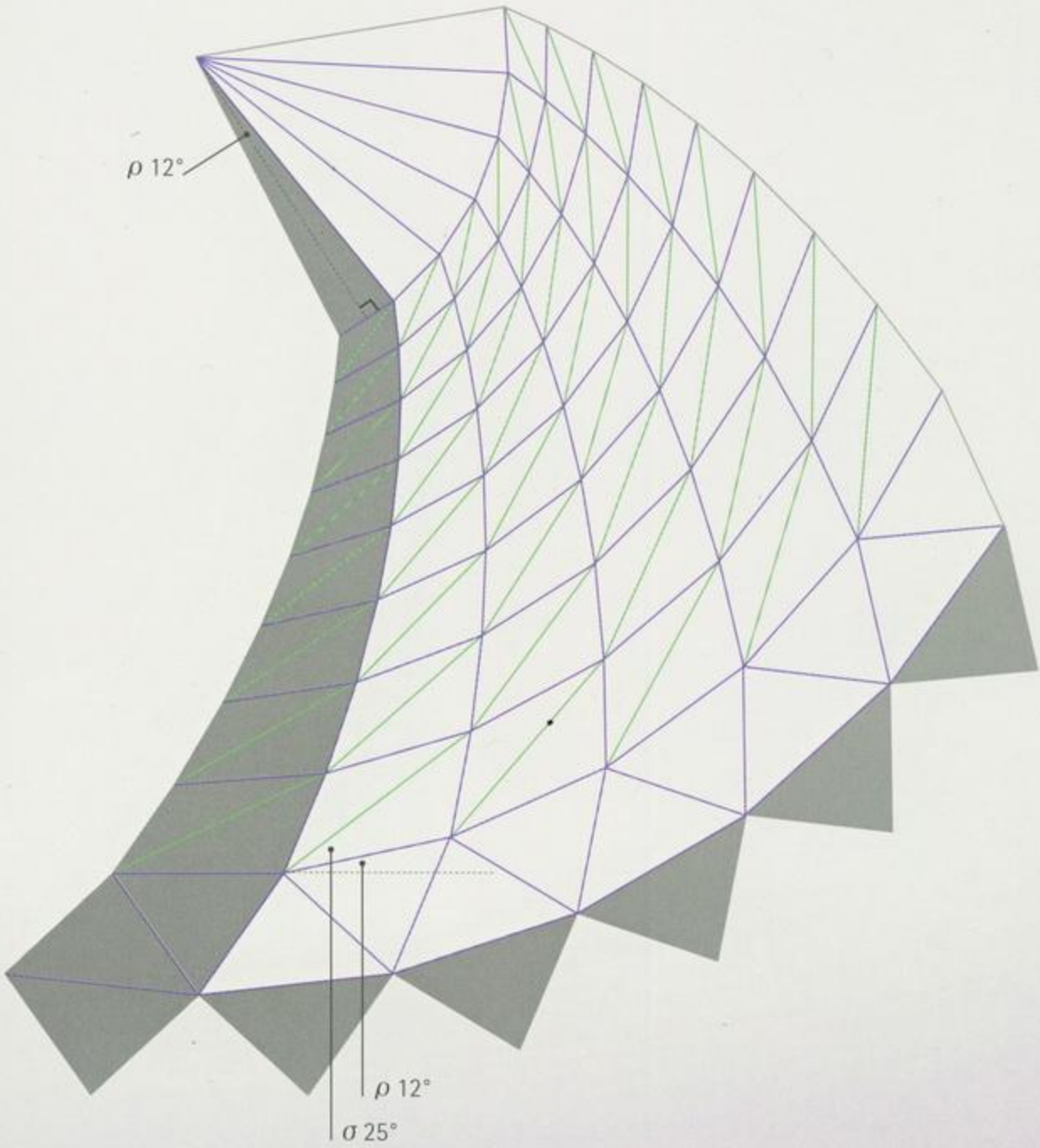




LAMPSHADE 5|12|25

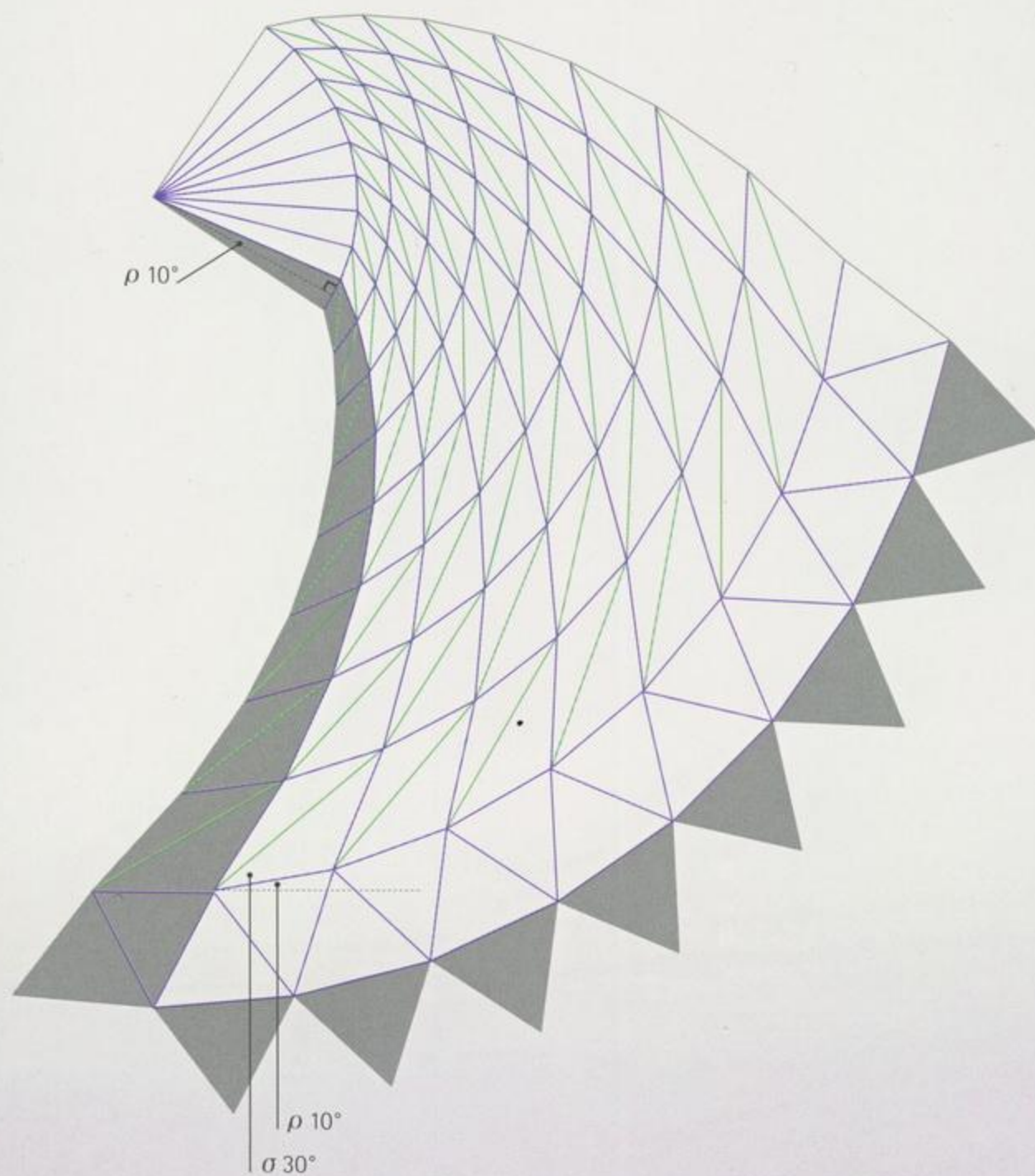
mountain fold

valley fold



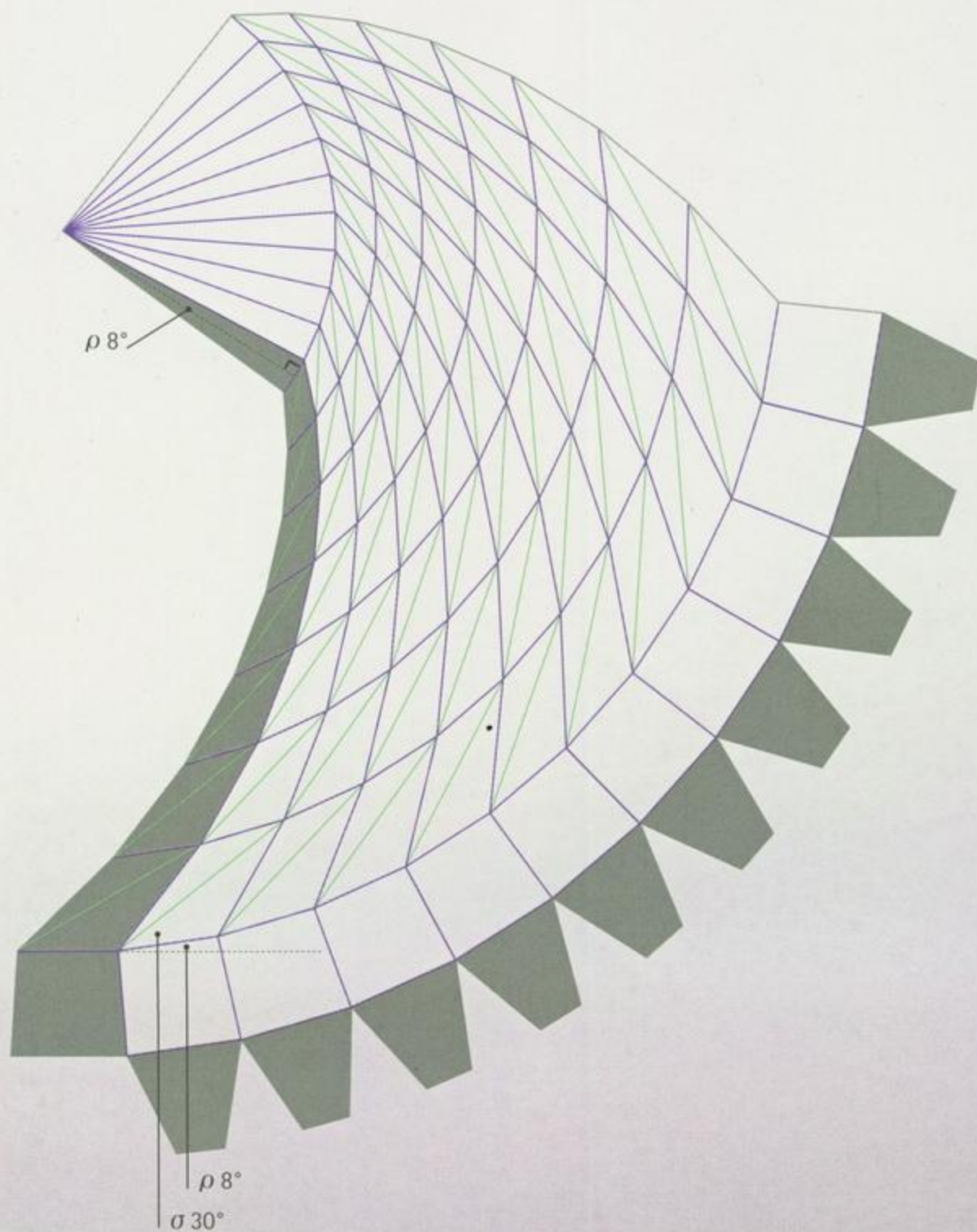


LAMPSHADE 8|10|30



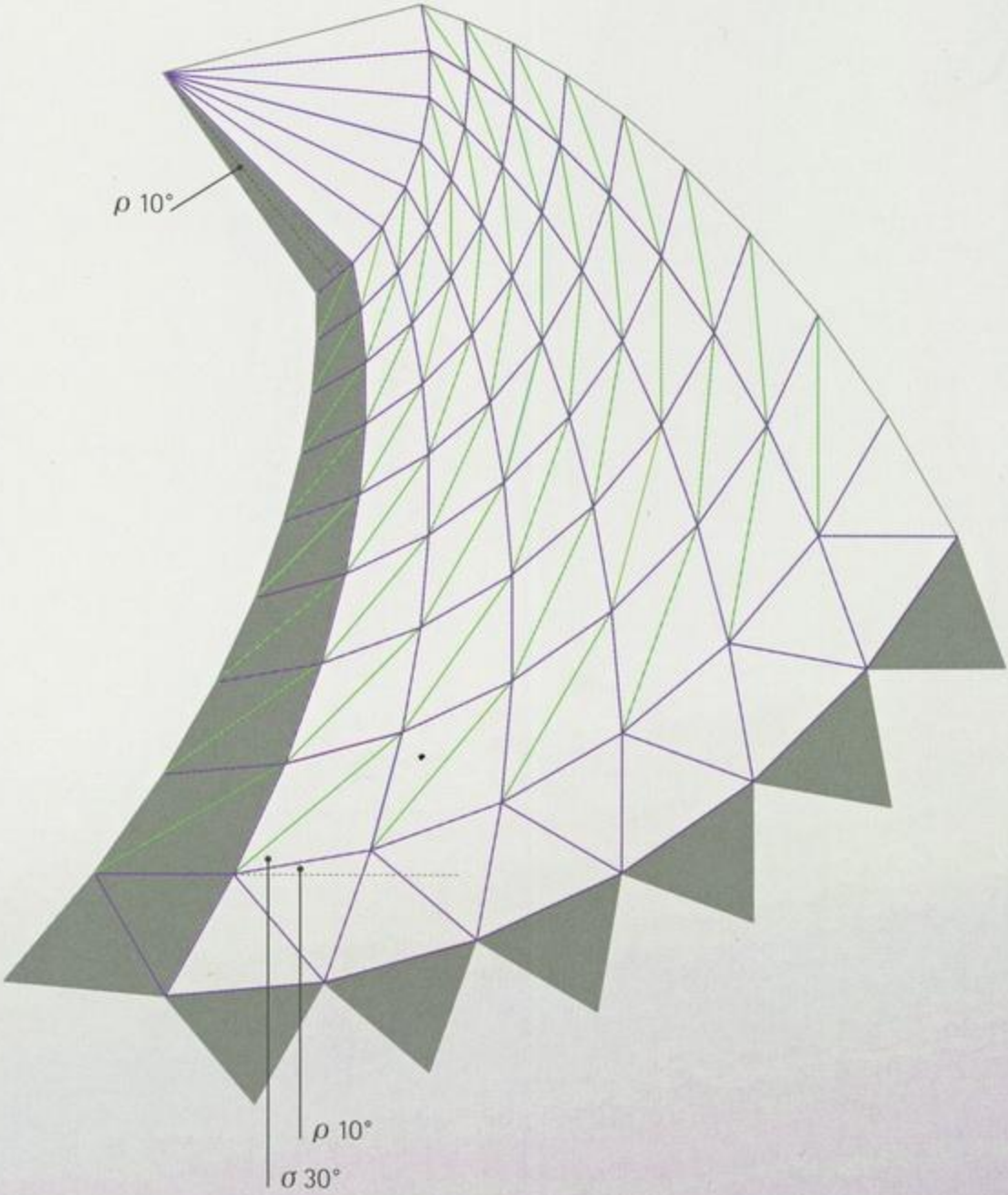


LAMPSHADE 10|8|30



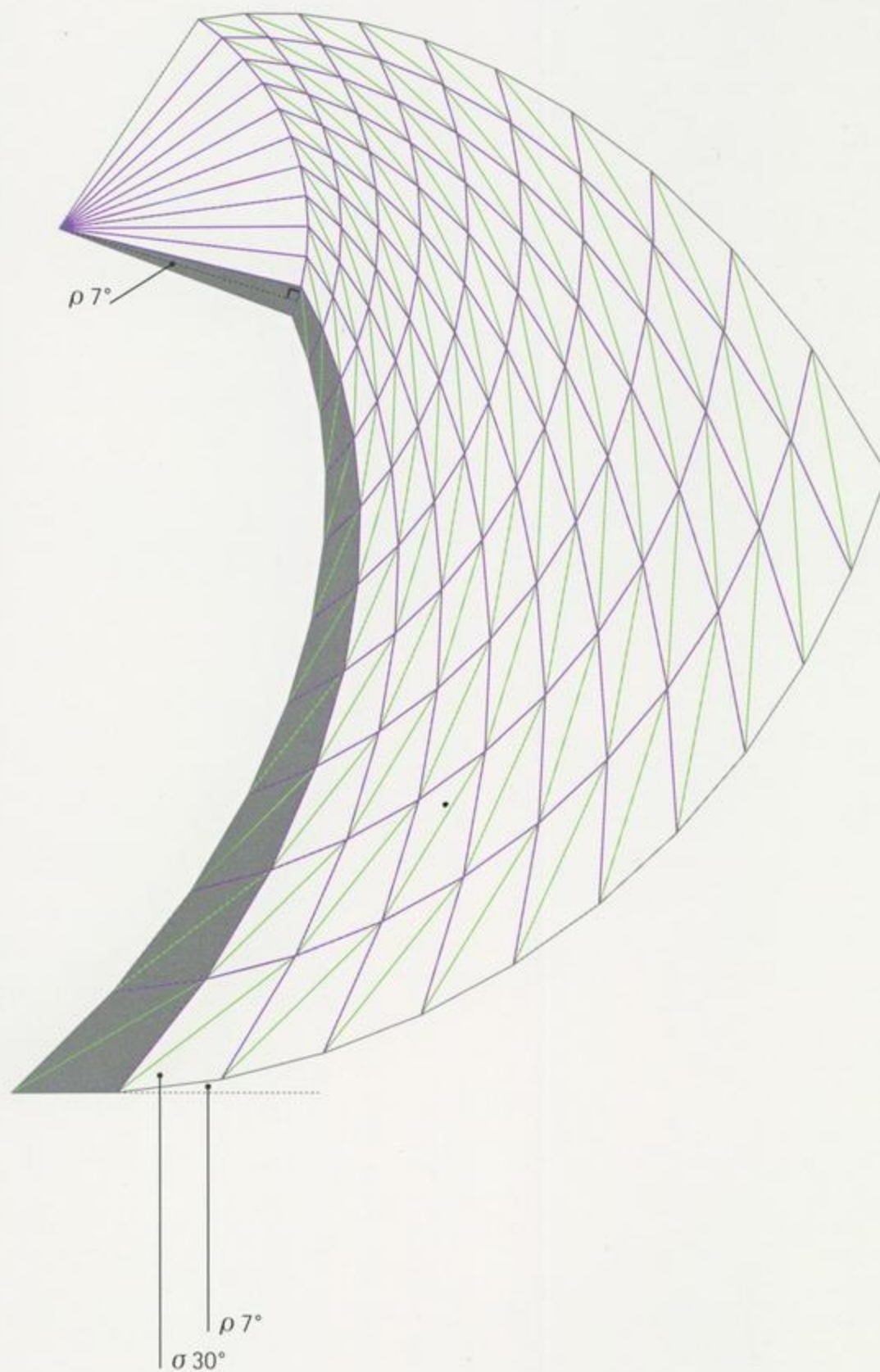


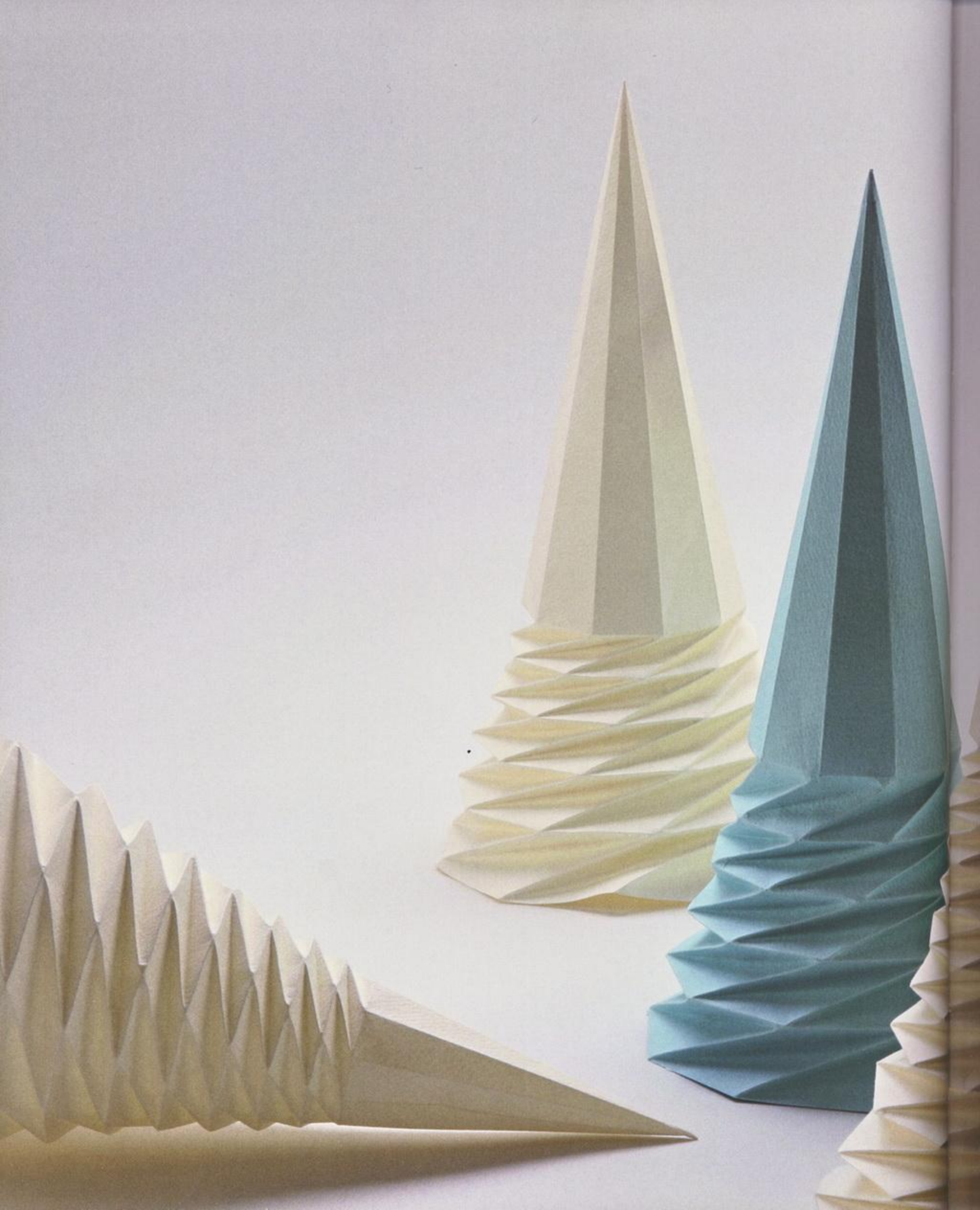
LAMPSHADE 6|10|30





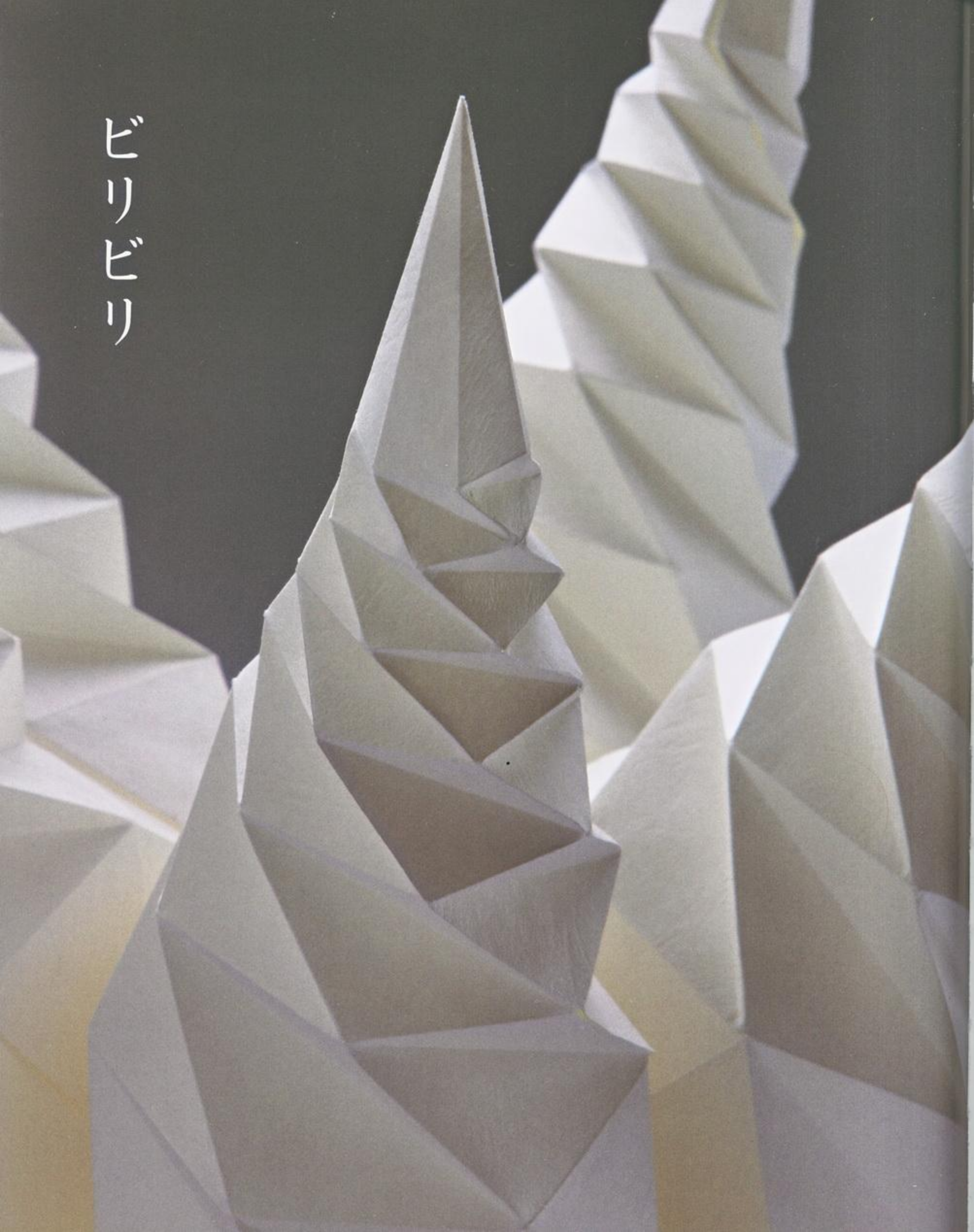
LAMPSHADE 10|7|30







ビリビリ

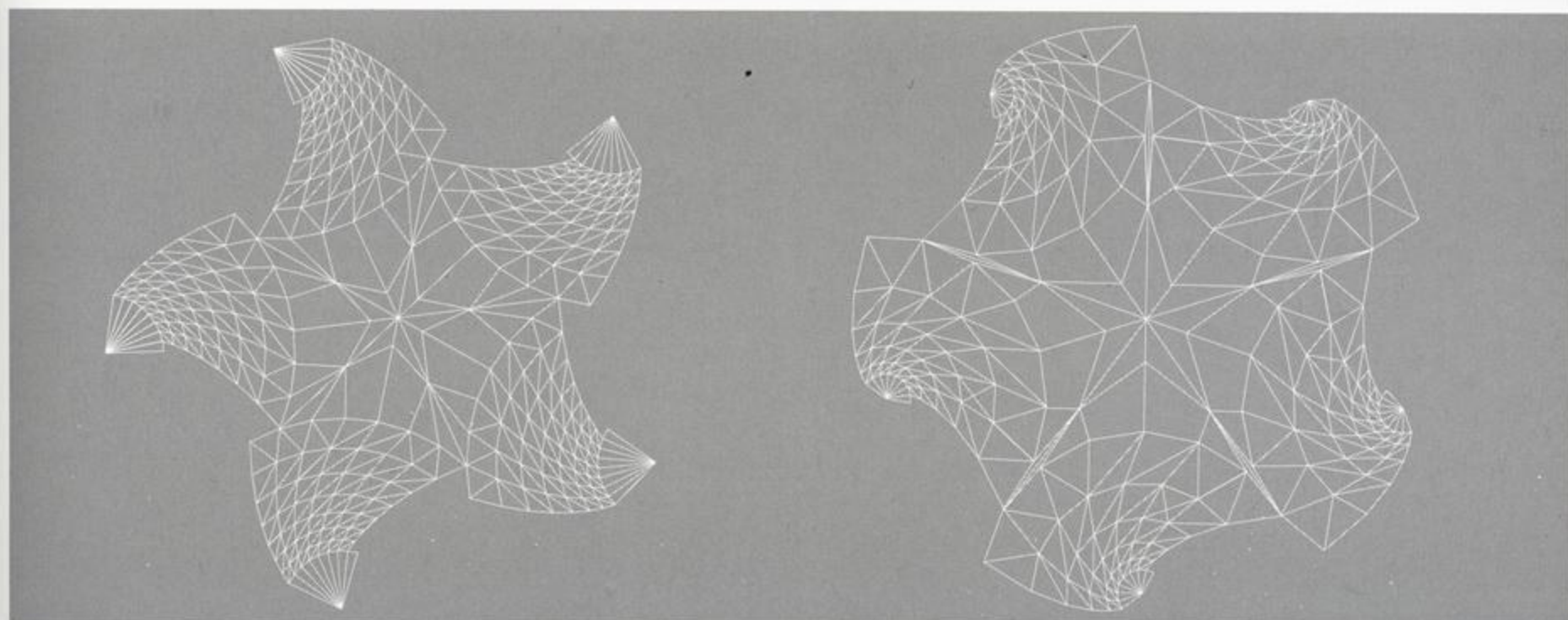
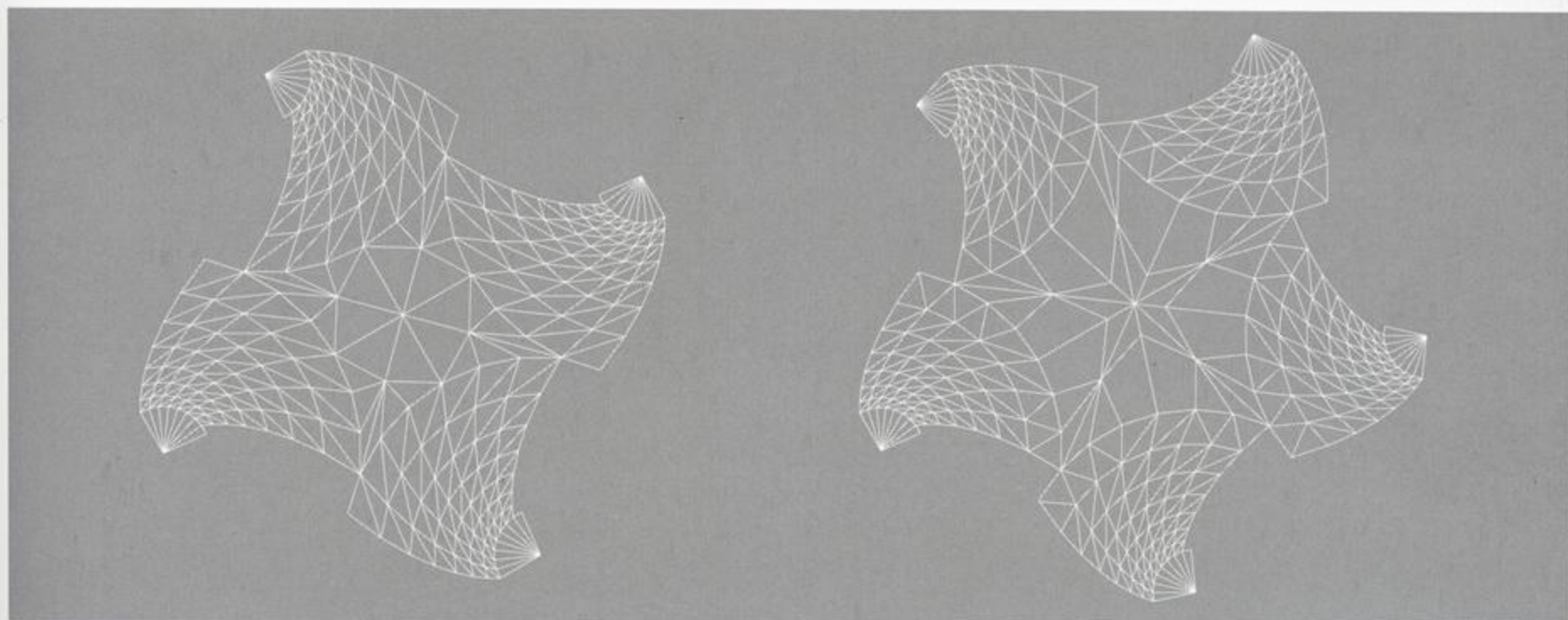


BIRIBIRI

Several connected Whirlpool Spirals make a remarkable structure that seems to represent a high voltage electrical discharge.

Biribiri, the Japanese name for this design, mimics the sound of the electrical discharge.

In addition to the models shown here, many other combinations of Whirlpool Spirals can be used to create Biribiris.



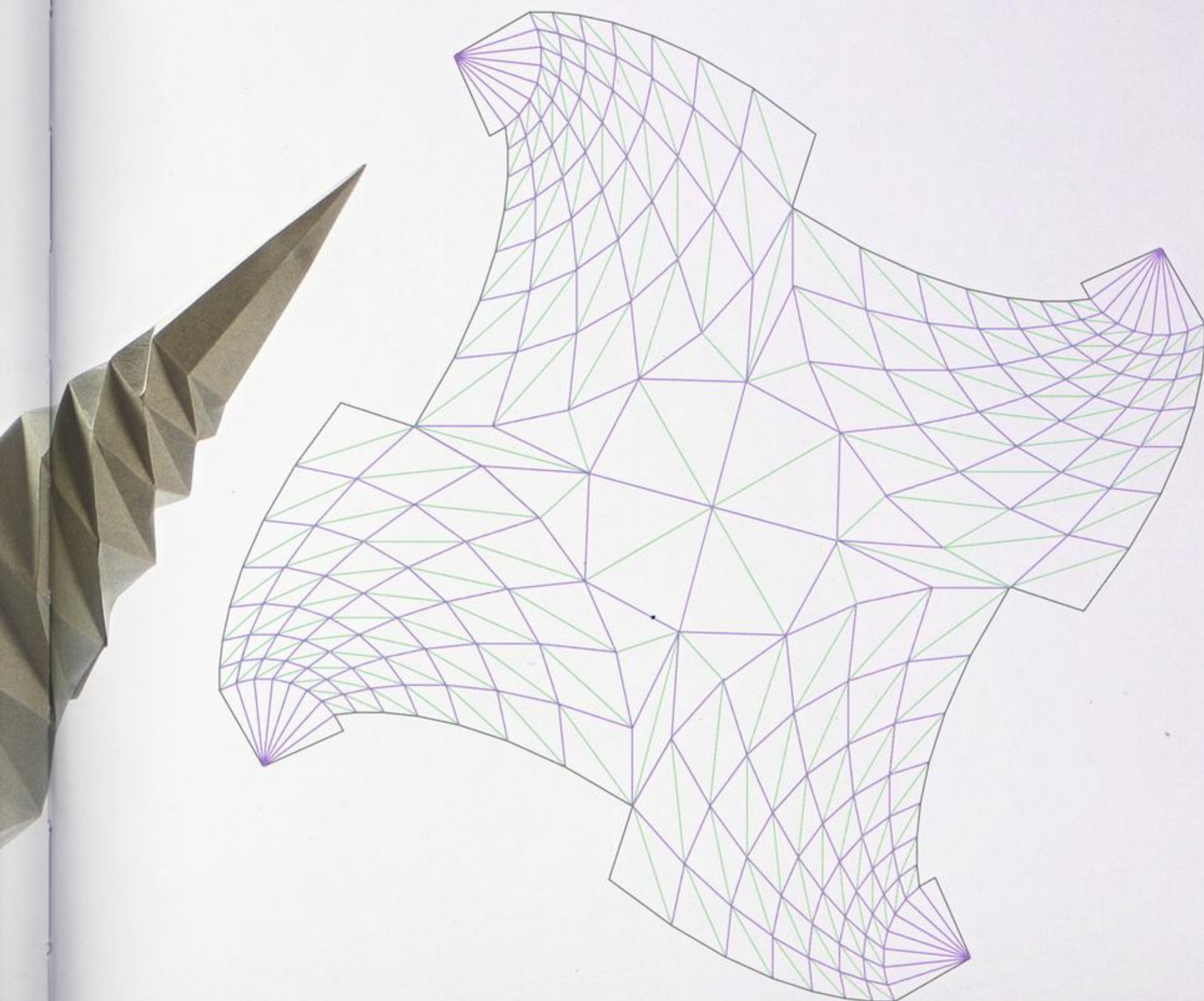


BIRIBIRI 6|12|36

4 SPIKES

mountain fold

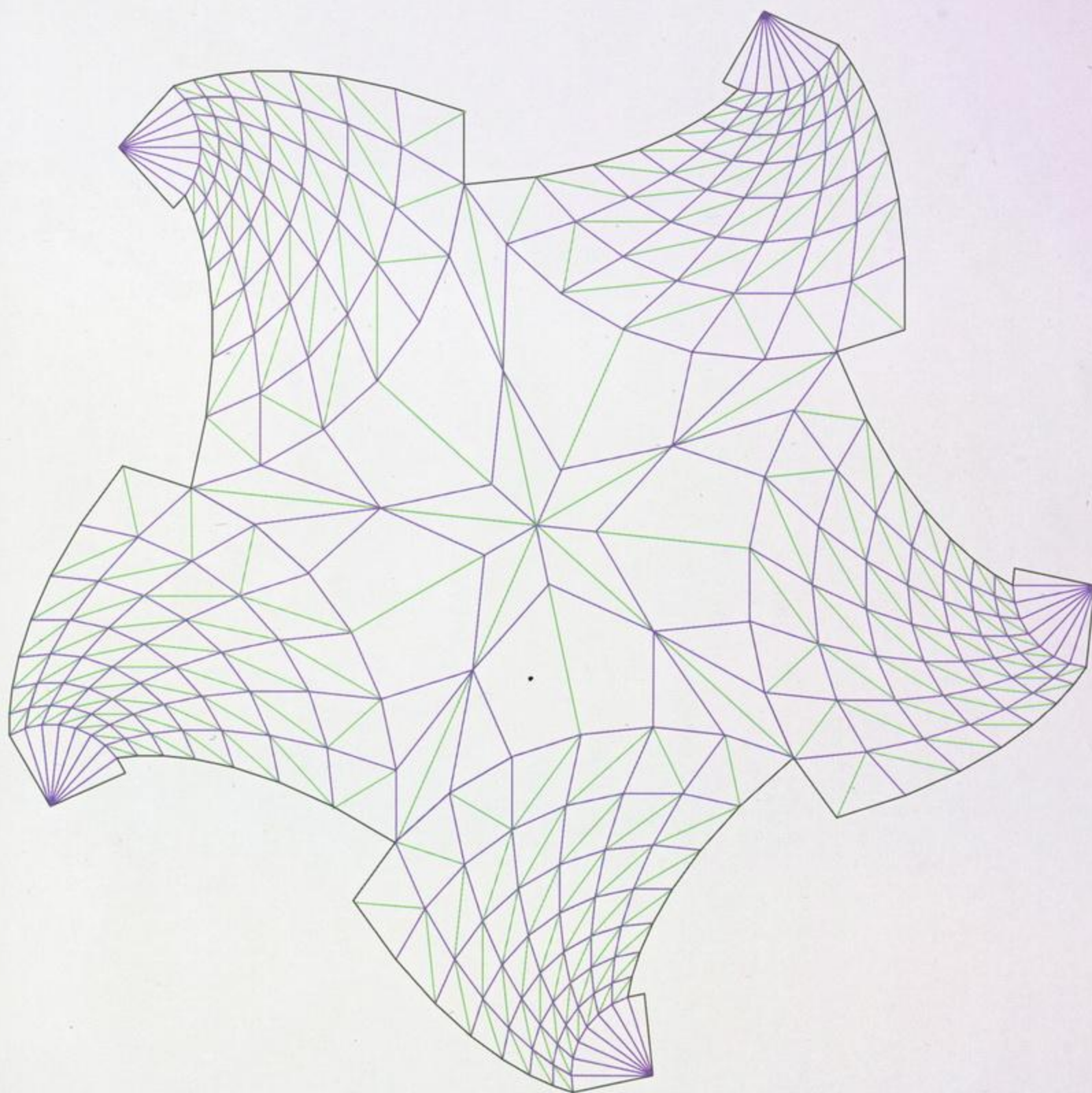
valley fold





BIRIBIRI 6|12|36

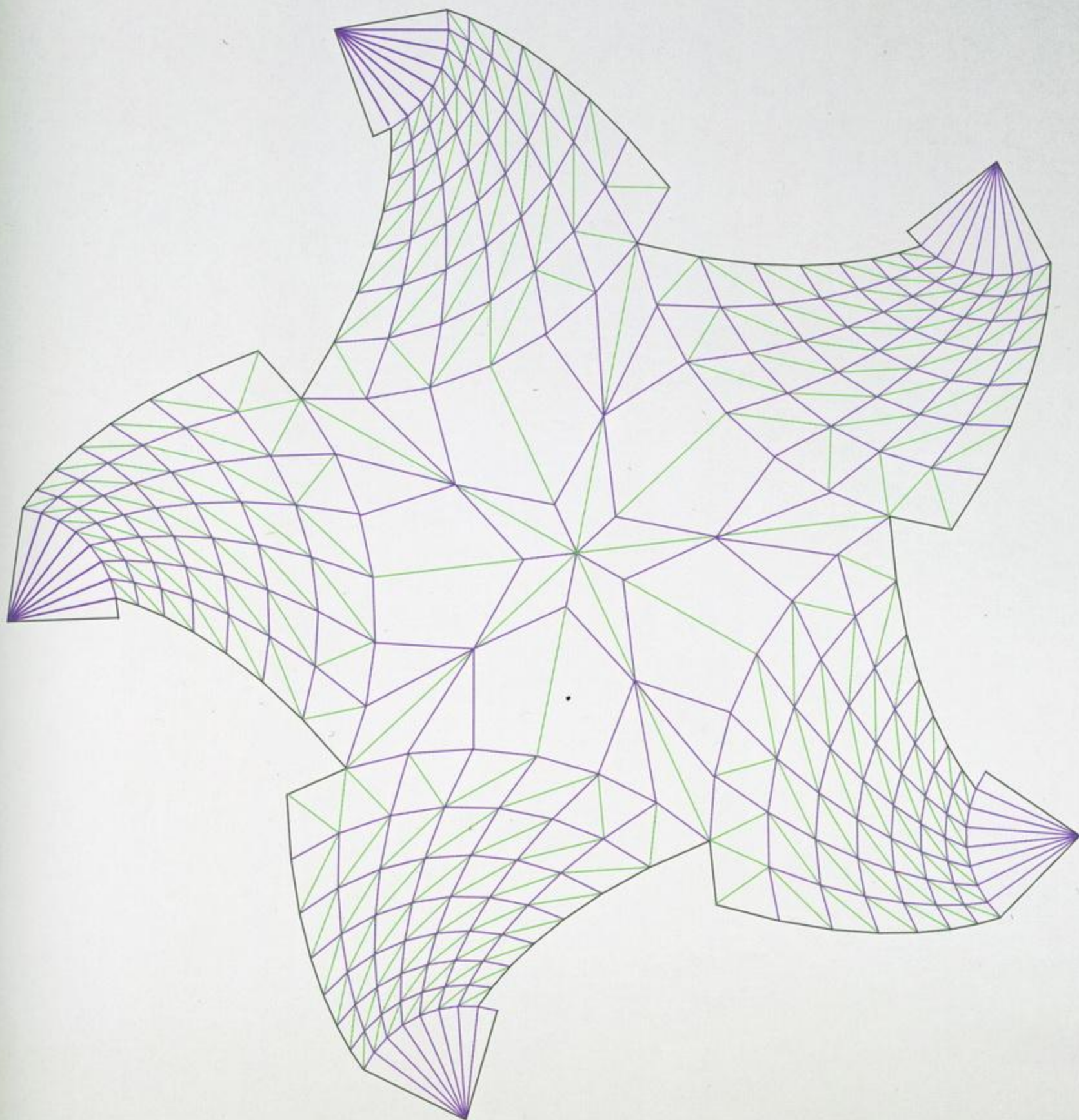
5 SPIKES





BIRIBIRI 6|10|35

5 SPIKES





BIRIBIRI 6|20|40

5 SPIKES



うず巻き折りの星



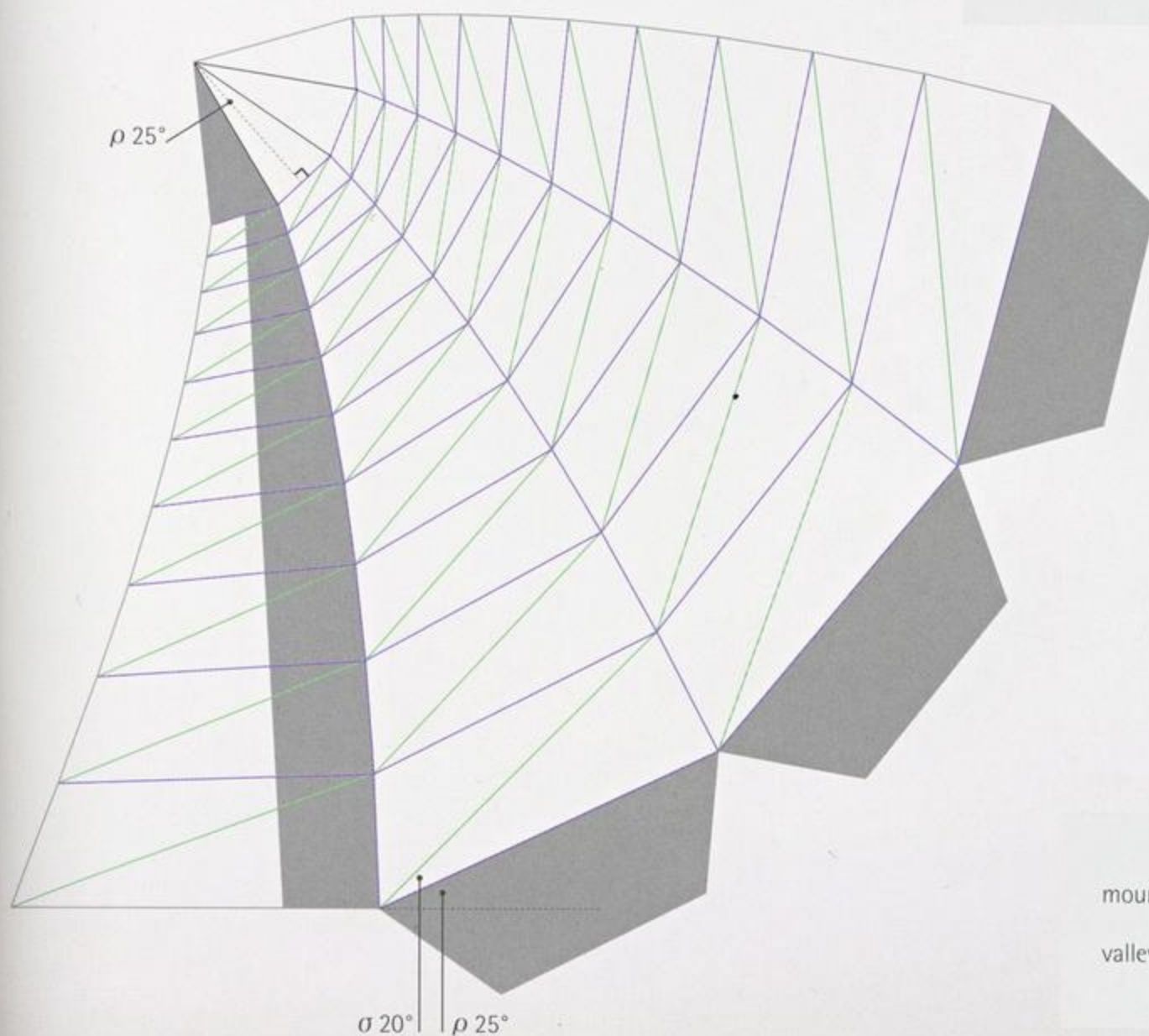
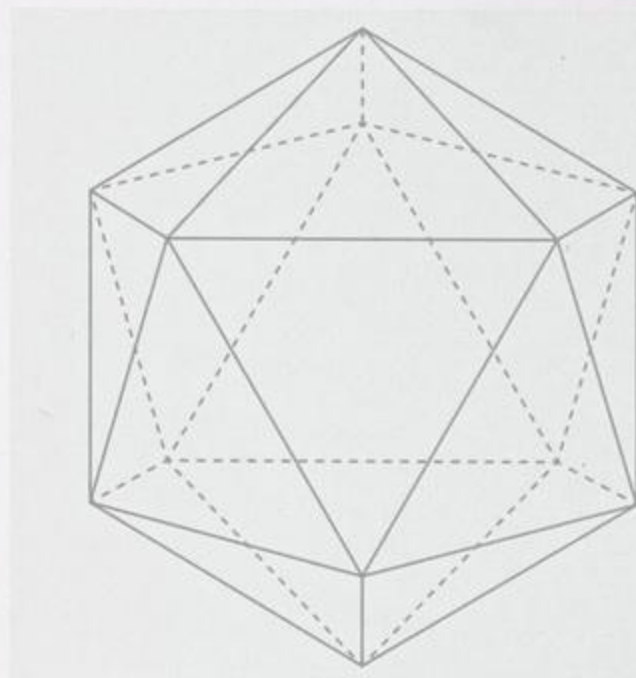
WHIRLPOOL STARS

ICOSAHEDRON WHIRLPOOL STAR

Whirlpool Stars are polyhedrons with Whirlpool Spiral faces.

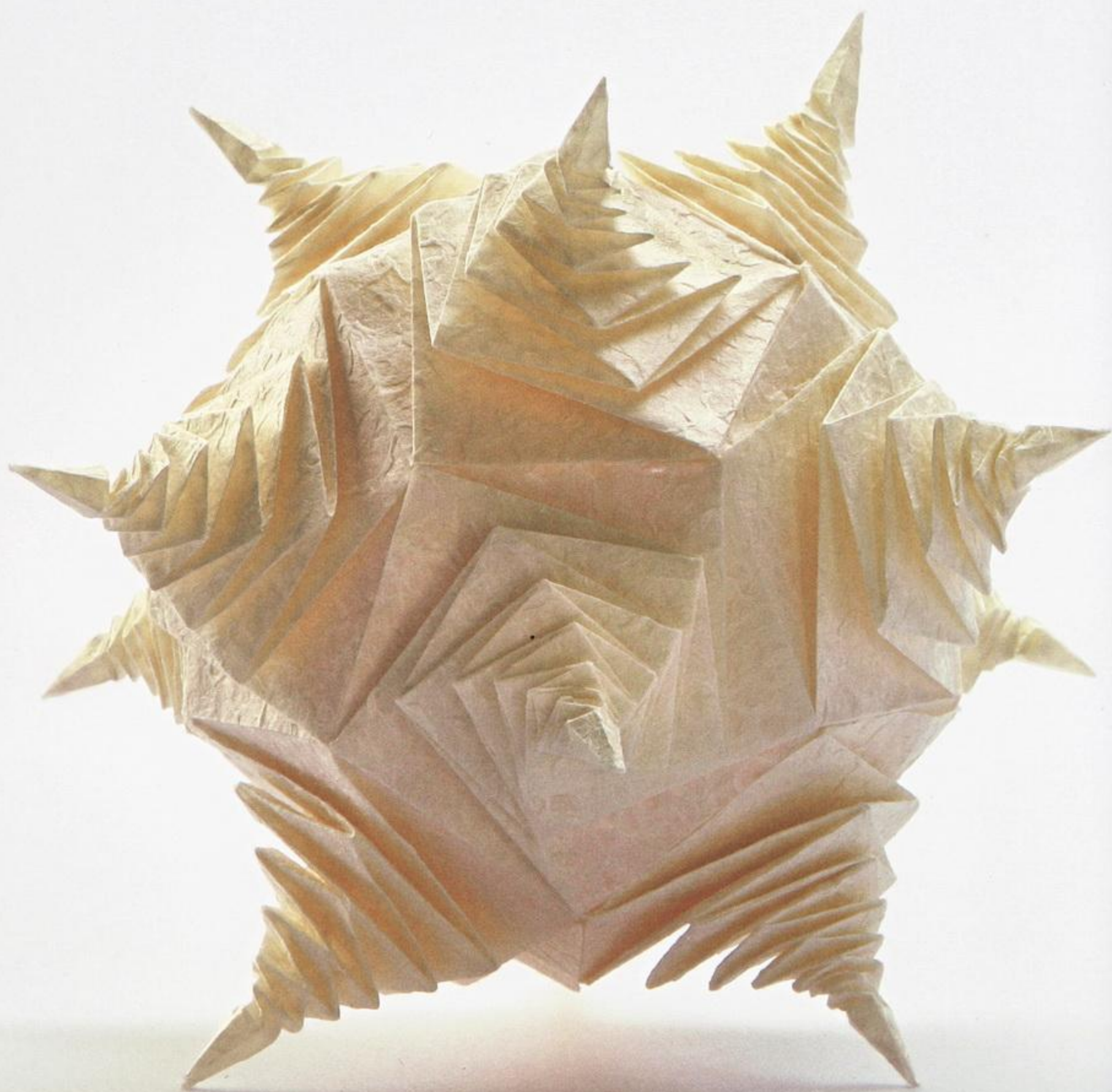
For the Icosahedron Whirlpool Star you need 20 whirlpool spirals of type 3|25|20.

Make an icosahedron base of cardboard and paste the whirlpool spirals on its faces. You may adjust the widths of the gluing flaps according to the thickness, quality and other properties of the paper.



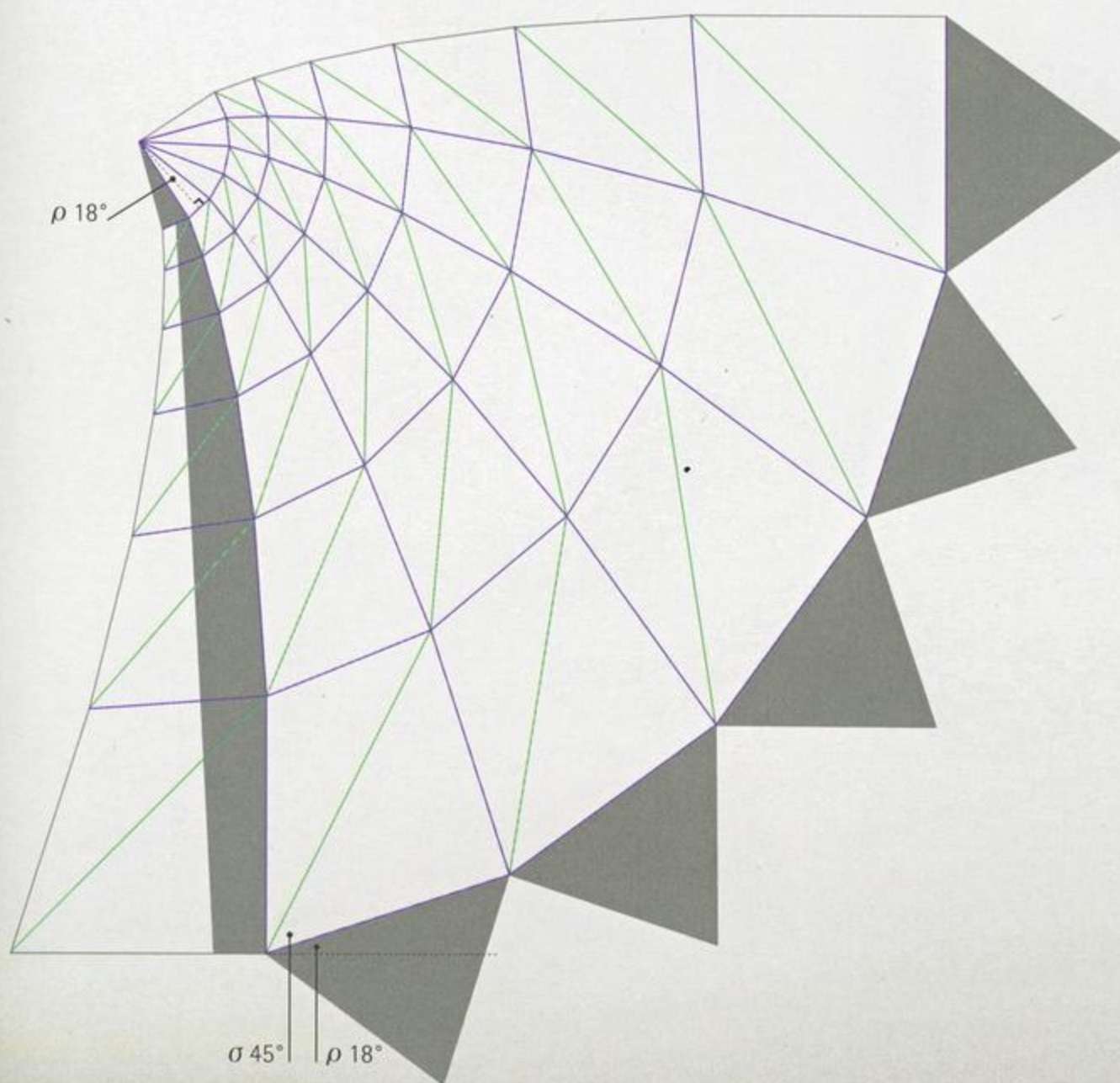
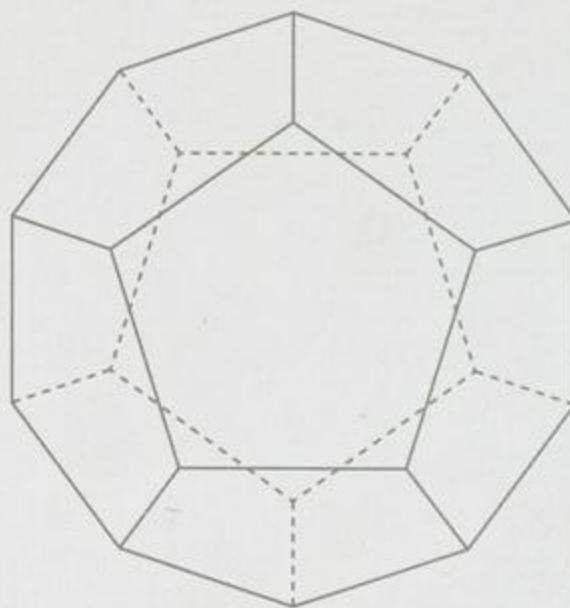
mountain fold

valley fold



DODECAHEDRON WHIRLPOOL STAR

For the Dodecahedron Whirlpool Star you need 12 whirlpool spirals of type 5|18|45.
Make a dodecahedron base of cardboard and paste the whirlpool spirals on its faces. You may adjust the widths of the gluing flaps according to the requirements.

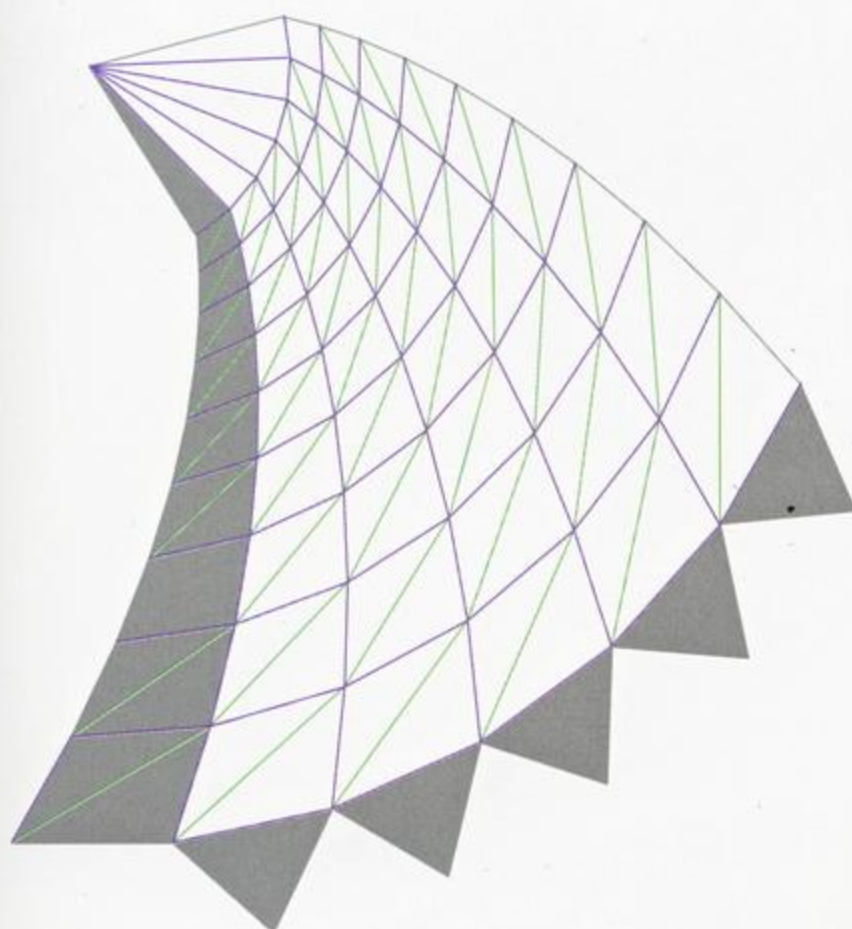
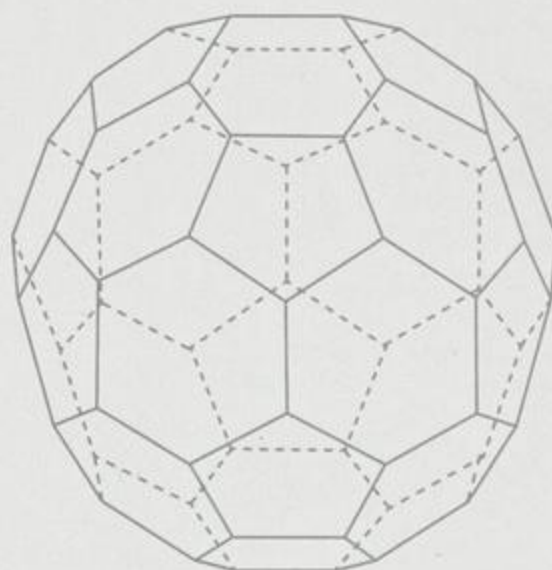




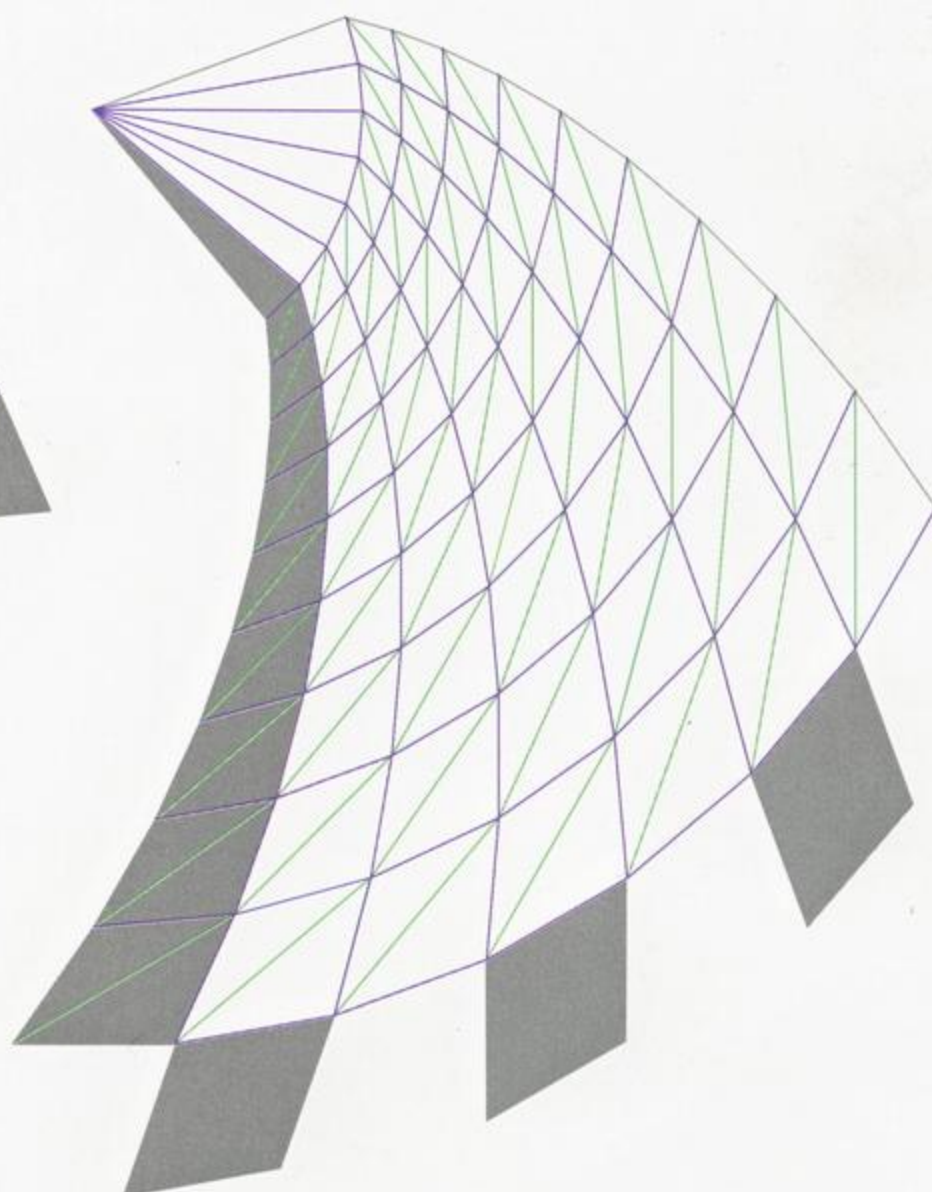
TRUNCATED ICOSAHDREDON WHIRLPOOL STAR

For the Truncated Icosahedron Whirlpool Star you need 12 whirlpool spirals of type 5|12|30 and 20 whirlpool spirals of type 6|10|30.

Make an truncated icosahedron base of cardboard and paste the whirlpool spirals on its faces. You may adjust the widths of the gluing flaps according to the requirements.



5|12|30



6|10|30





4!

Sometimes origami seems to be an art for strong hands, which produces heavy solid objects. In fact we are captivated by the delicate translucency of these forms, and any preconceptions of bulk or mass are quickly forgotten. Standing in the window, submerged in light, like coloured air or delicate vases, they enchant us with the beauty of a fleeting moment.

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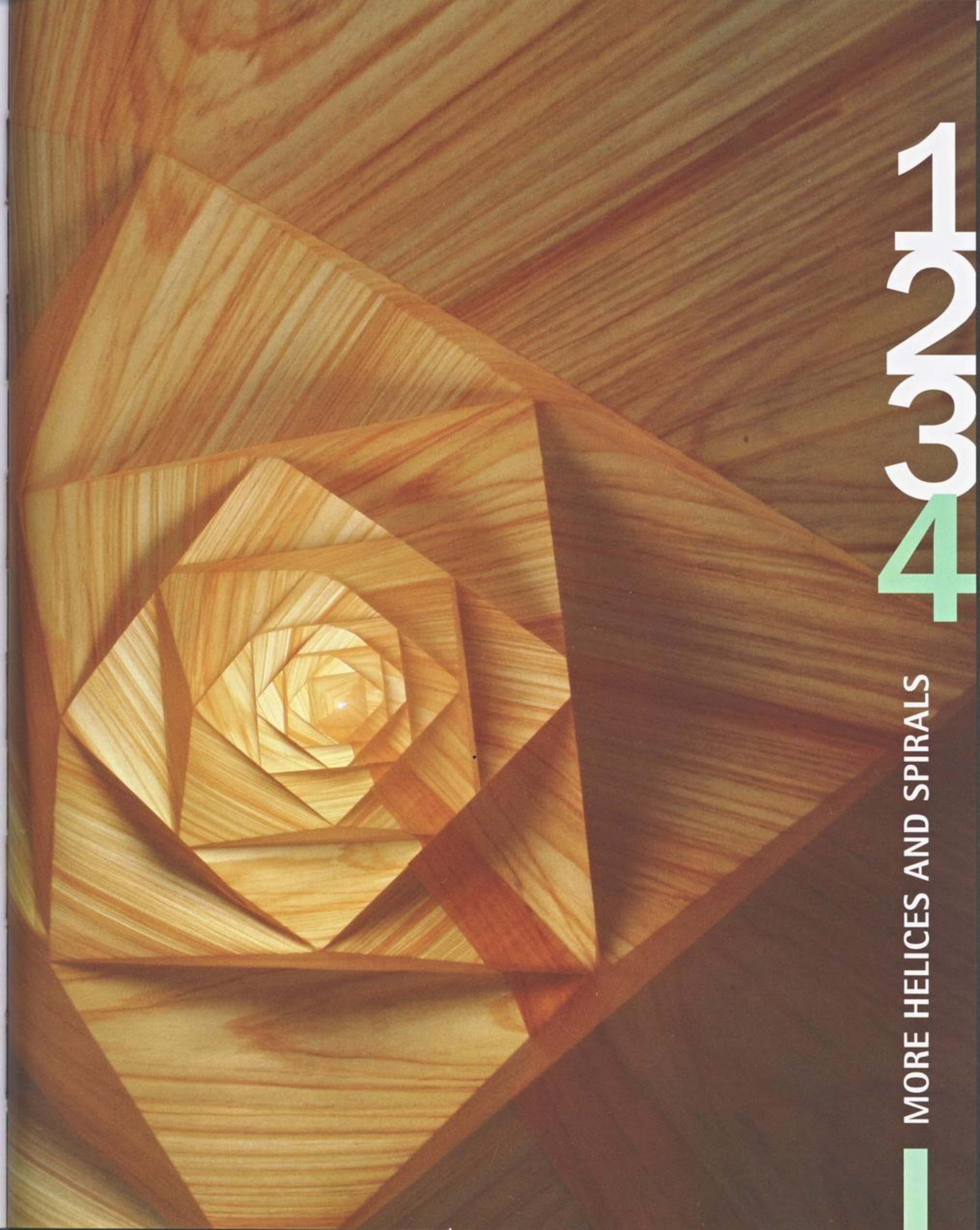
MORE HELICES AND SPIRALS

Starting with right-angled spirals, I will demonstrate how, by combining their crease patterns and rearranging the orientations and alignments of some creases, a multitude of spiral towers can be constructed.

One species of this group was featured in an article *The Infinite Rabbit Ear* by Ernst Bläuensten in 1992 in the origami magazine *der falter*.

Then I continue with Coil Folds, cylindrical versions of the Whirlpool Spirals shown in chapter 3 and Pako Pako, a neat toy made from a Coil Fold.

Some spiral-faced solids and a number of solids enclosing helices complete the chapter.



MORE HELICES AND SPIRALS

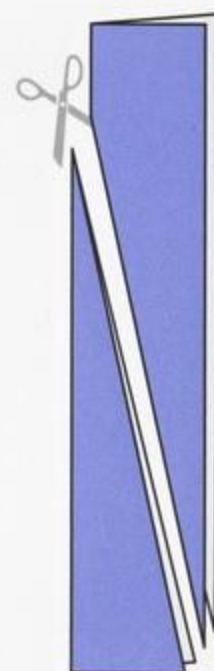
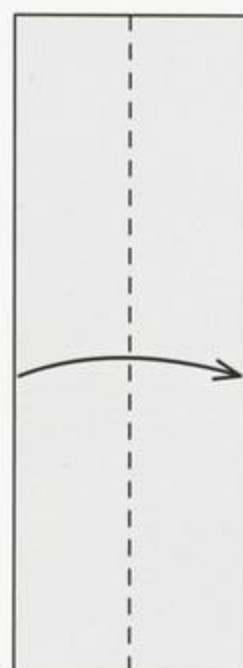
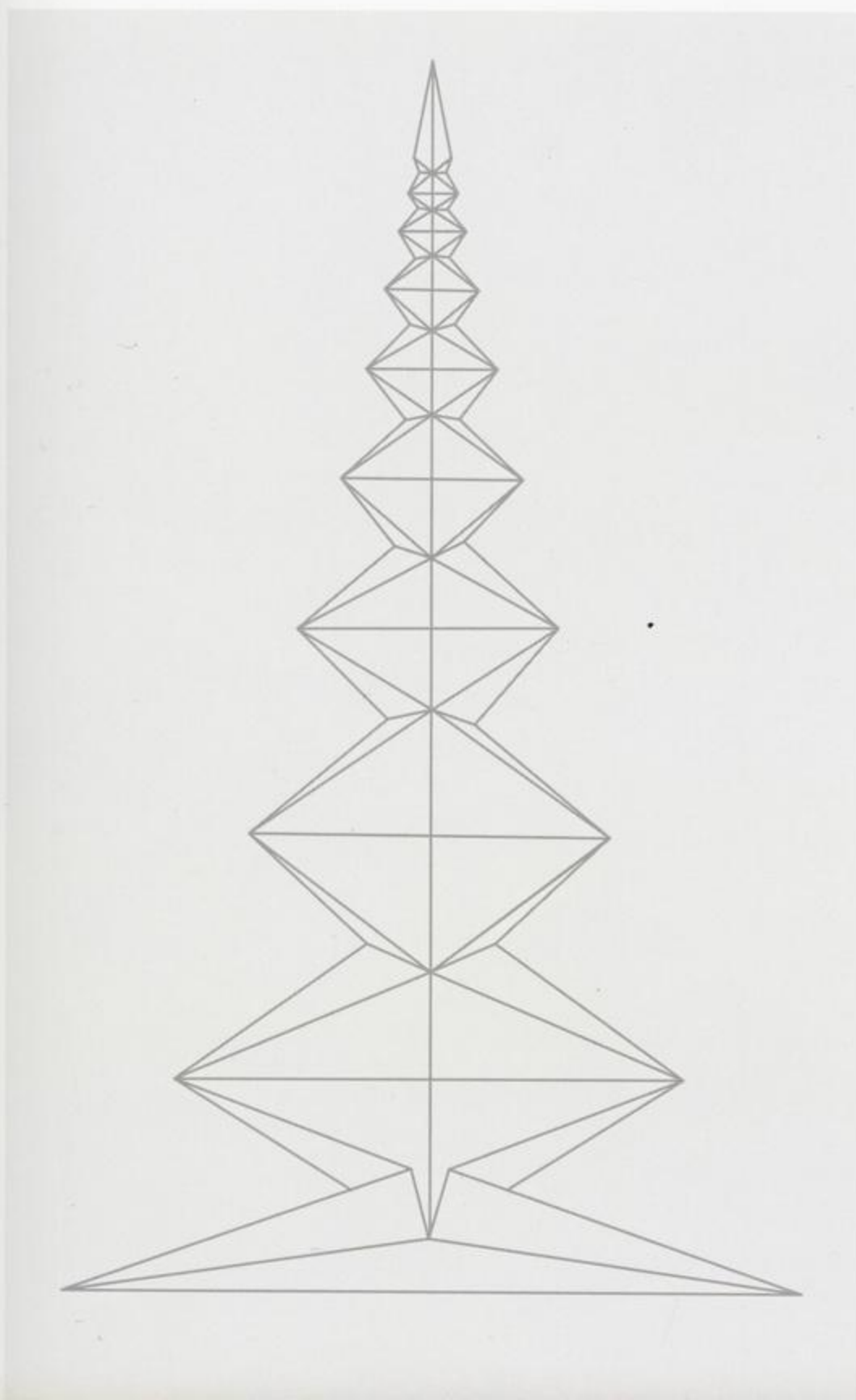
4321

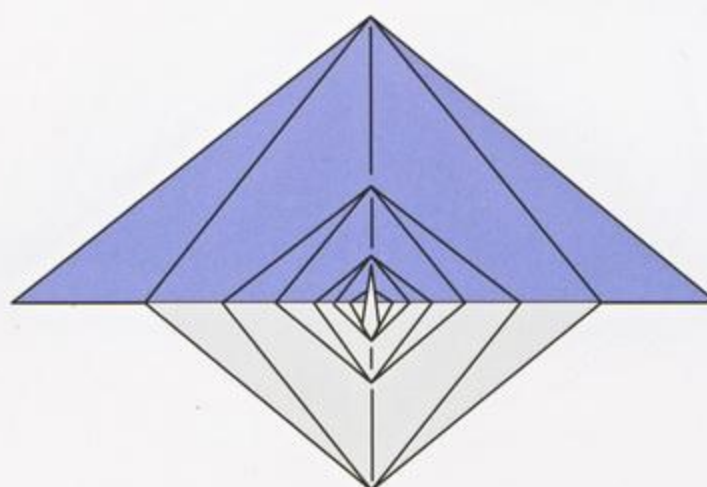
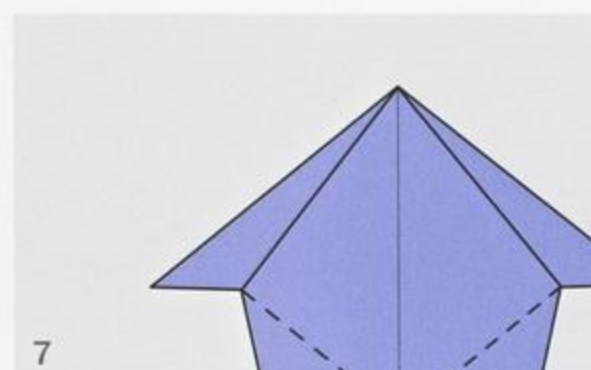
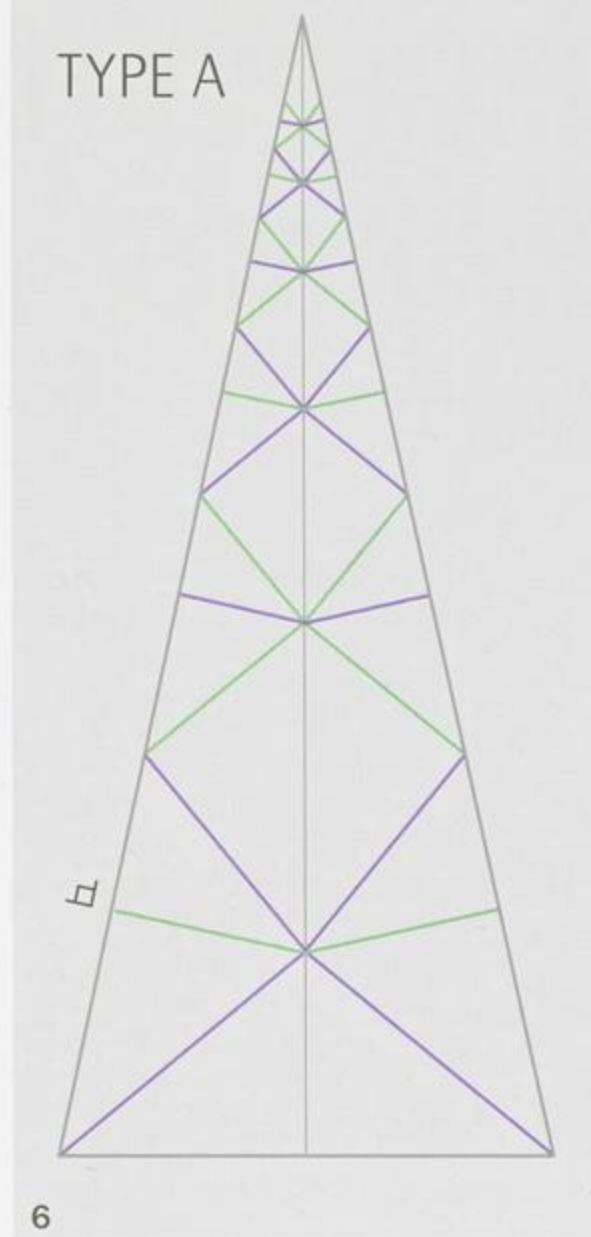
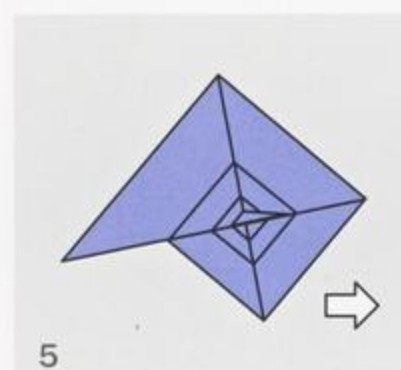
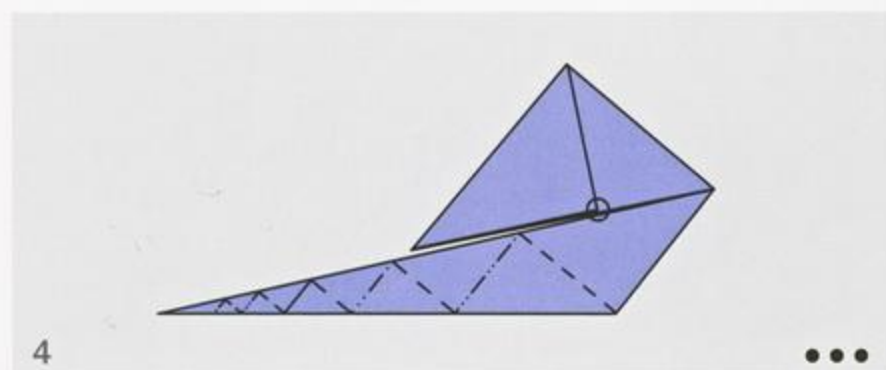
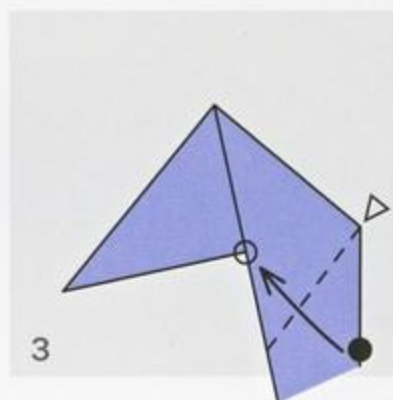
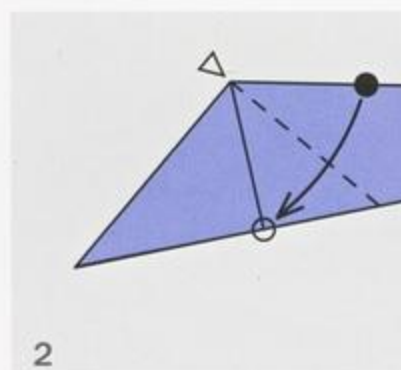
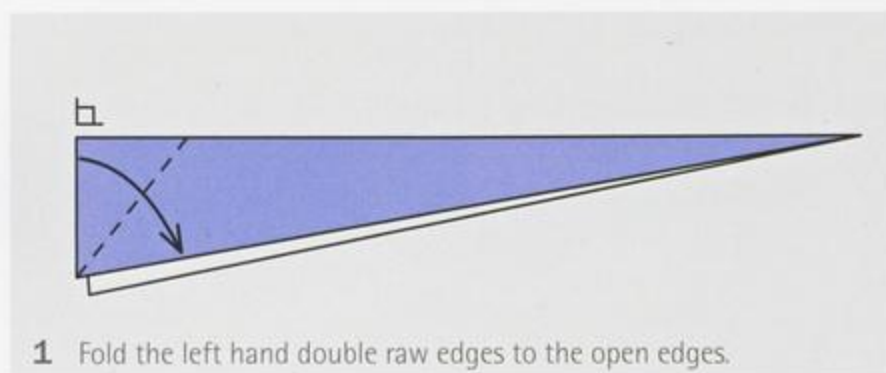
直角らせん折り



RIGHT-ANGLED SPIRALS

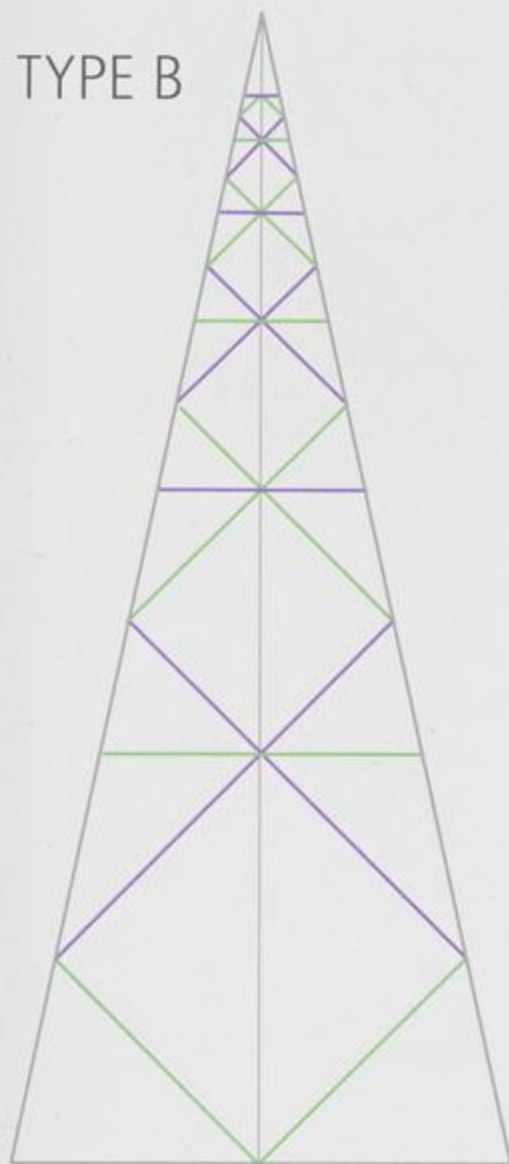
Start with a two-layered right-angled triangle cut from an A4 and coil it to a right-angled spiral. This can be done in two ways. Unfold and fold again with the orientation of creases rearranged to receive interesting forms. See the details on the following pages.



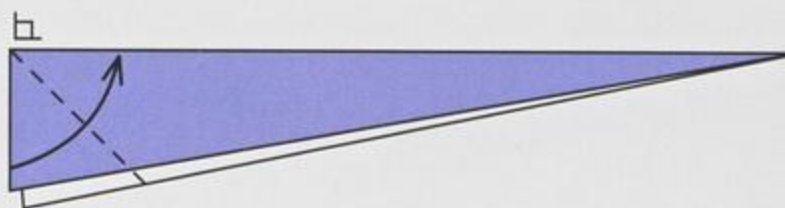


— mountain fold
— valley fold

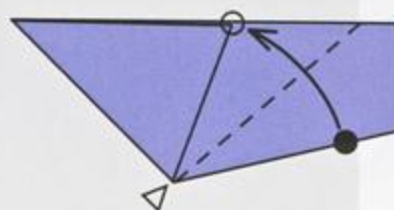
TYPE B



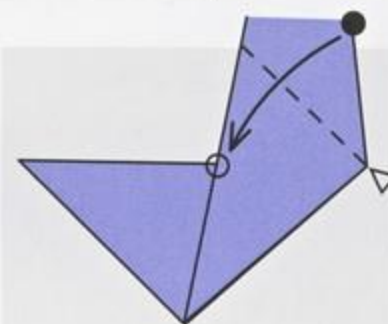
6



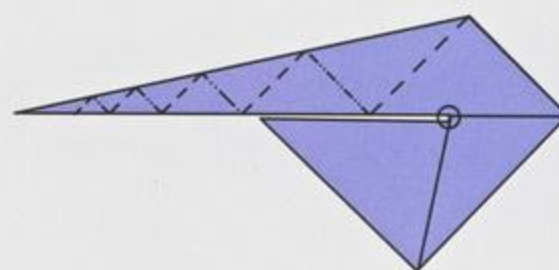
1. Fold the left hand double raw edges to the folded edge.



2

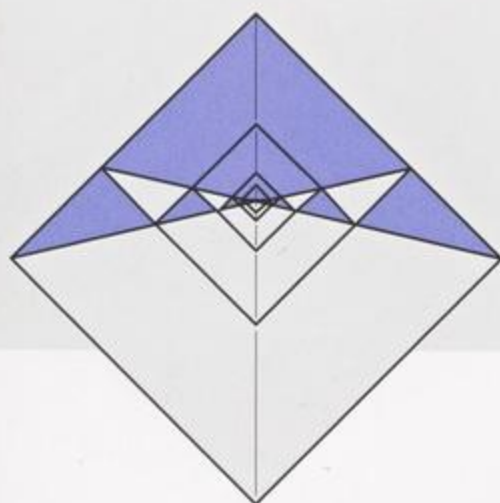


3



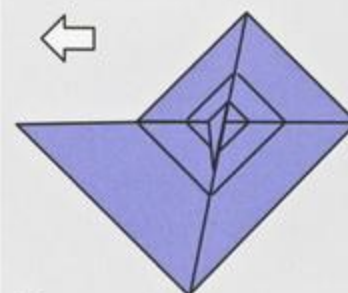
4

...

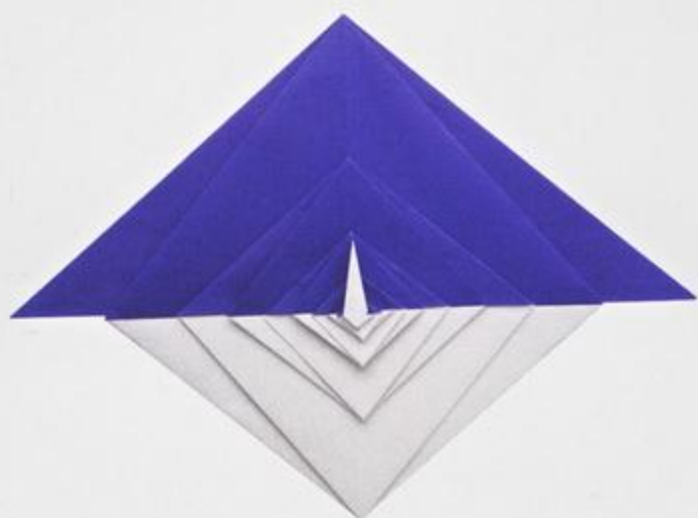


7

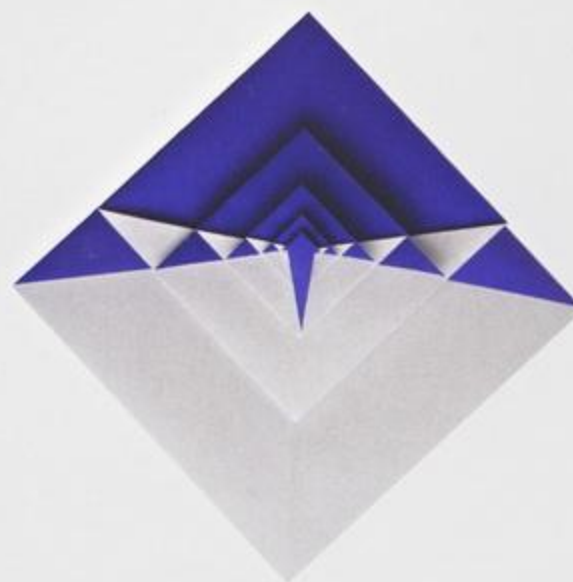
Type B with small
centre angle.



5



TYPE A



TYPE B





スパイラルタワー



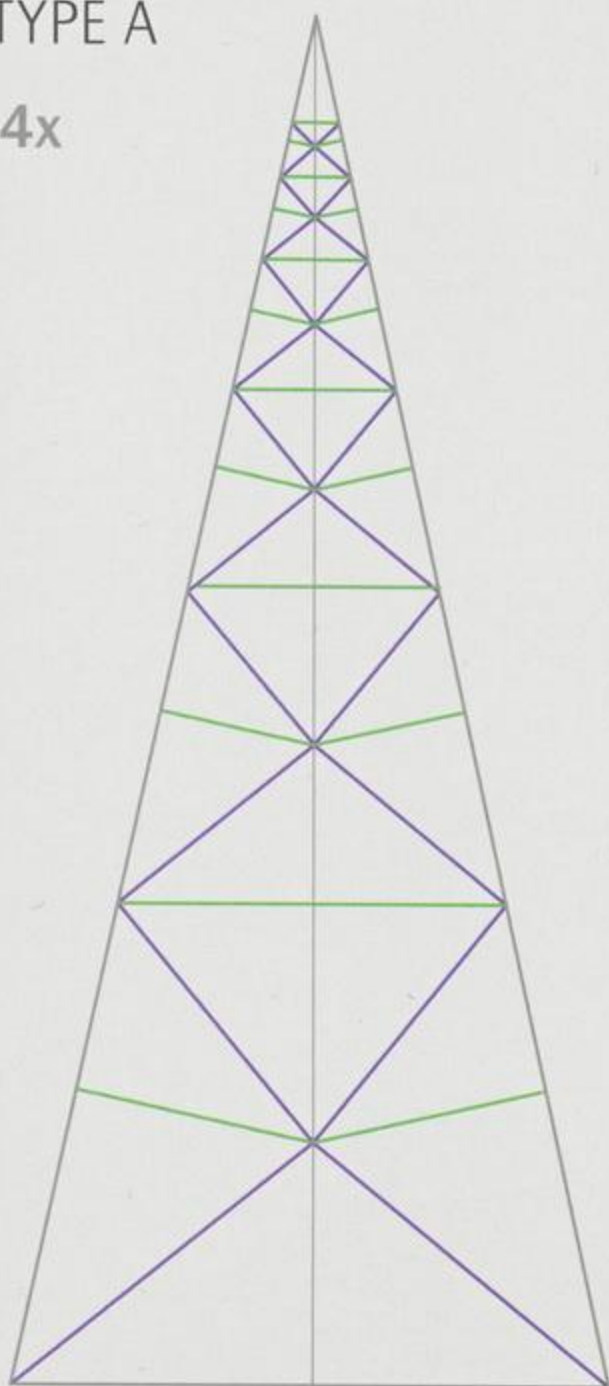
SPIRAL TOWERS

Rearrange the crease orientations of the Right-Angled Spirals and add some new creases as shown below to get new basic crease patterns. These too can be folded flat as shown on the following pages. Combine three or four of them to arrive at the full crease patterns for the 3D Spiral Towers.

— mountain fold
— valley fold

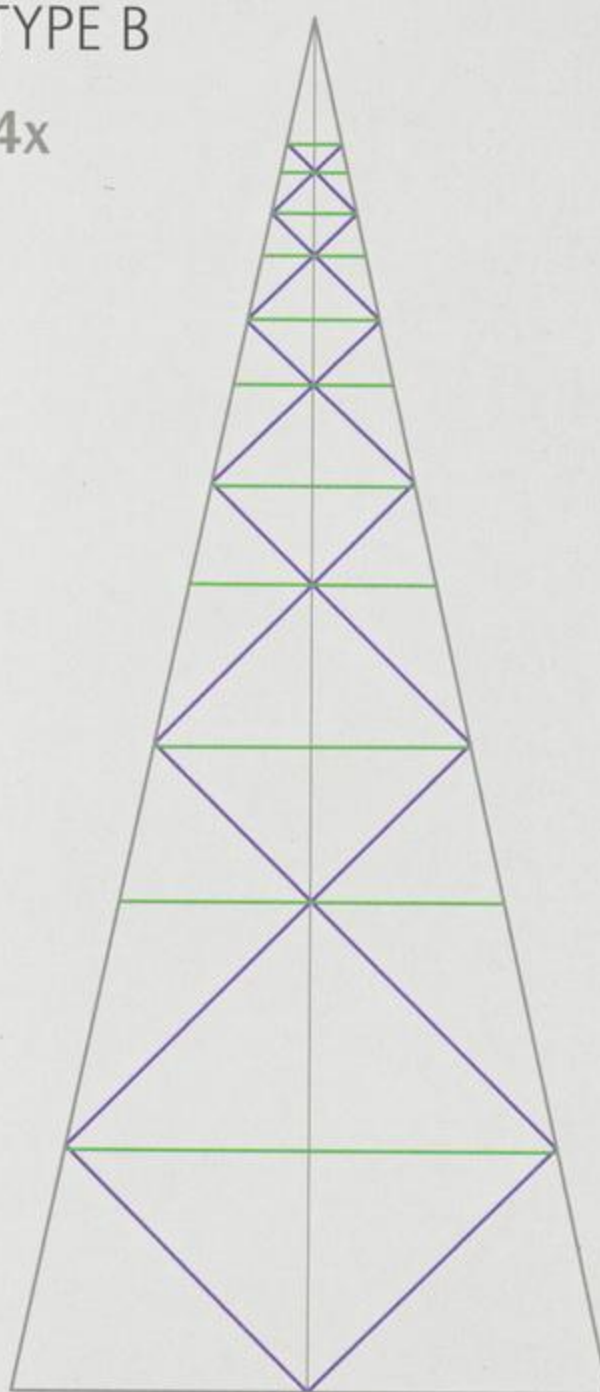
TYPE A

4x



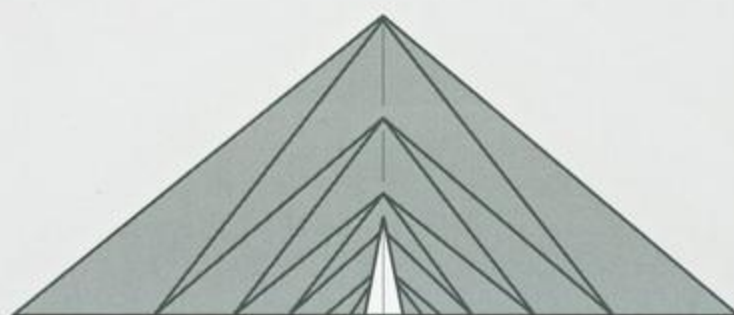
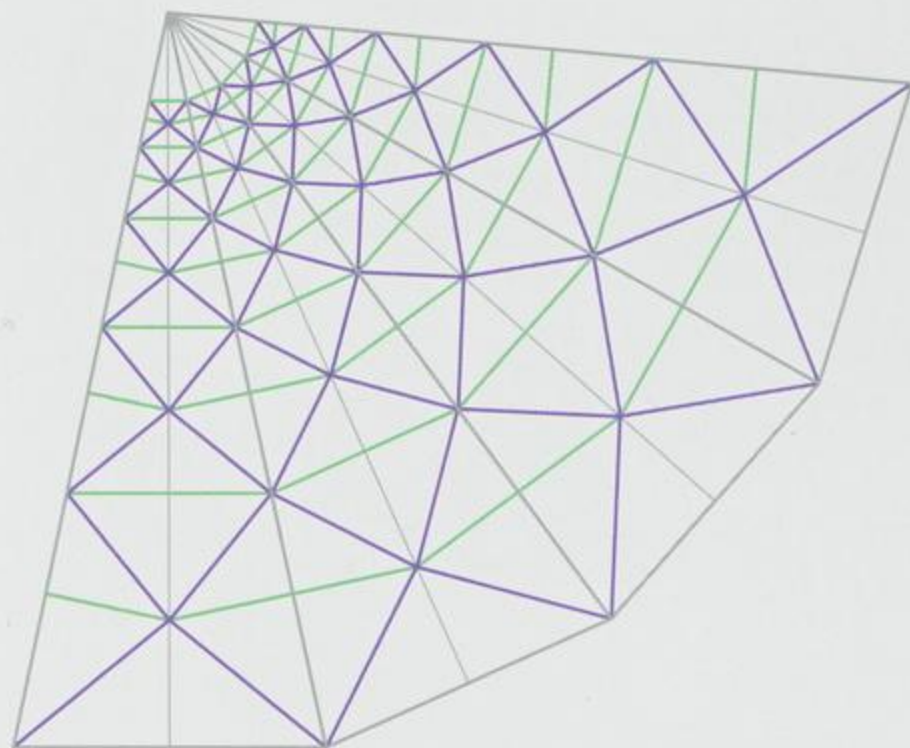
TYPE B

4x

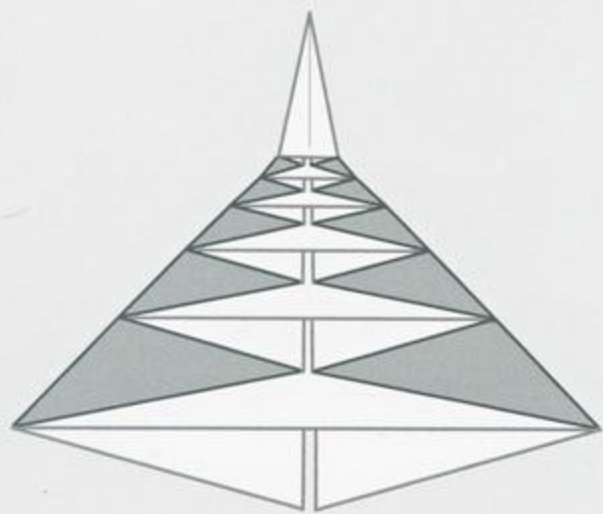
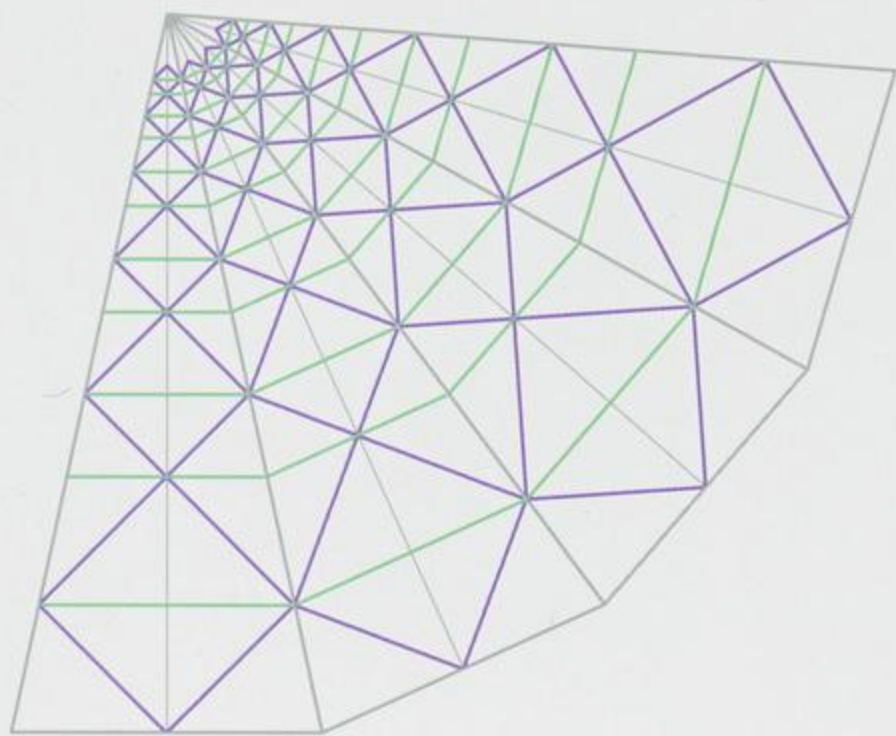




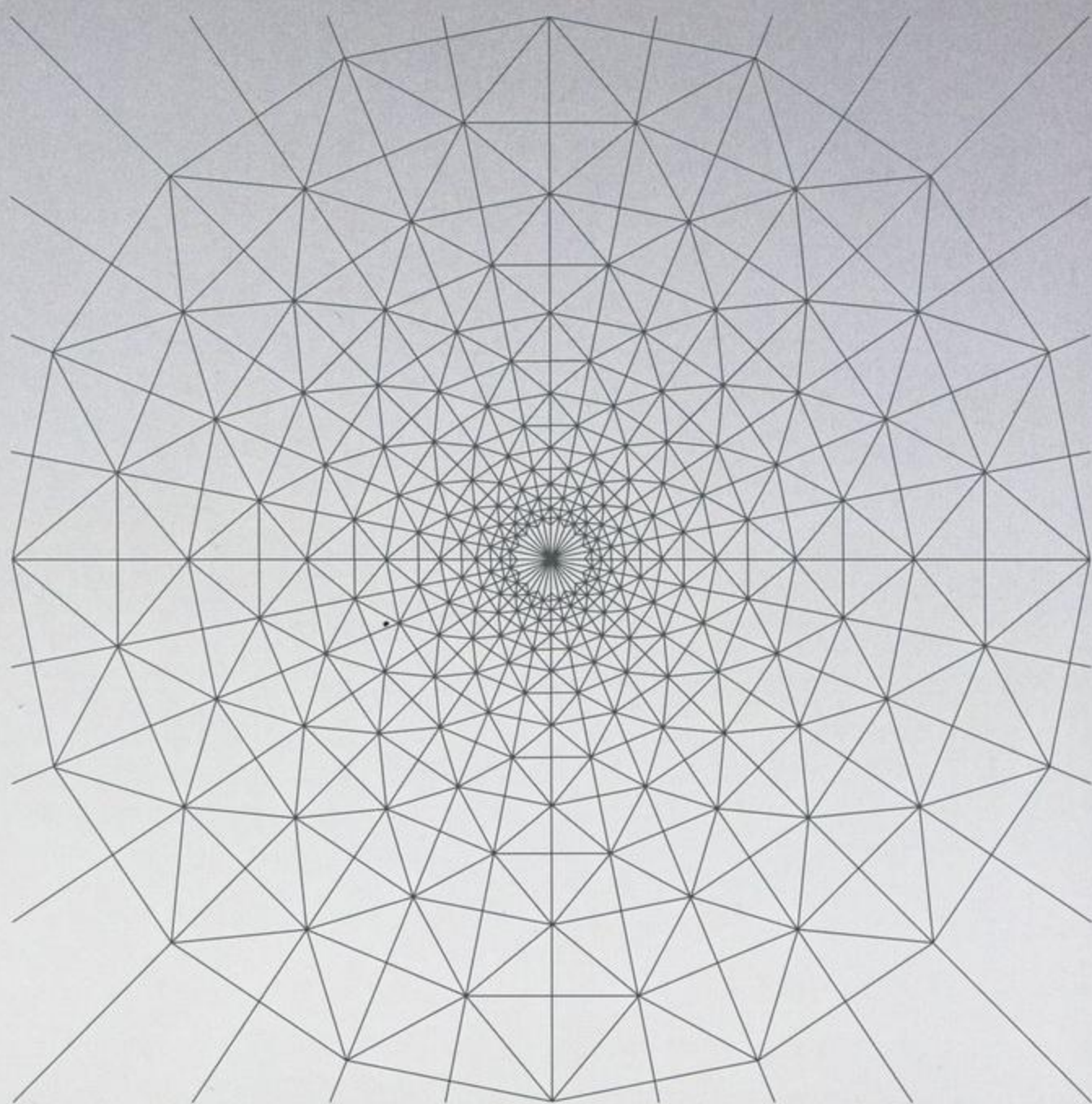
TYPE A



TYPE B



エルンストさんのパターン



CREASE PATTERN BY ERNST BLÄUENSTEIN

The Spiral Towers pattern »Type A« on page 227 with a centre angle 22.5° has been featured in the article entitled *The Infinite Rabbit Ear* by Ernst Bläuenstein in the German Origami magazine *der falter* vol. 9. The content is summarized as follows.

If 4 pieces of figure 1 are joined next to each other, they become figure 2.

FIG. 1

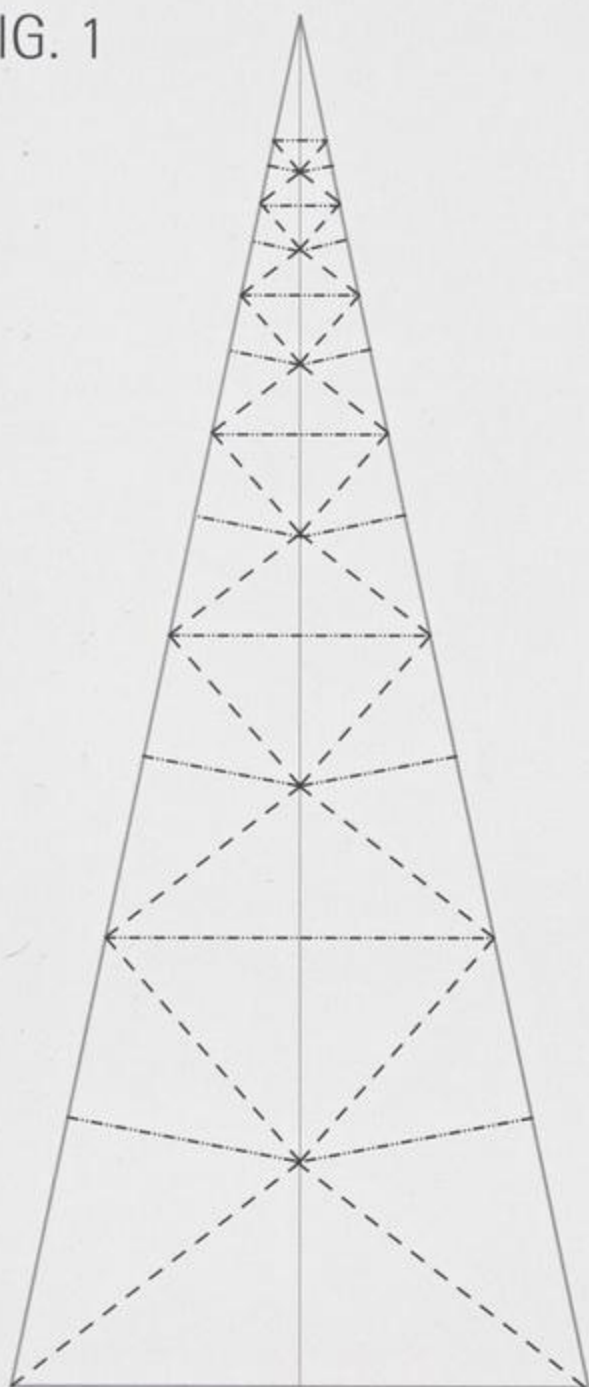
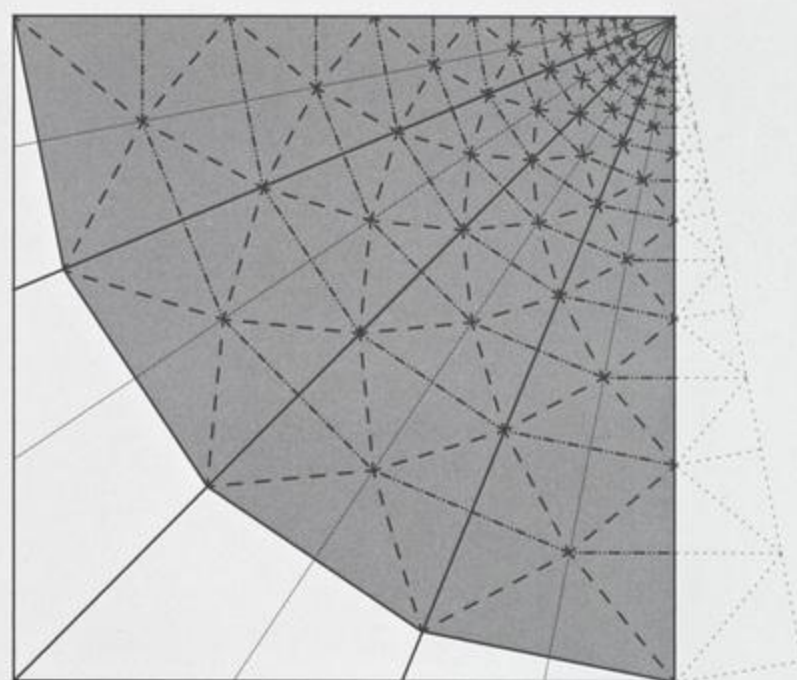


FIG. 2



The extra section on the right is used as a tab to glue the tower.

Ernst Bläuenstein's version with
centre angle 22.5°

FIG. 3

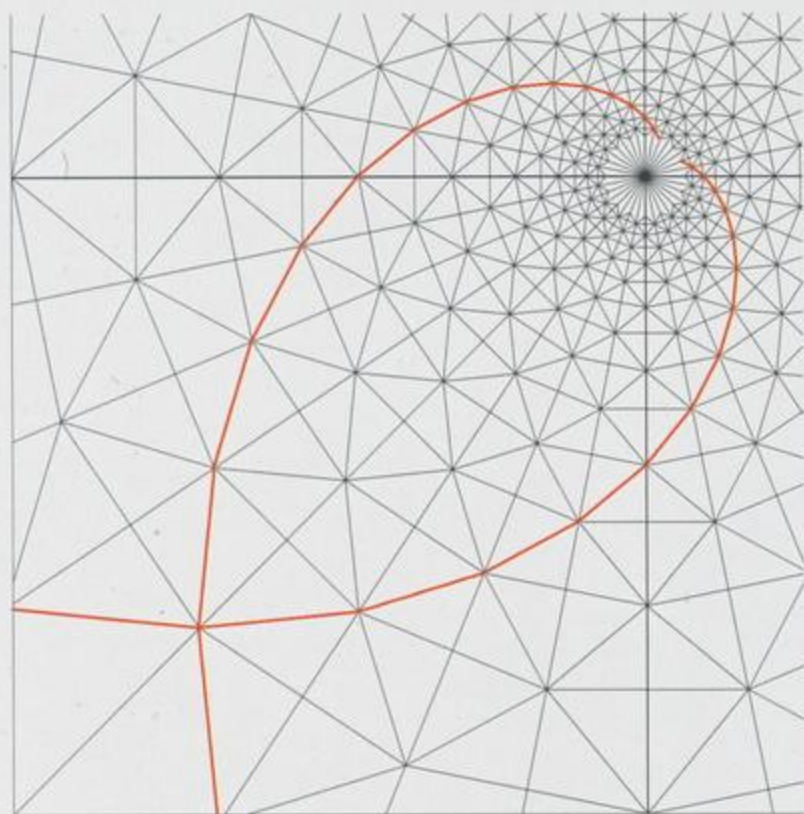
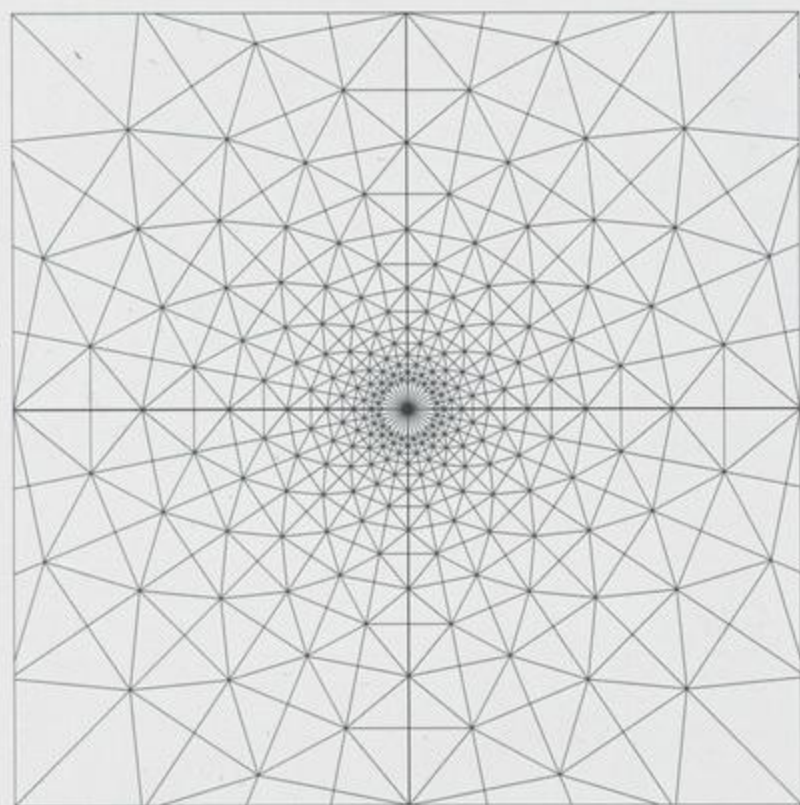


Fig. 2 from previous page is contained within Fig. 3. In Fig. 3 the endpoints of the highlighted lines are in line with logarithmic spirals. These lines run continuously over the entire crease pattern in Fig. 4, which is actually four times Fig. 2, arranged rotationally.

Mr Ernst Bläuenstein actually used the pattern of figure 2 to make a lamp shade. To make a tower or lamp shade, the unshaded part in figure 2 needs to be cut off. Precrease the pattern, then form a square pyramid and arrange the creases.

FIG. 4





スパイラルタワーのバリエーション



SPIRAL TOWER VARIATIONS

On this and the following pages I show some variants of the A and B type Spiral Towers. Not all of them can be folded into flat figures. Observe the hints in the crease patterns like equal divisions of angles and 90° angles.

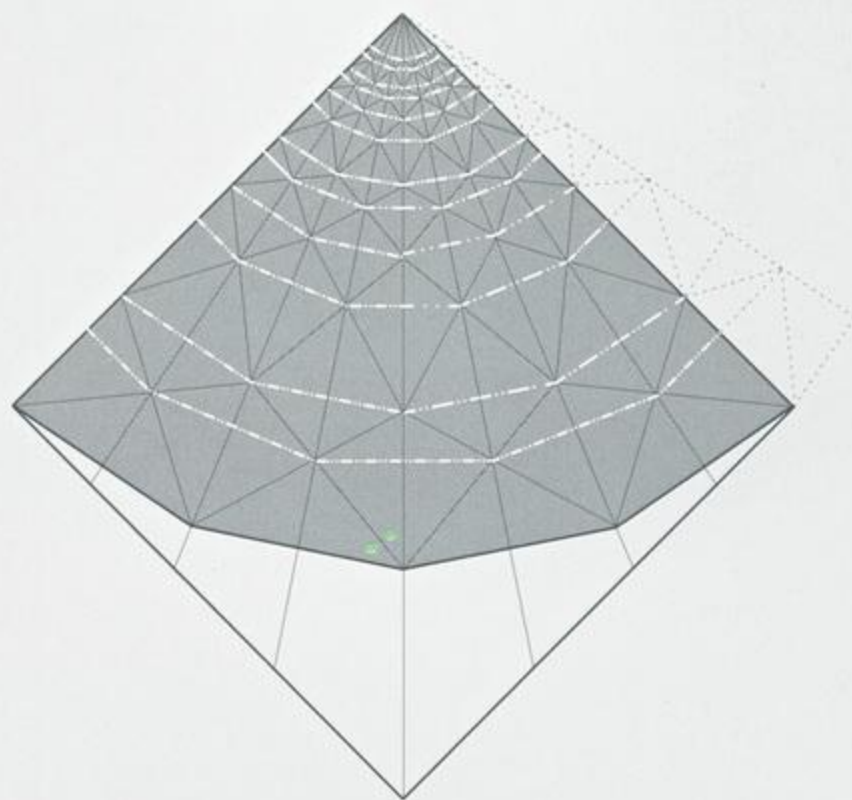
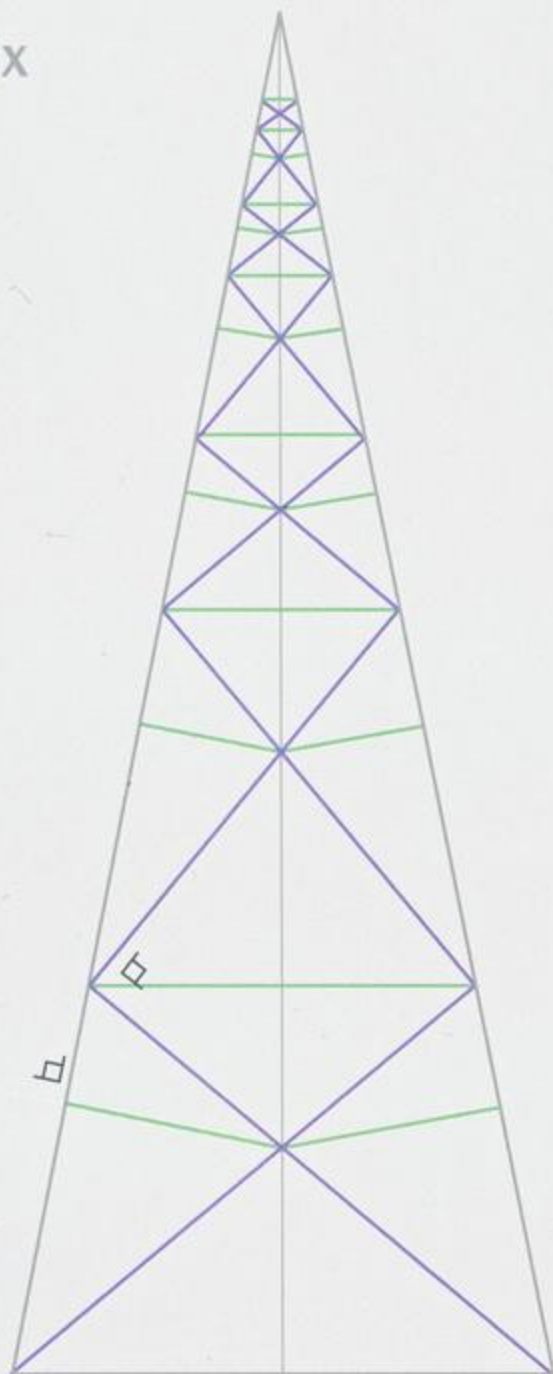
Connect 3 or 4 basic patterns to get the full crease pattern. The centre angles can vary in some degree.



TYPE A' $22,5^\circ$

TOWER BASE: SQUARE

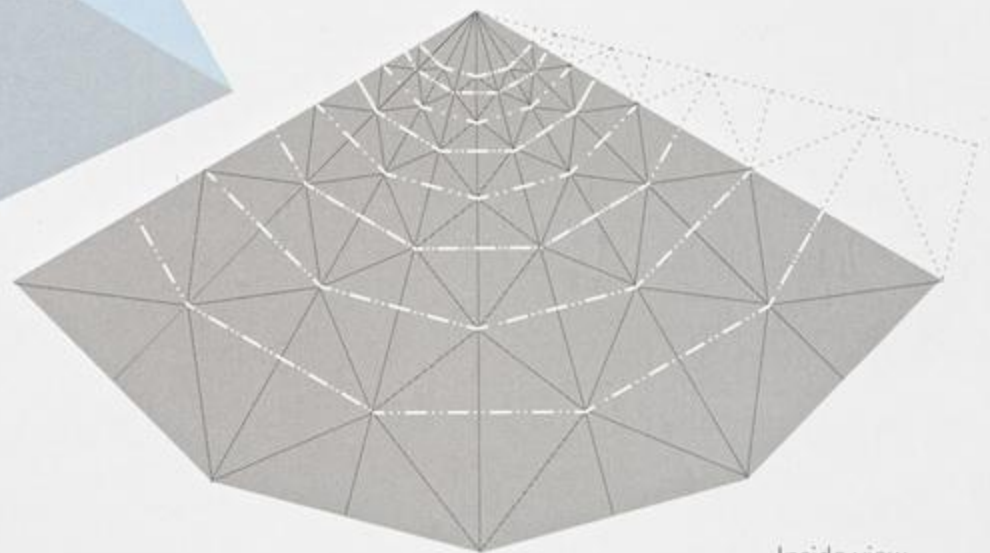
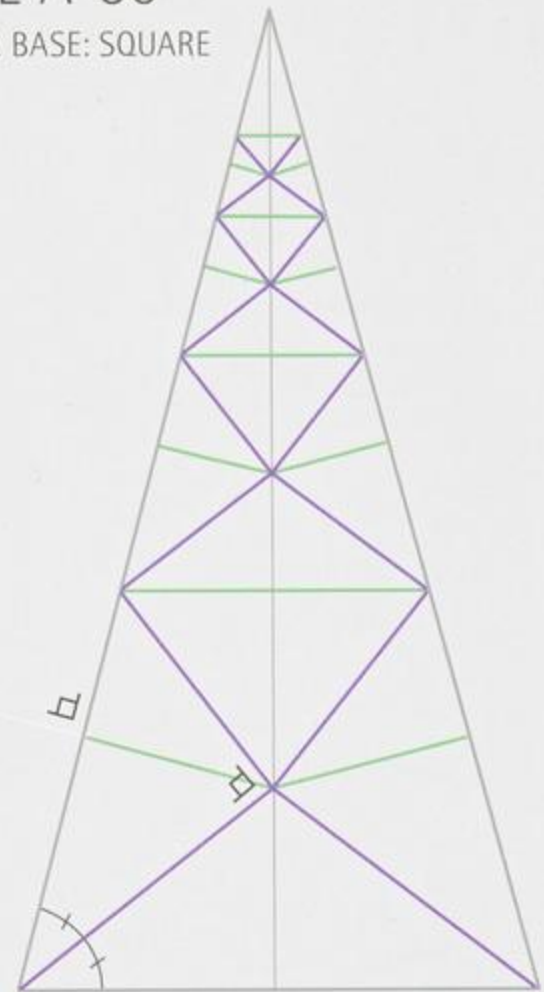
4x



Inside view.

TYPE A' 30°
TOWER BASE: SQUARE

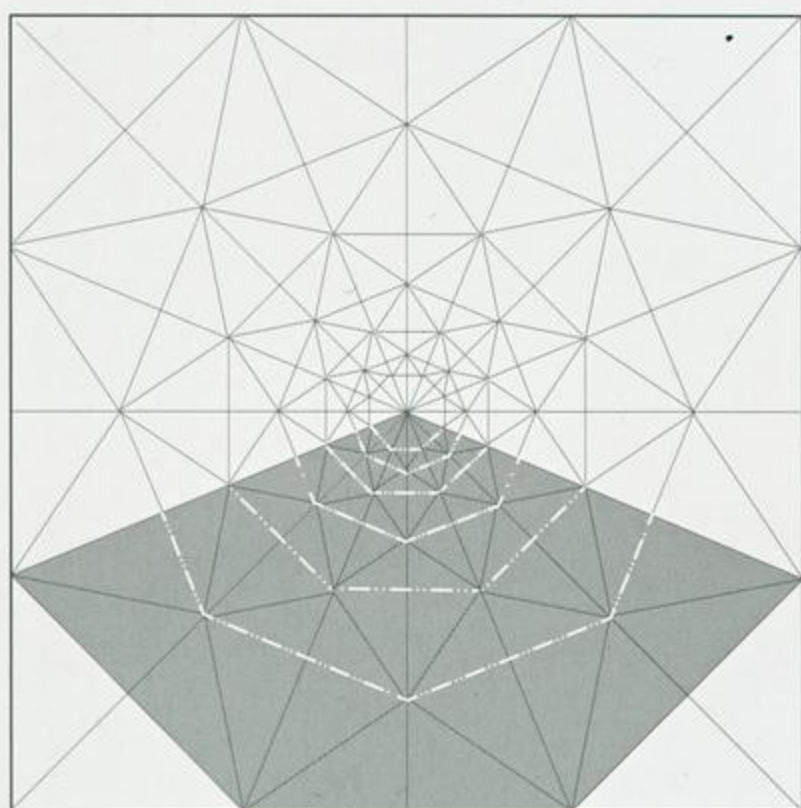
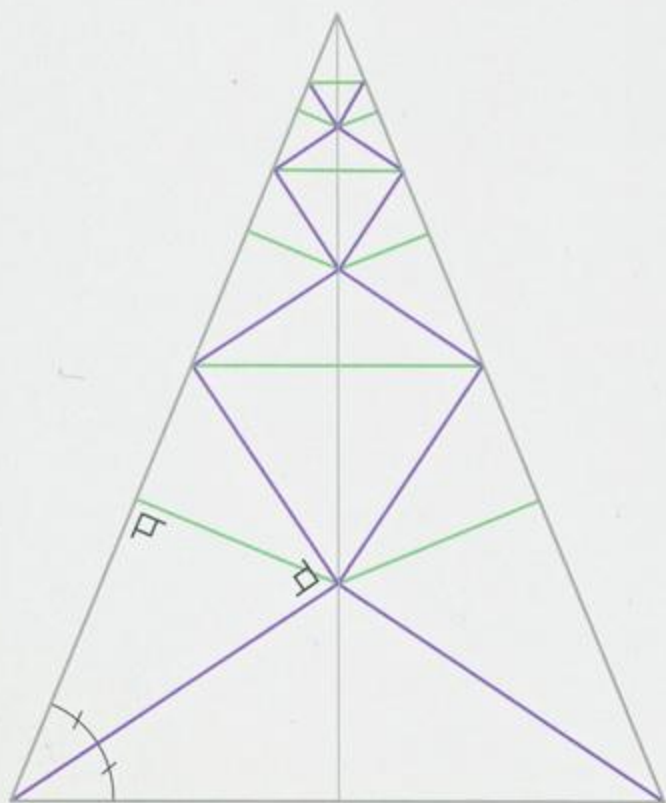
4x



Inside view.

TYPE A' 45°
TOWER BASE: TRIANGLE

3x



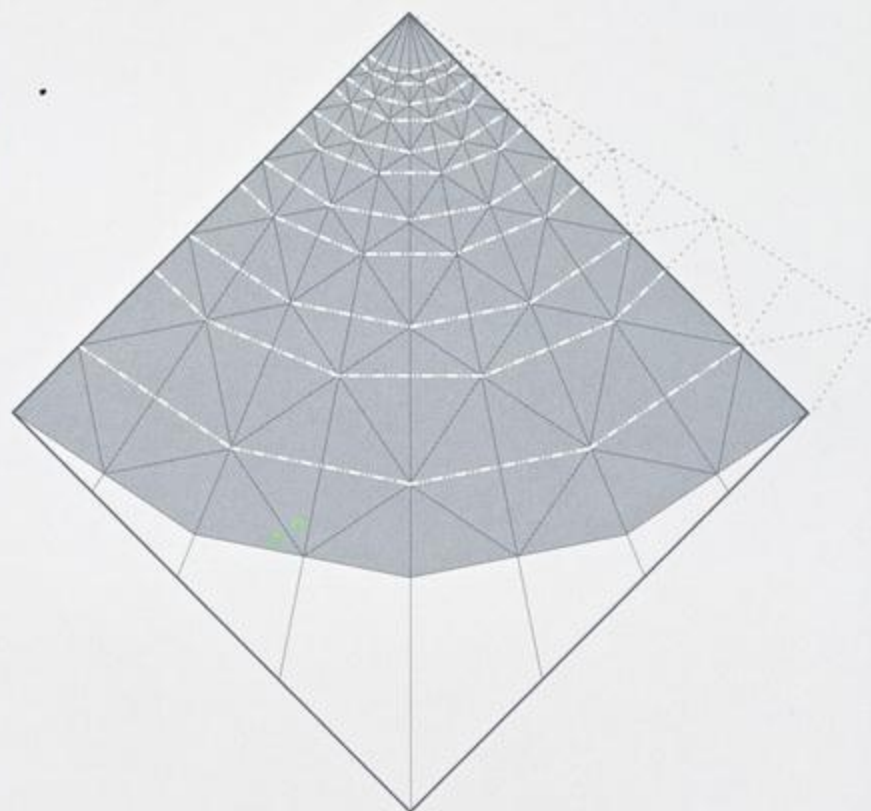
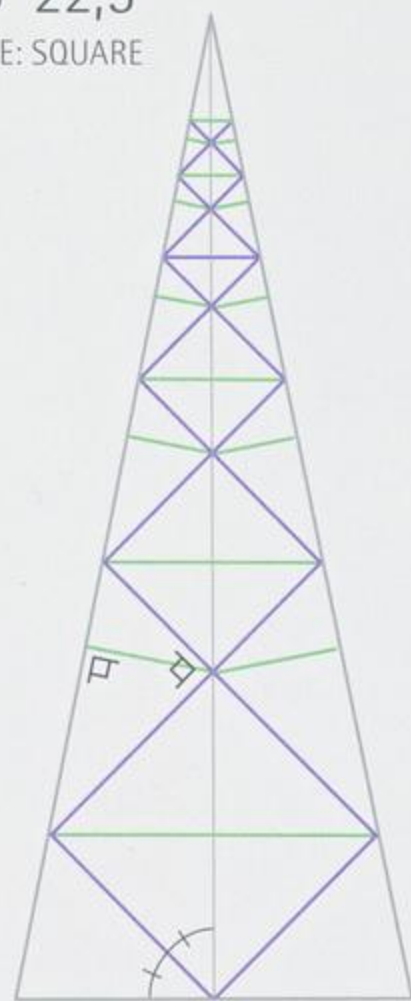
Inside view.



TYPE B' 22,5°

TOWER BASE: SQUARE

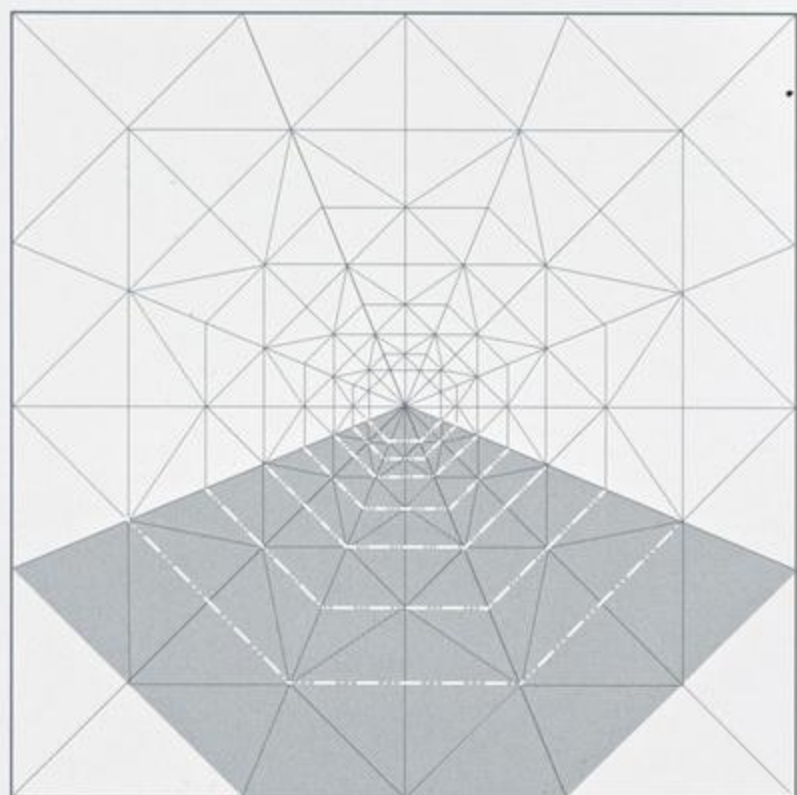
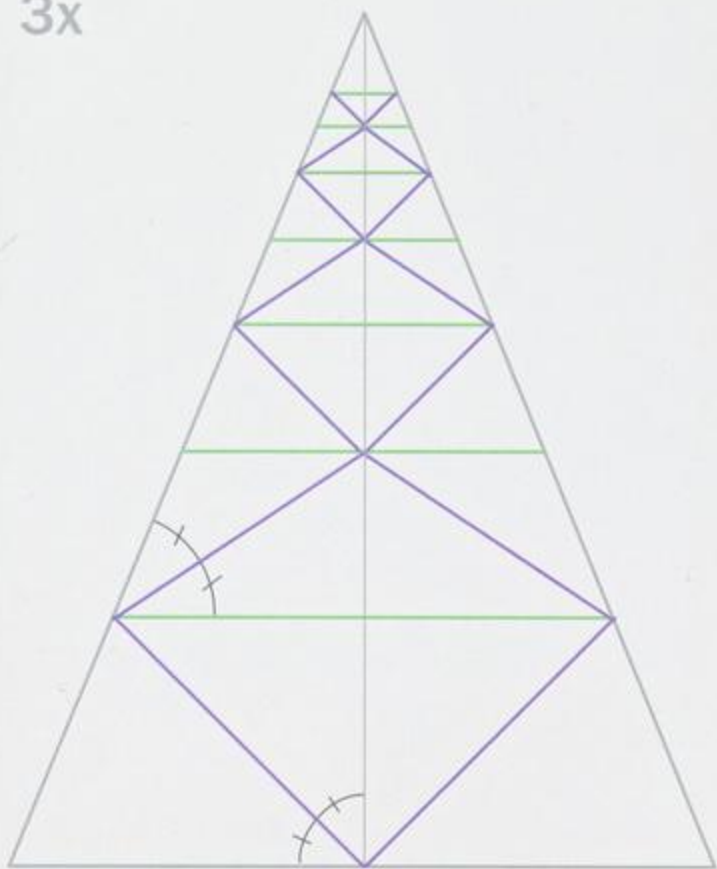
4x



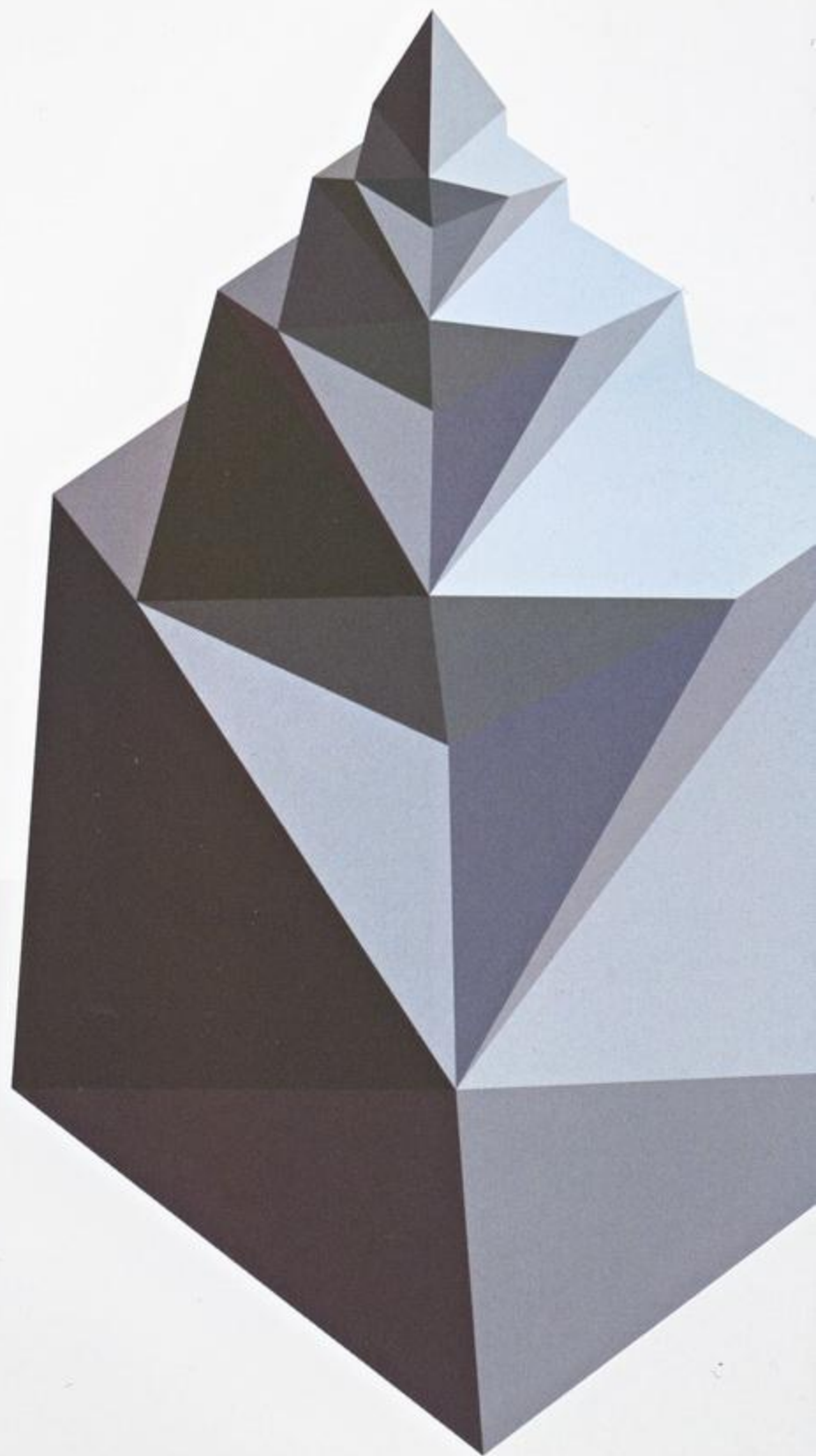
Inside view.

TYPE B'' 45°
TOWER BASE: TRIANGLE

3x



Inside view.







コイル折り



COIL FOLDS

With Coil Folds you can fold cylinders that can contract and expand. A good example of a coil fold is a Japanese lantern. Japanese lanterns are made of coiled bamboo frames that are covered with Washi.

Coil Folds do not need a frame, just paper and creases.

According to my definition in »Helices and Spirals« on page 18 Coil Folds are helices.

EXPLANATION OF THE CONSTRUCTION OF CREASE PATTERNS AND THE NOTATION

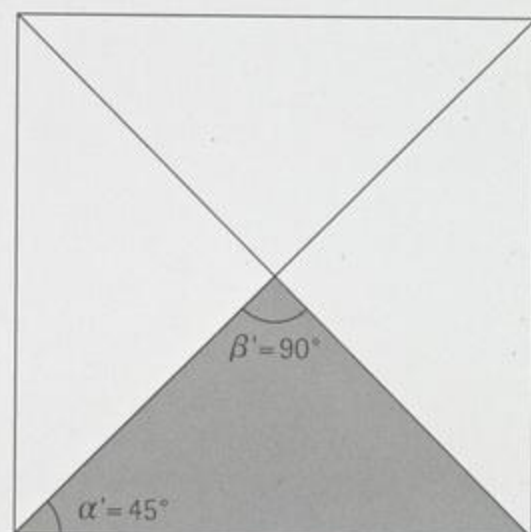
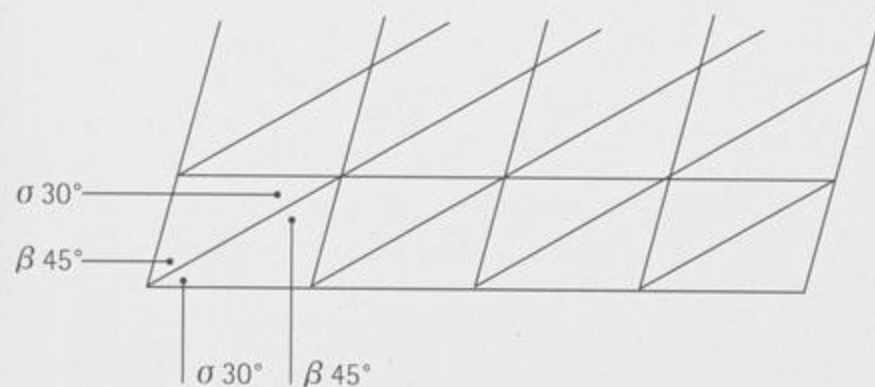
Coil Folds are variants of *Whirlpool Spirals* with angles of rotation $\rho = 0^\circ$. Therefore the same rules apply to Coil Folds (see »Explanation of the Notation and Construction of Crease Patterns« on page 153). The simplified rules with $\rho = 0^\circ$ for some primal polygons are shown below and on the following page.

SQUARES

PRIMAL POLYGON AND PRIMAL TRIANGLE

$$\sigma = \alpha' = 45^\circ$$

Special case 2, coil fold does not have a hole.



$n = 4$

$$0^\circ < \sigma \leq \alpha' = 45^\circ$$

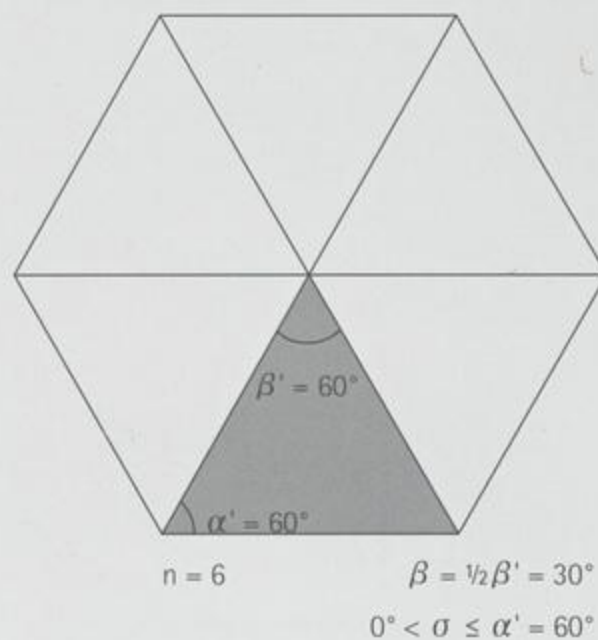
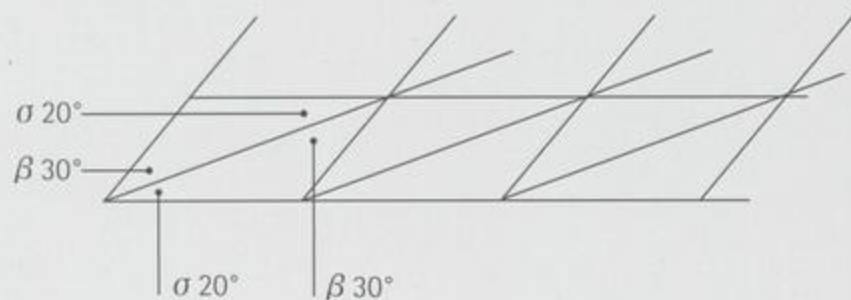
$$\beta = \frac{1}{2}\beta' = 45^\circ$$

HEXAGONS

PRIMAL POLYGON AND PRIMAL TRIANGLE

$$\sigma = \alpha' = 60^\circ$$

Special case 2, coil fold does not have a hole.

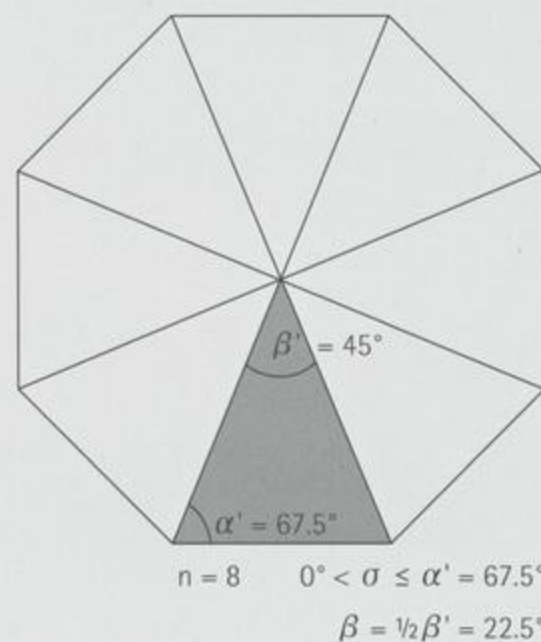
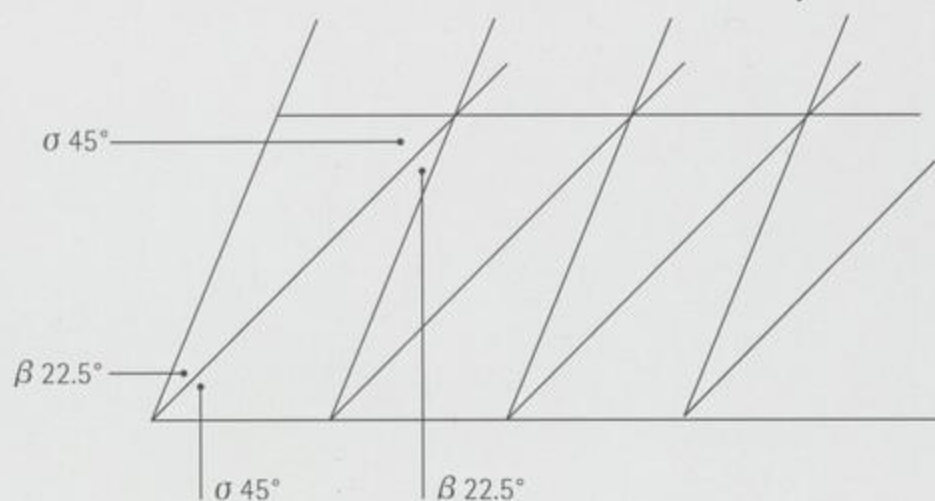


OCTAGONS

PRIMAL POLYGON AND PRIMAL TRIANGLE

$$\sigma = \alpha' = 67.5^\circ$$

Special case 2, coil fold does not have a hole.

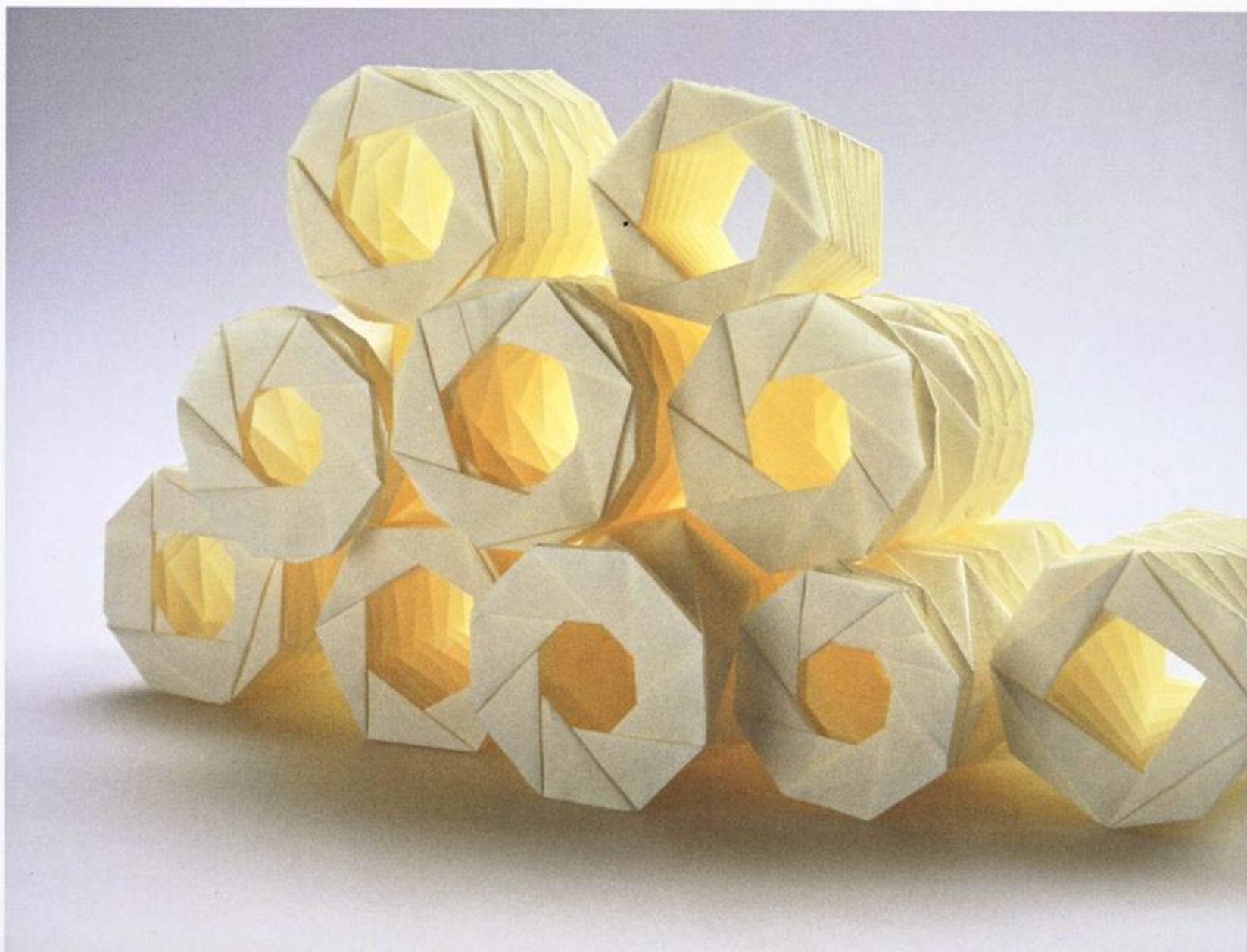
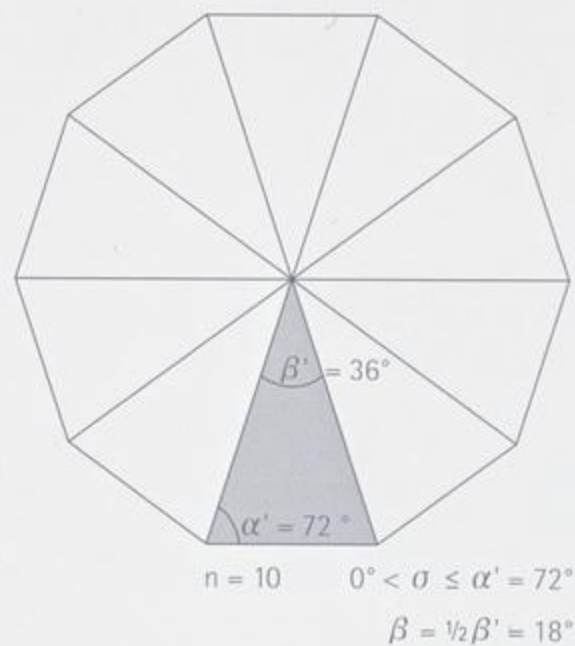
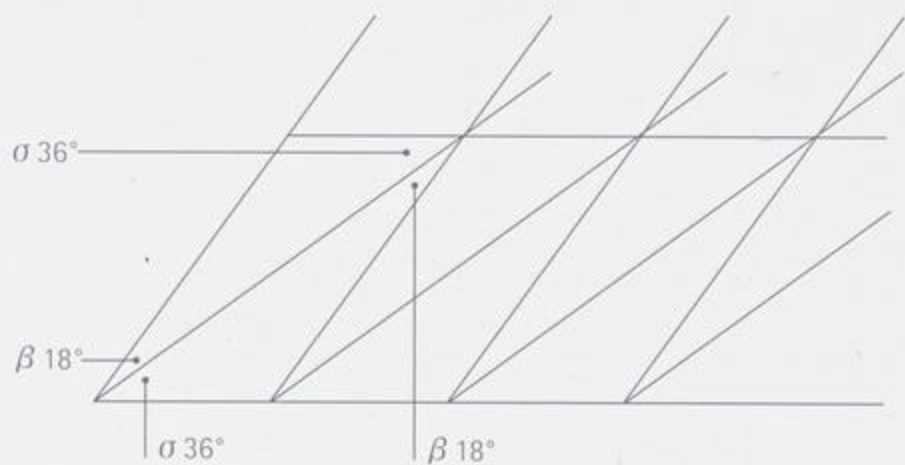


DECAGONS

PRIMAL POLYGON AND PRIMAL TRIANGLE

$$\sigma = \alpha' = 72^\circ$$

Special case 2, coil fold does not have a hole.



LEGEND

The Coil Fold notation is similar to the notation of Whirlpool Spirals. The legend explains the respective meanings.

Taking 4 | 30 | S as an example

4, the number of corners of the primal polygon, a square in this case
30, the angle of spirality
S, for Standard stacking

Taking 4 | 30 | M as an example

4, the number of corners of the primal polygon, a square in this case
30, the angle of spirality
M, for Mirror Standard stacking

S | Standard

The crease patterns in the standard case S are constructed as shown in »3. Construct the crease pattern« on page 168 by stacking rows of basic triangles. Because of $\rho = 0^\circ$ there is no scaling down of the successive rows and the sides of the crease patterns remain parallel. However, besides the standard stacking case there are some additional cases.

M | Mirror Standard

In this case each row of stacked basic triangles is the mirror image of its predecessor row.

H | Hexagon

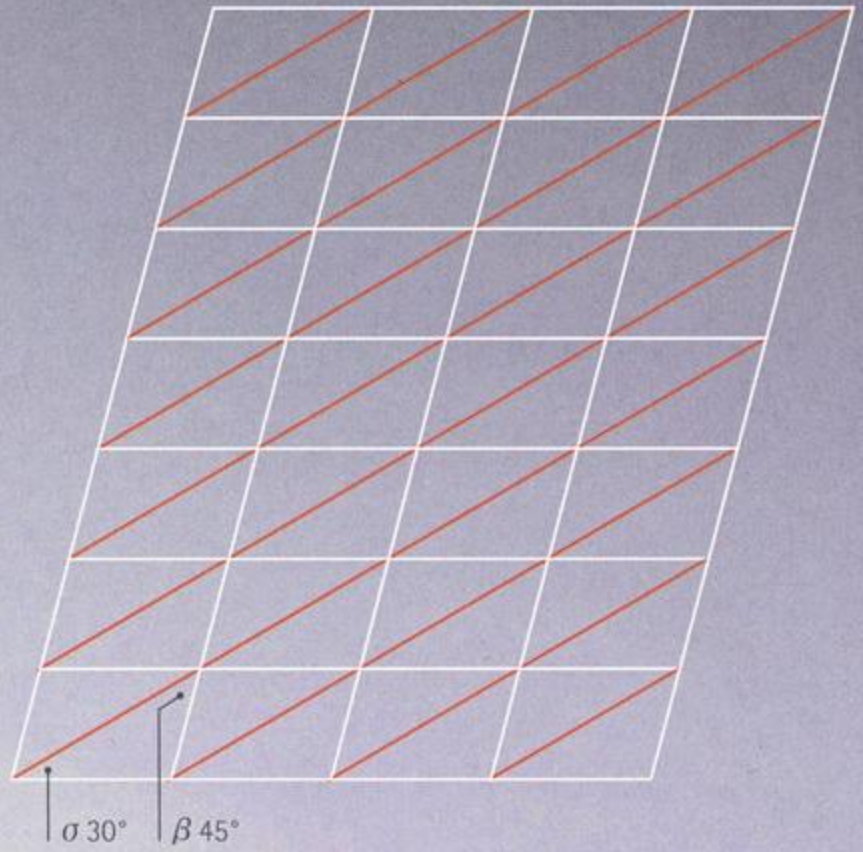
In this case the stacked pairs of triangles (parallelograms) are converted into hexagons by exchanging the top and bottom edges of the parallelograms by the sides of an isosceles triangle with centre angle $180^\circ - \beta$. Have a look at an appropriate crease pattern on the next pages to understand this case.

MH | Mirror Hexagon

In this case both of the operations M and H are applied simultaneously.

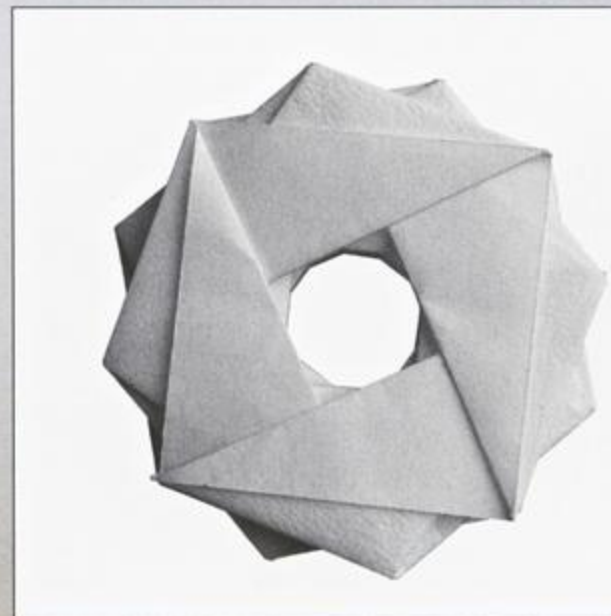
MSP | Mirror Space

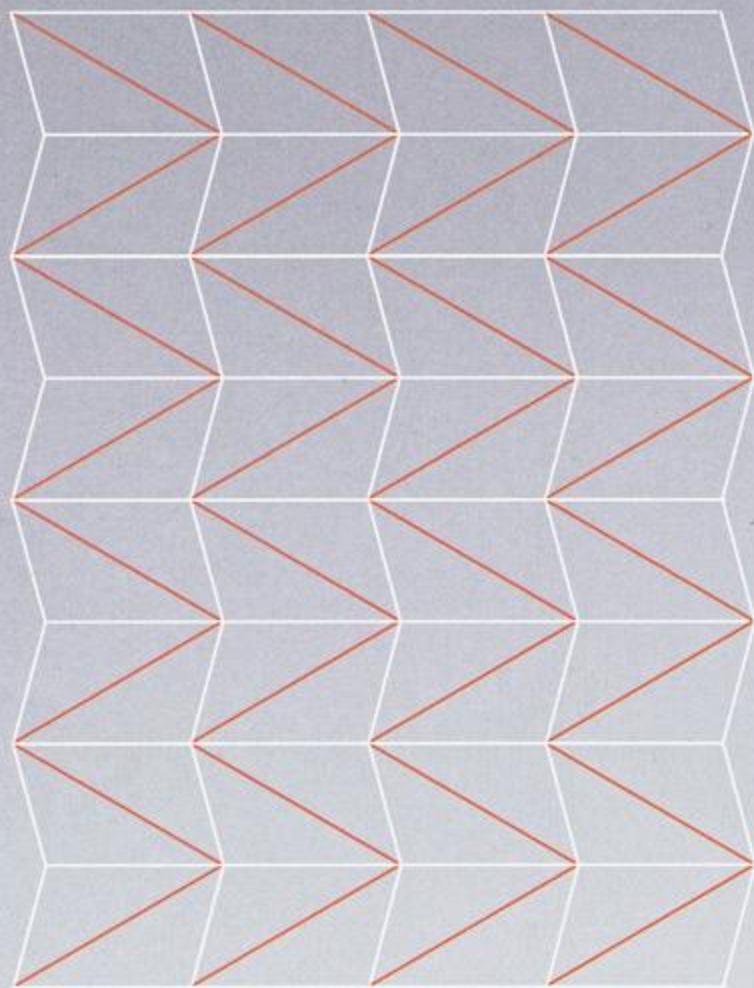
In the M cases vertically running zigzag mountain and valley creases meet in a single vertex when crossing the horizontal valley creases. In the MSP cases the mountain vertices are moved away a certain amount (=space) from the valley vertices. Have a look at an appropriate crease pattern on the next pages to understand this case.



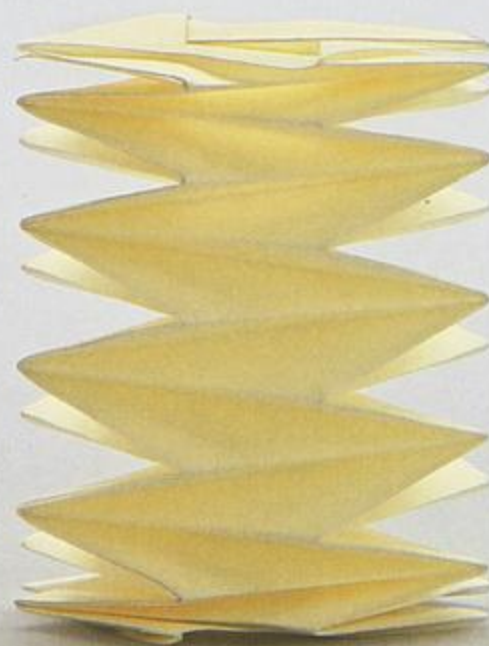
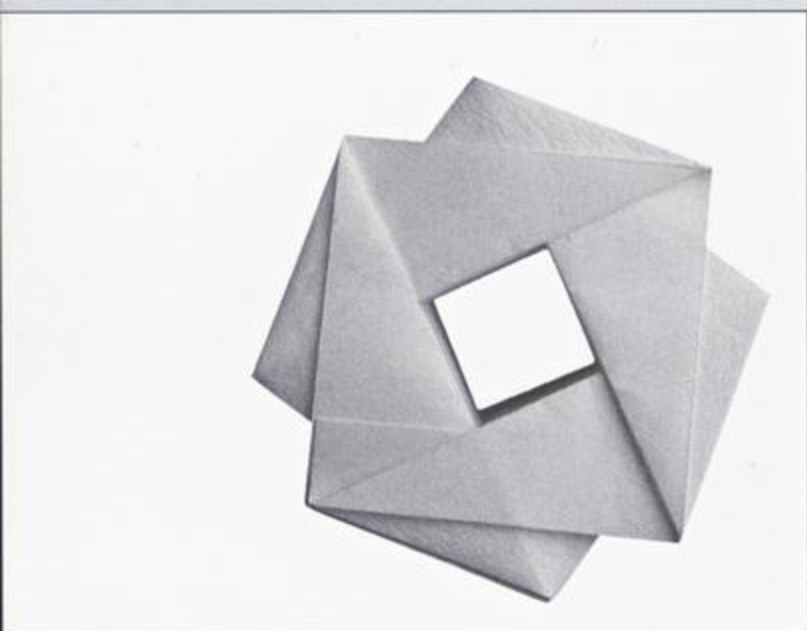
— mountain fold

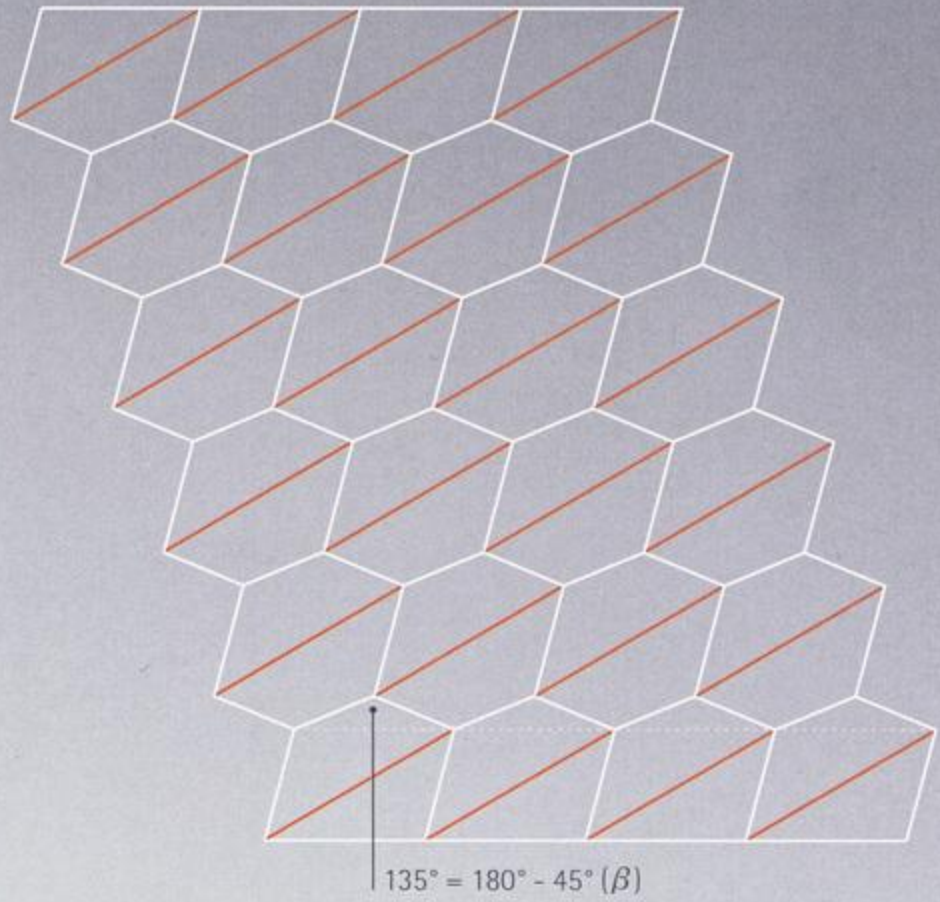
COIL FOLD 4|30|S





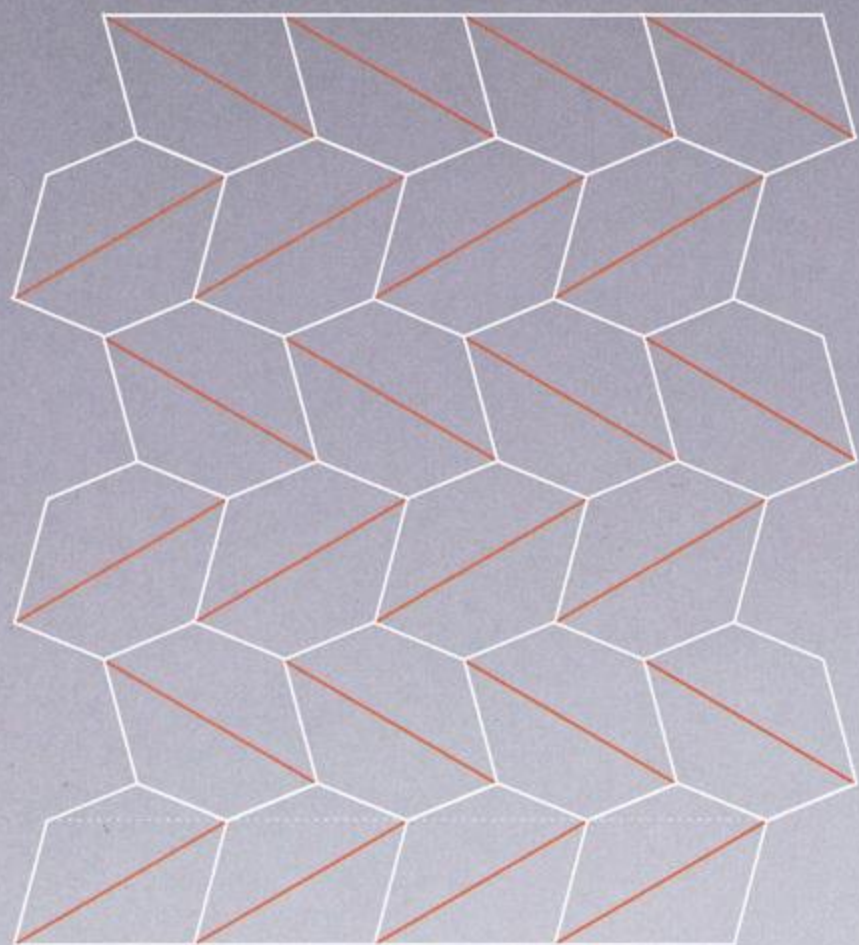
COIL FOLD 4|30|M



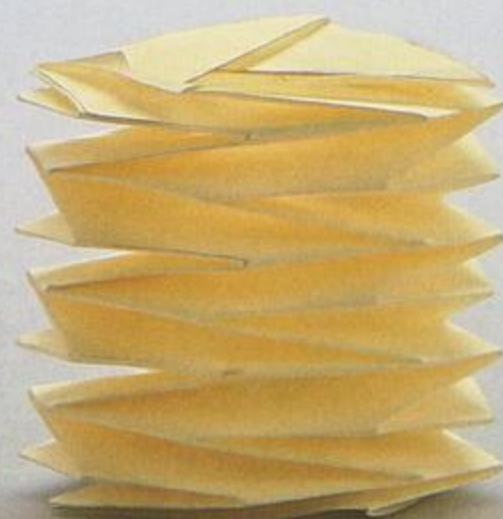
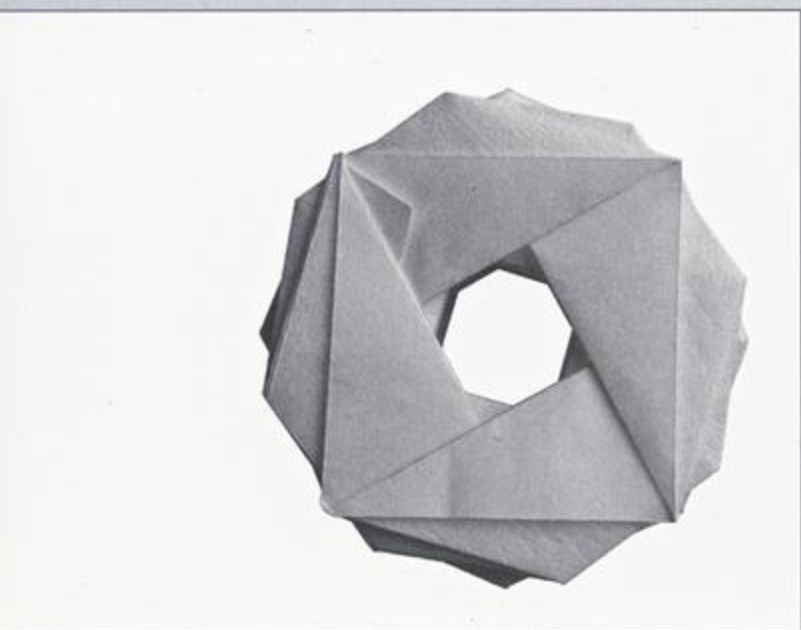


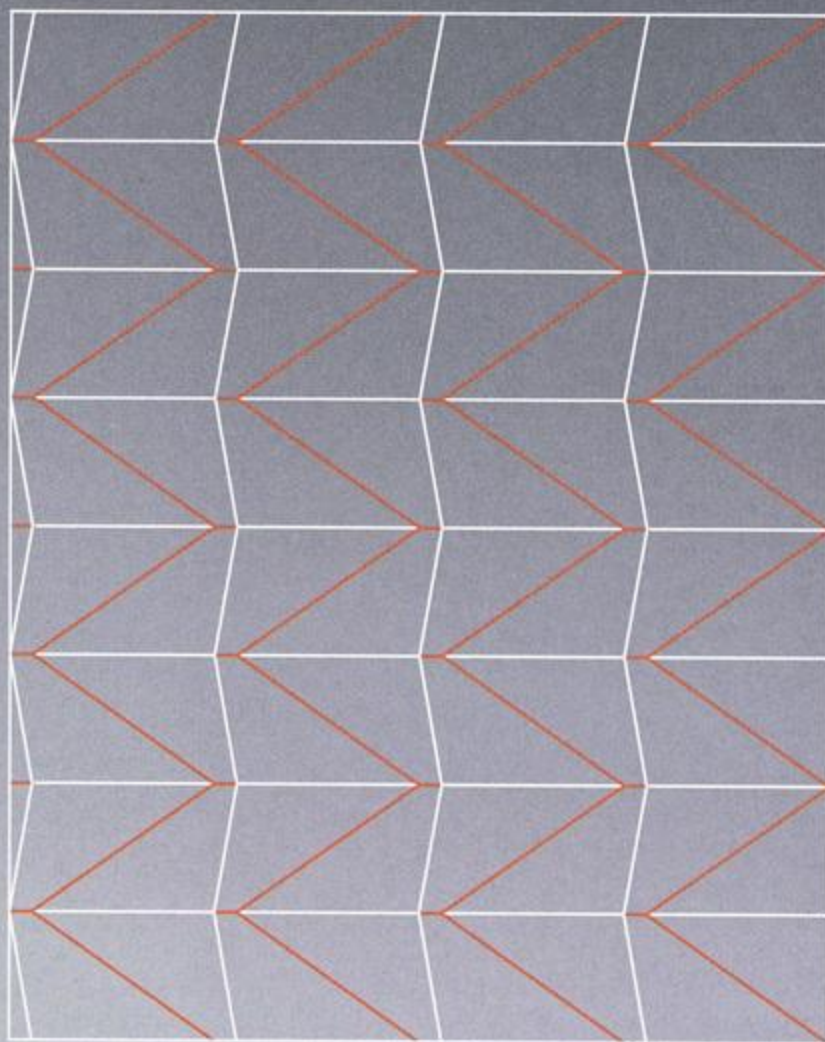
COIL FOLD $4|30|H$



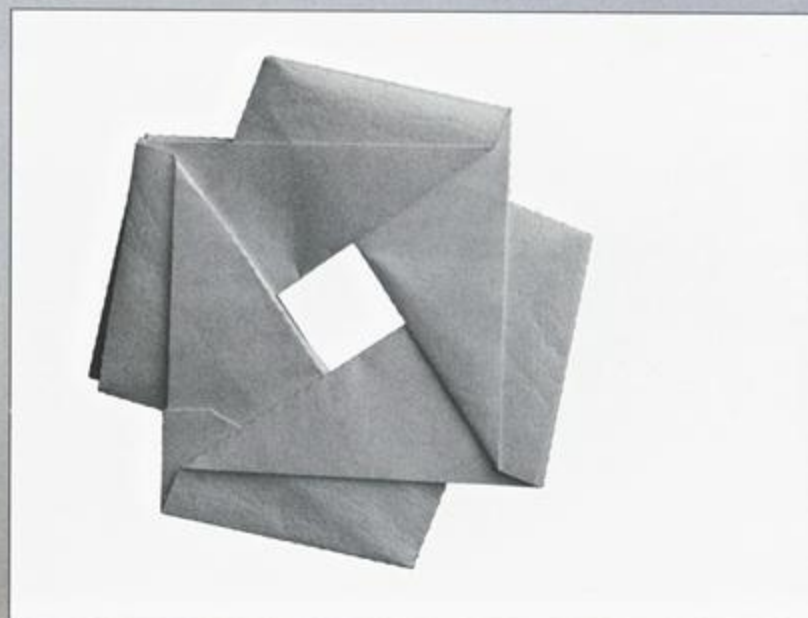


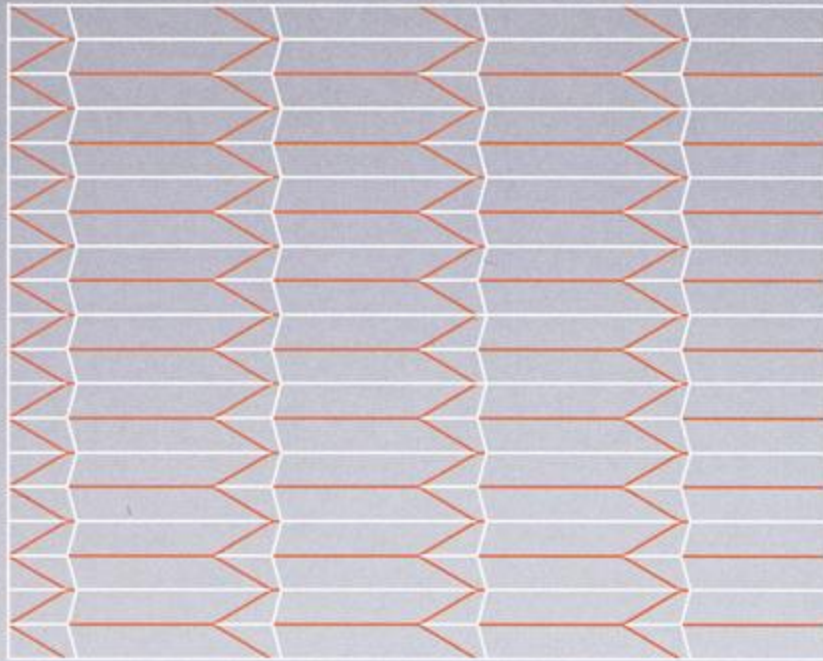
COIL FOLD 4|30|MH



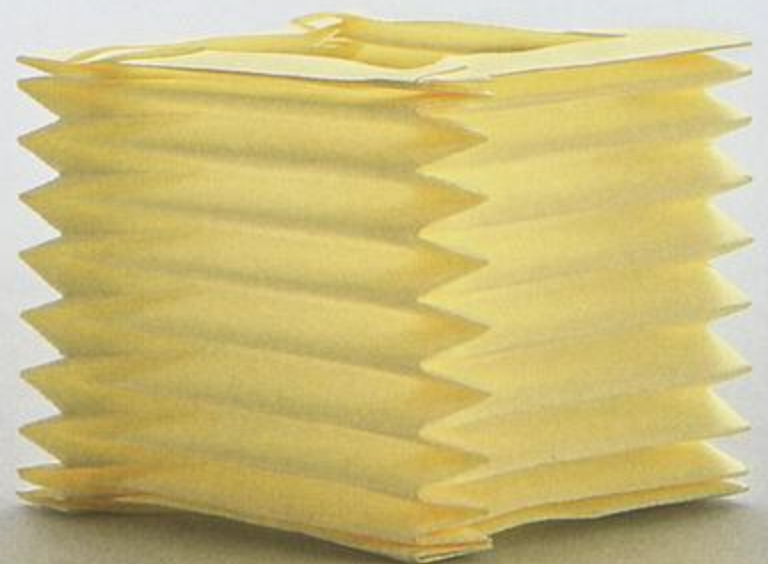


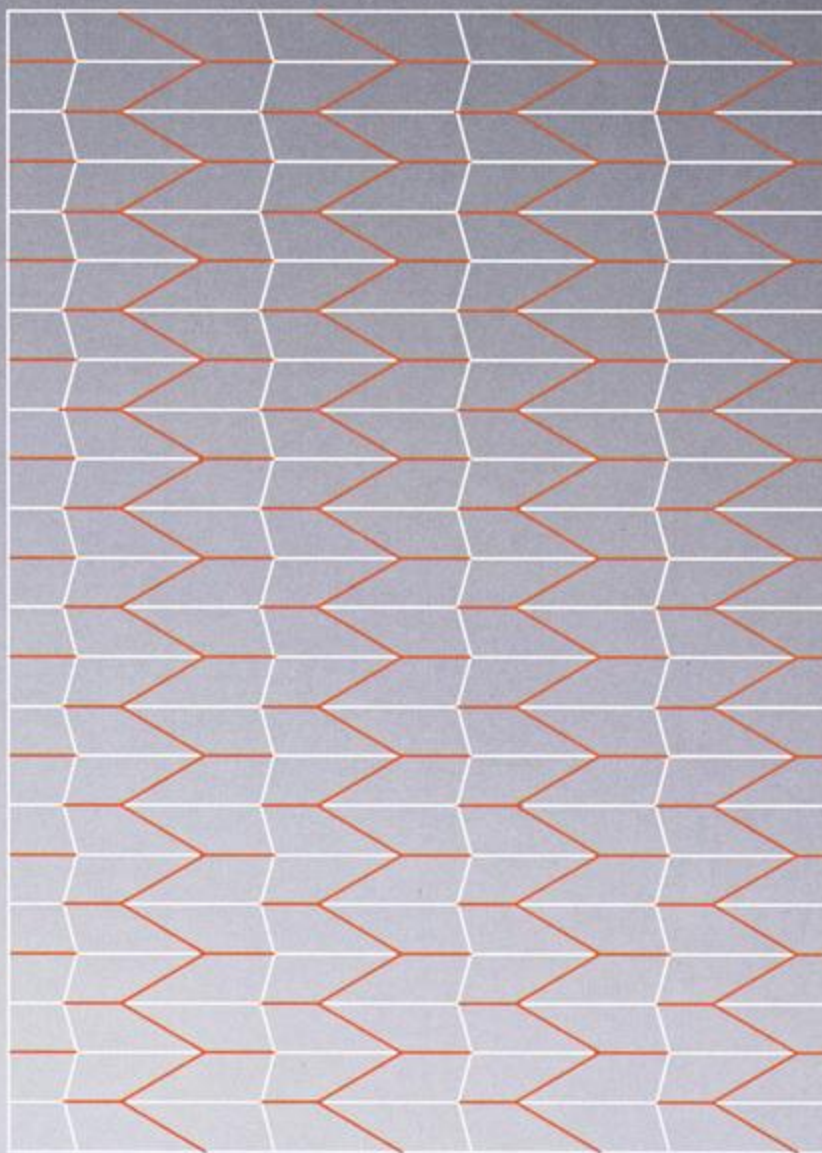
COIL FOLD 4|30|MSP 1



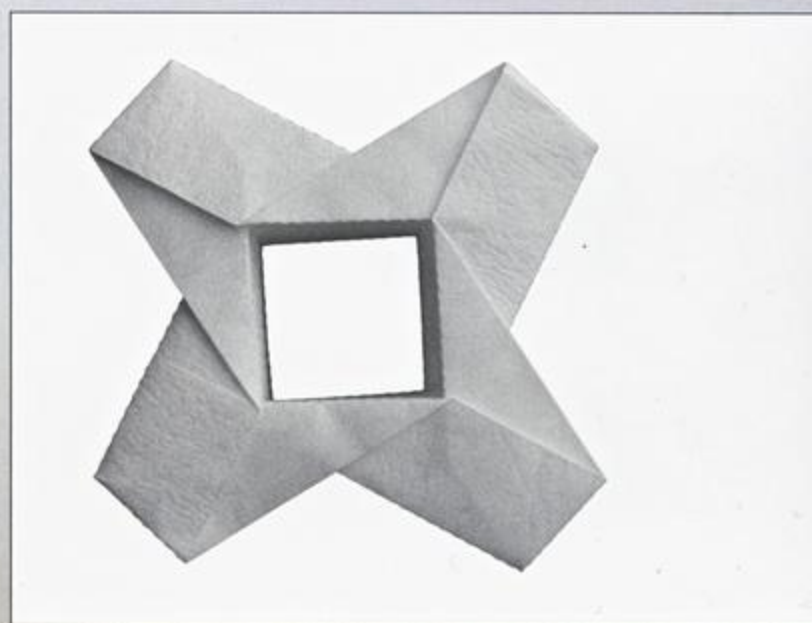


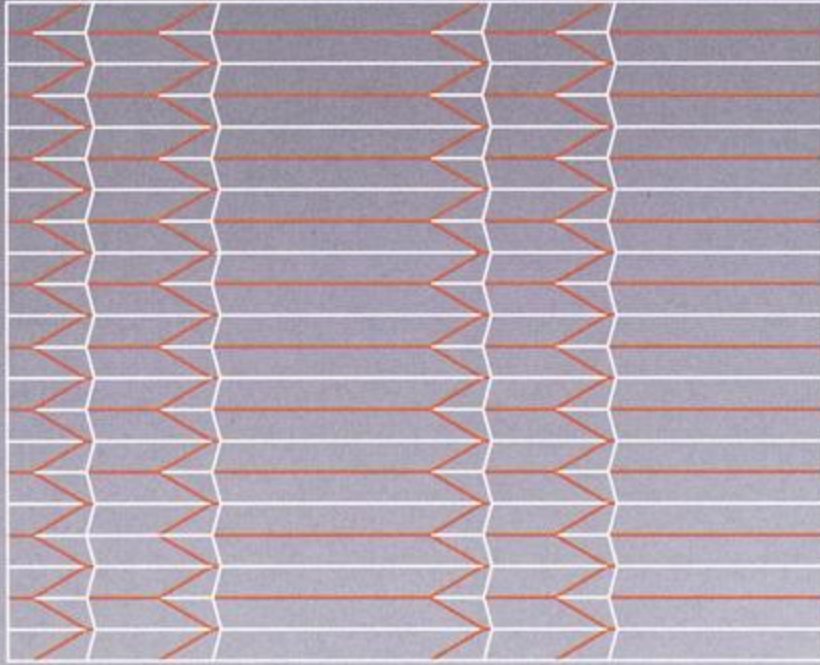
COIL FOLD 4|30|MSP 2



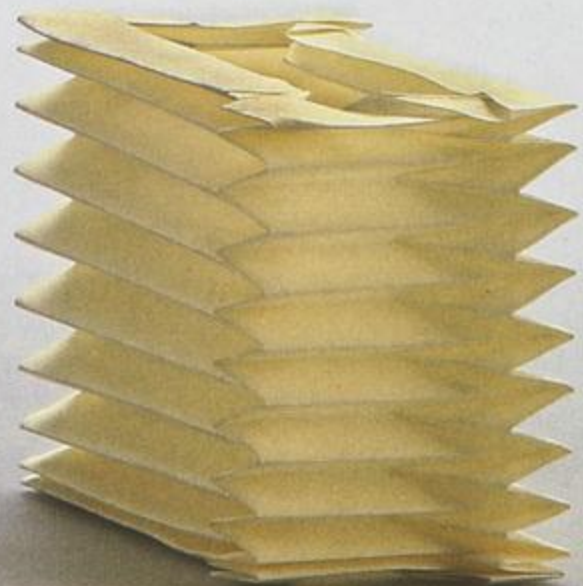
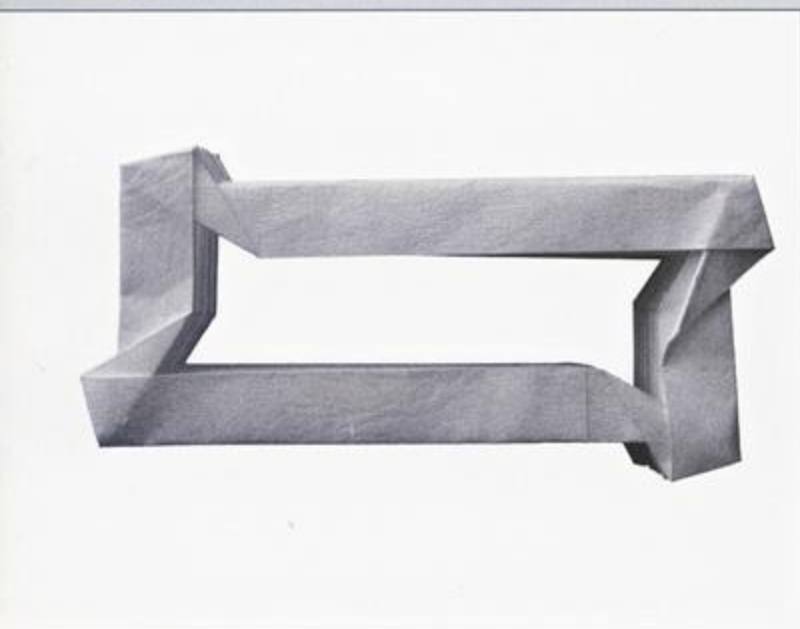


COIL FOLD 4|30|MSP 3

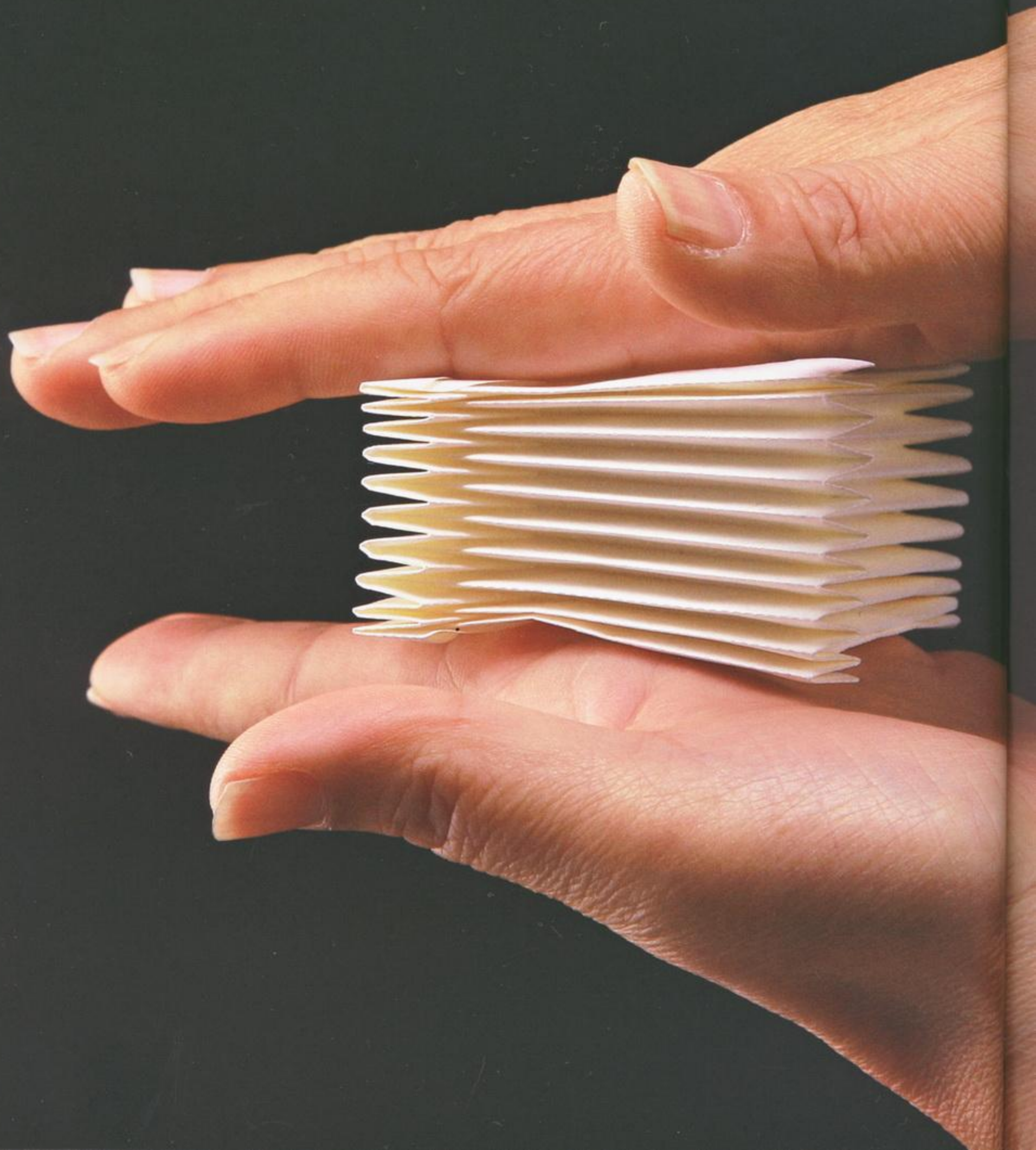


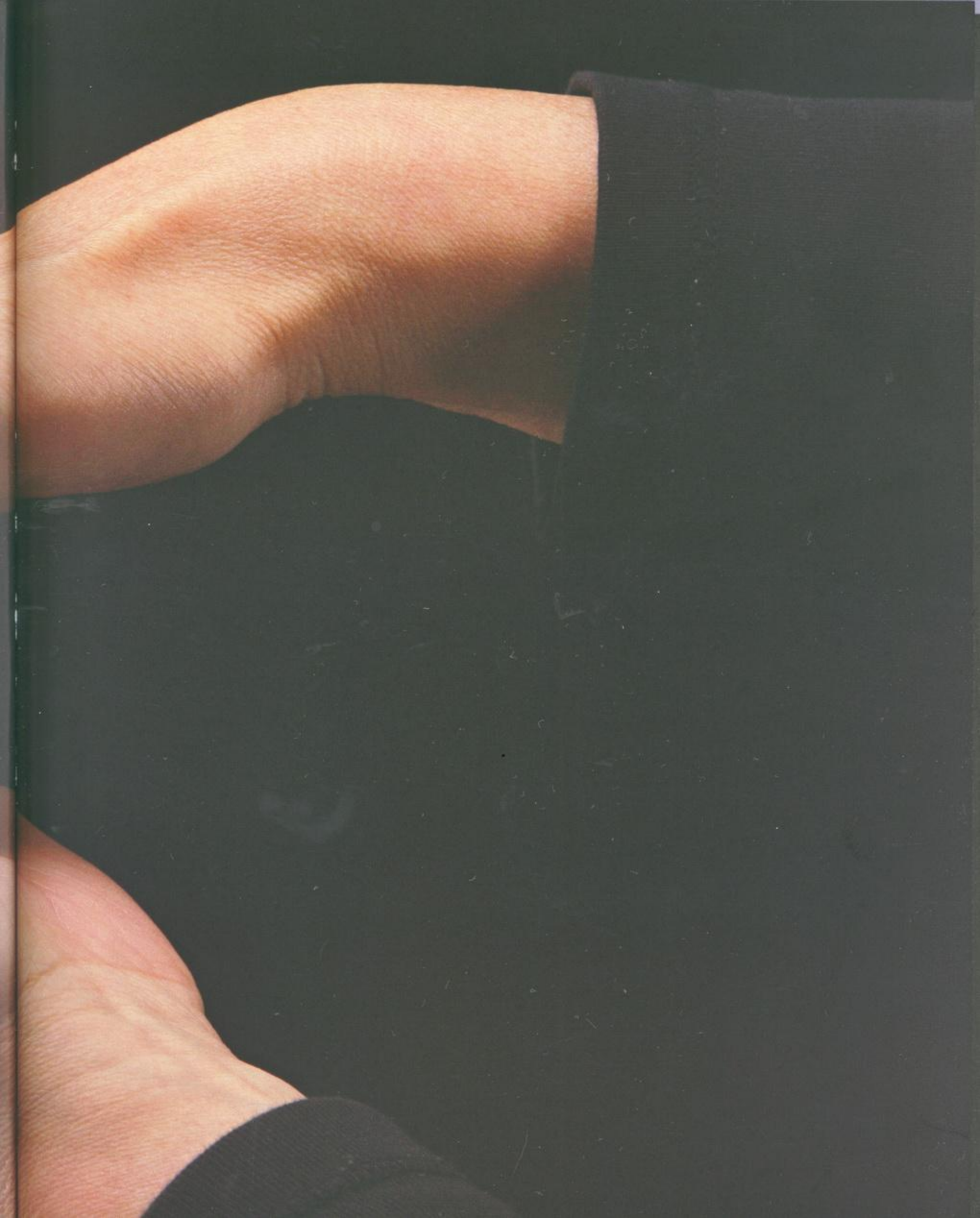


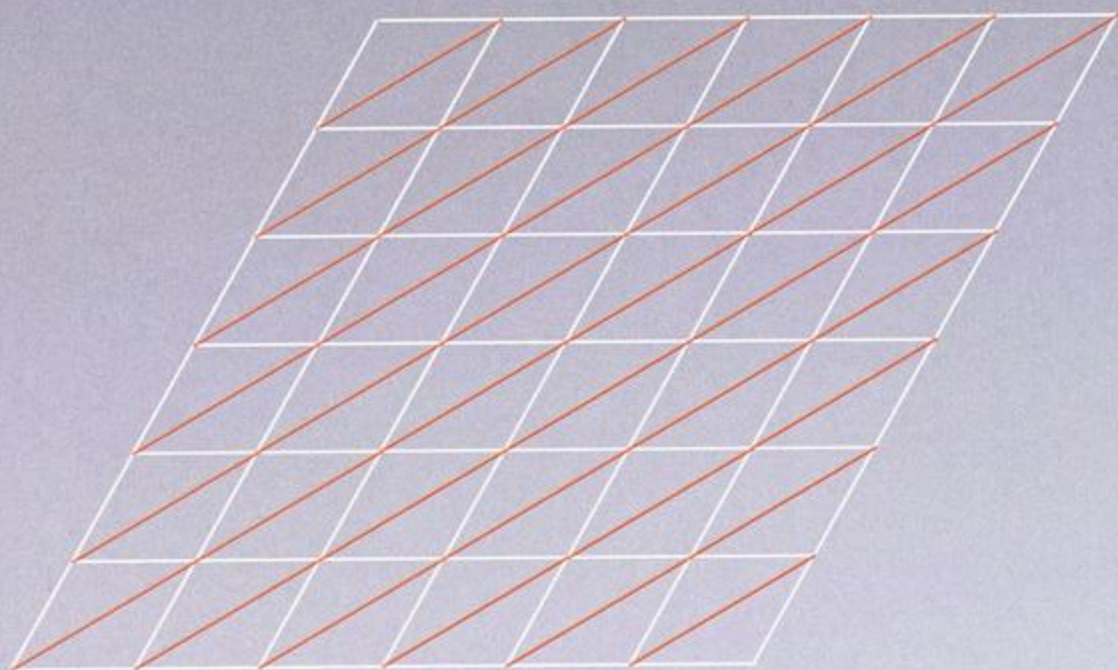
COIL FOLD 4|30|MSP 4



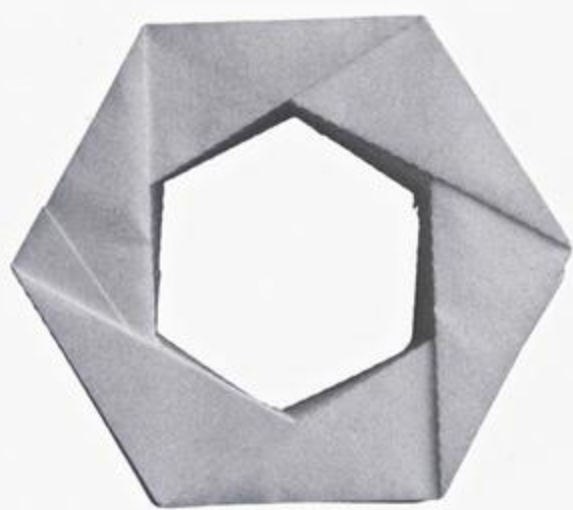


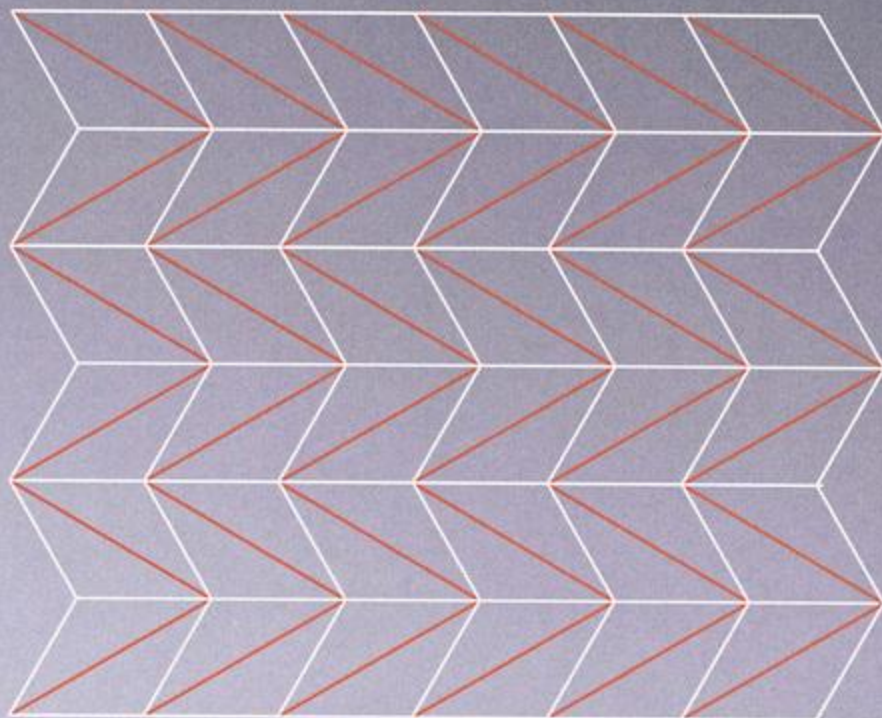




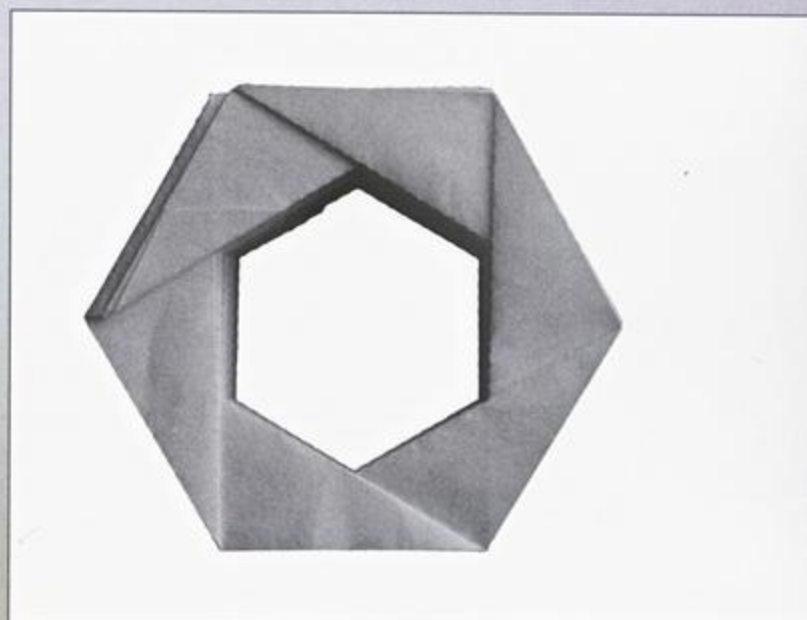


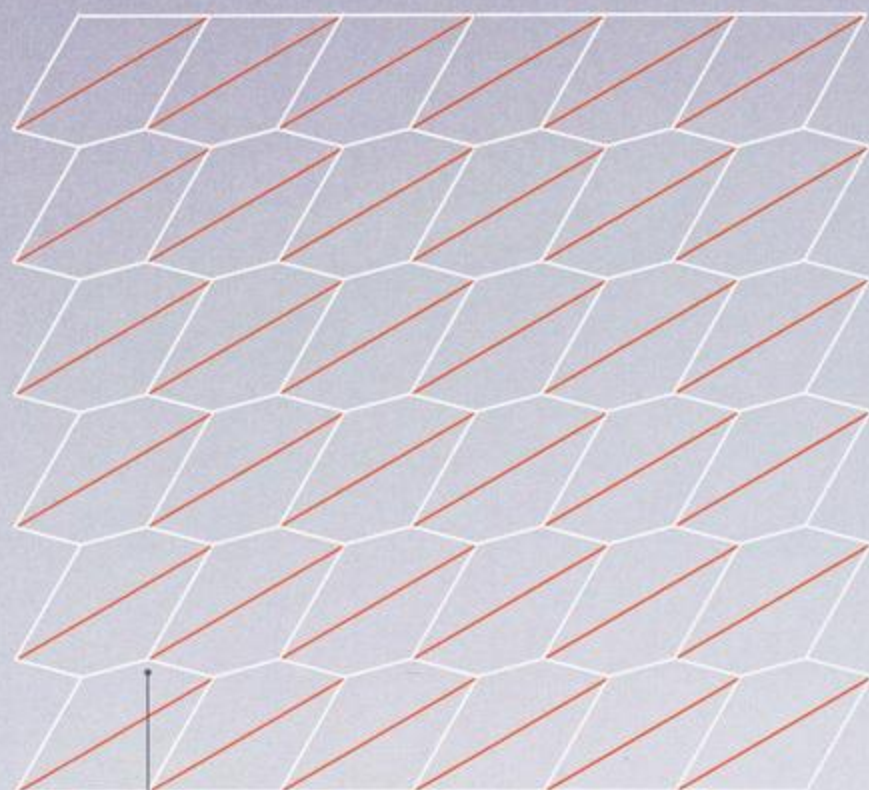
COIL FOLD 6|30|S





• COIL FOLD 6|30|M

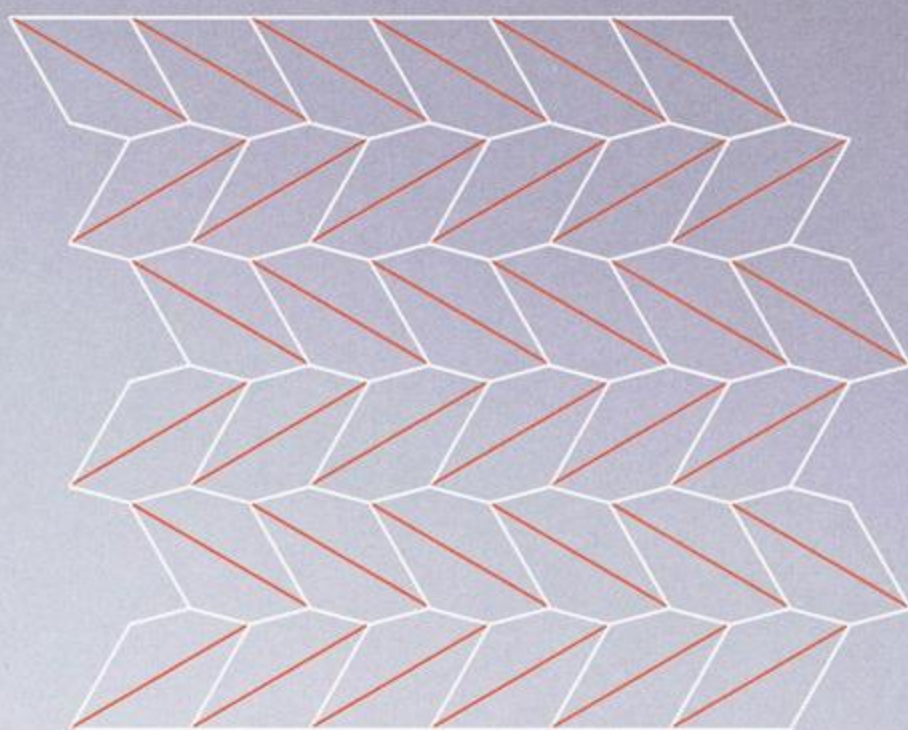




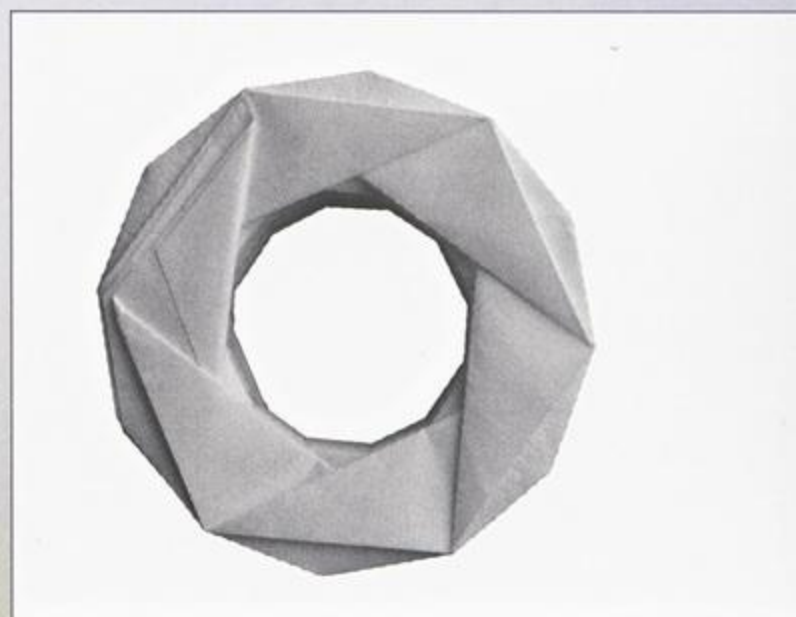
$$150^\circ = 180^\circ - 30^\circ (\beta)$$

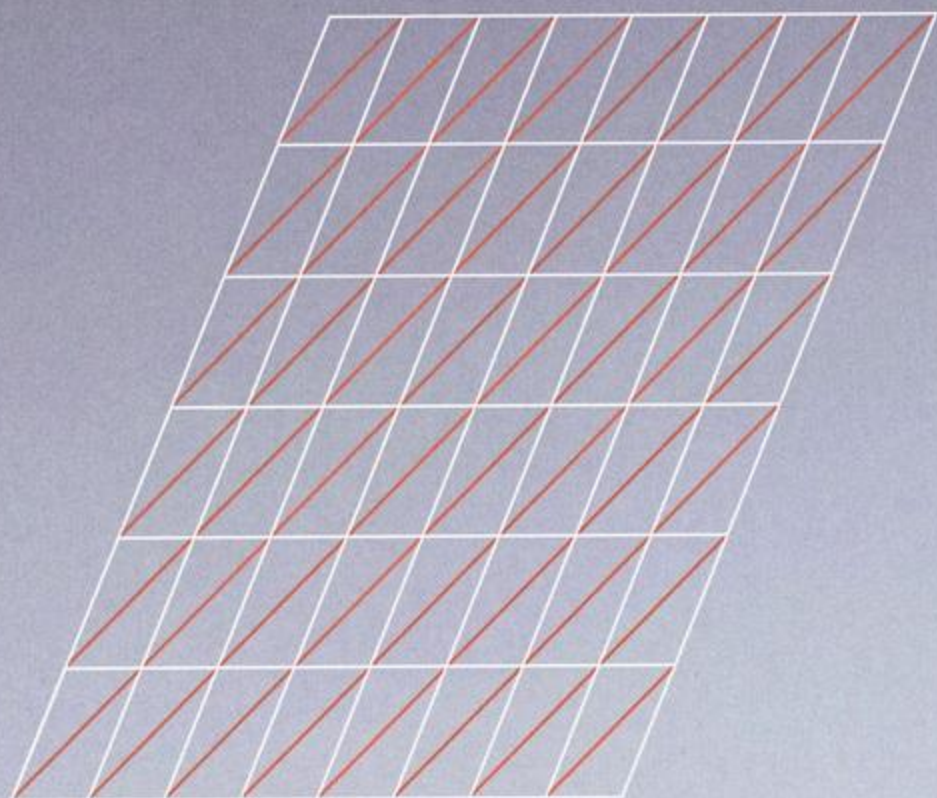
COIL FOLD 6|30|H



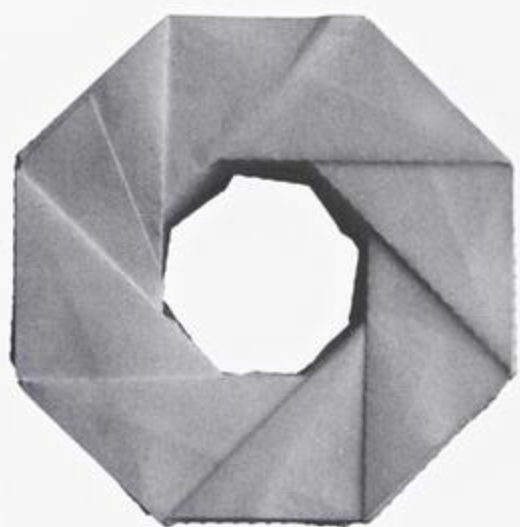


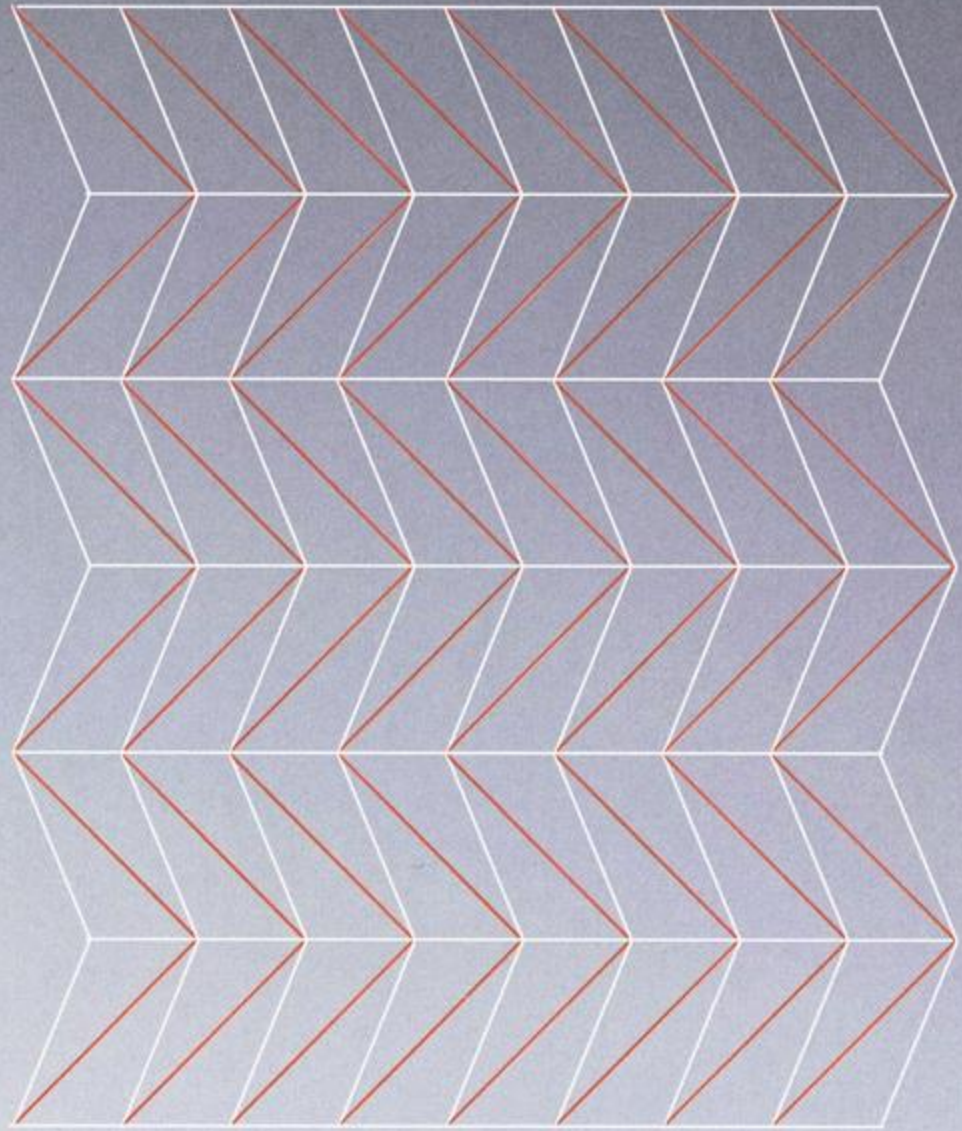
• COIL FOLD 6|30|MH



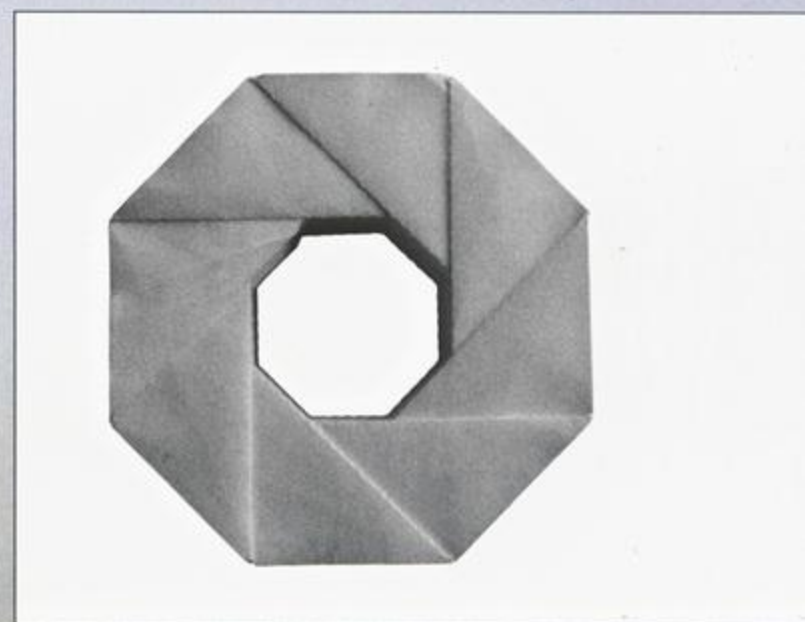


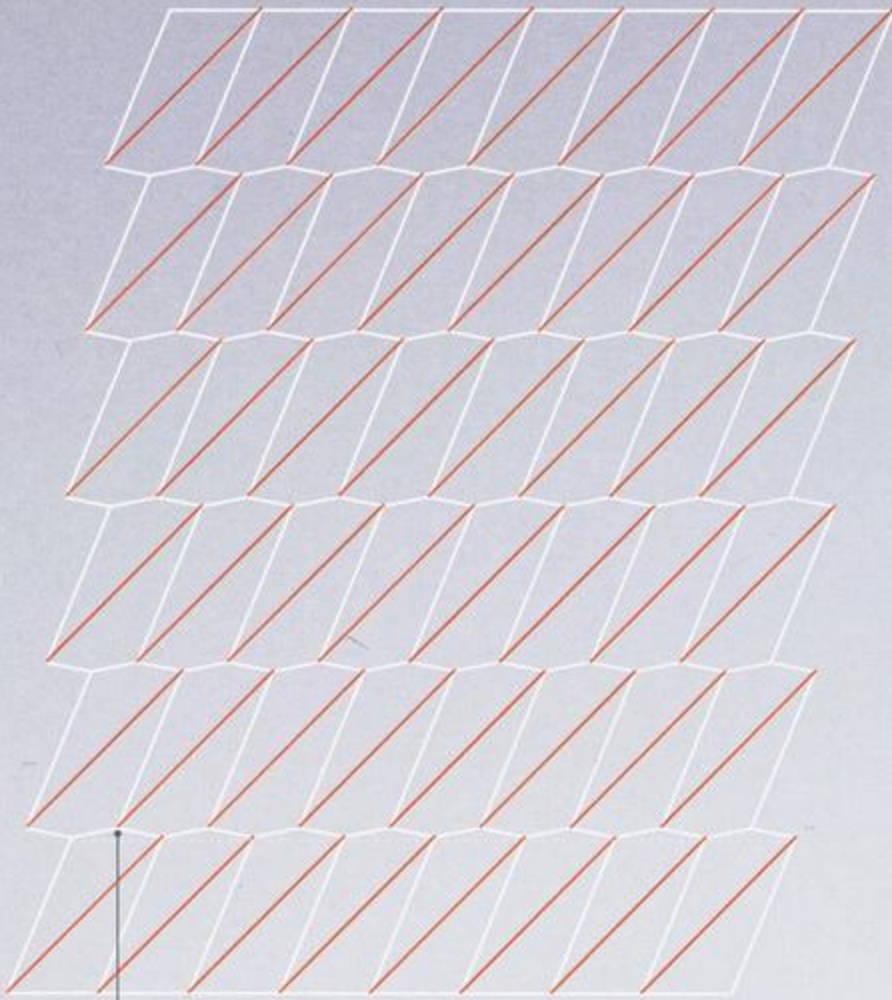
COIL FOLD 8|45|S





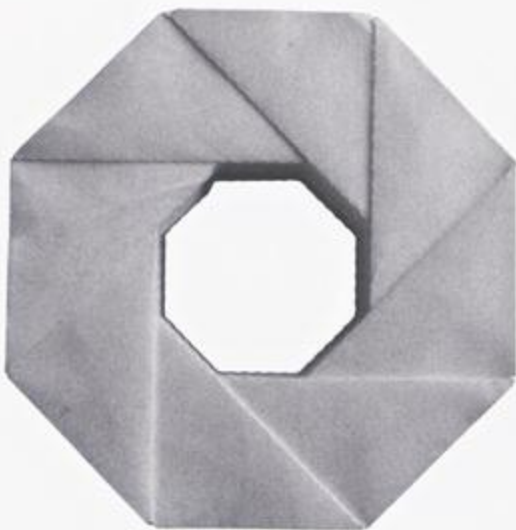
COIL FOLD 8|45|M

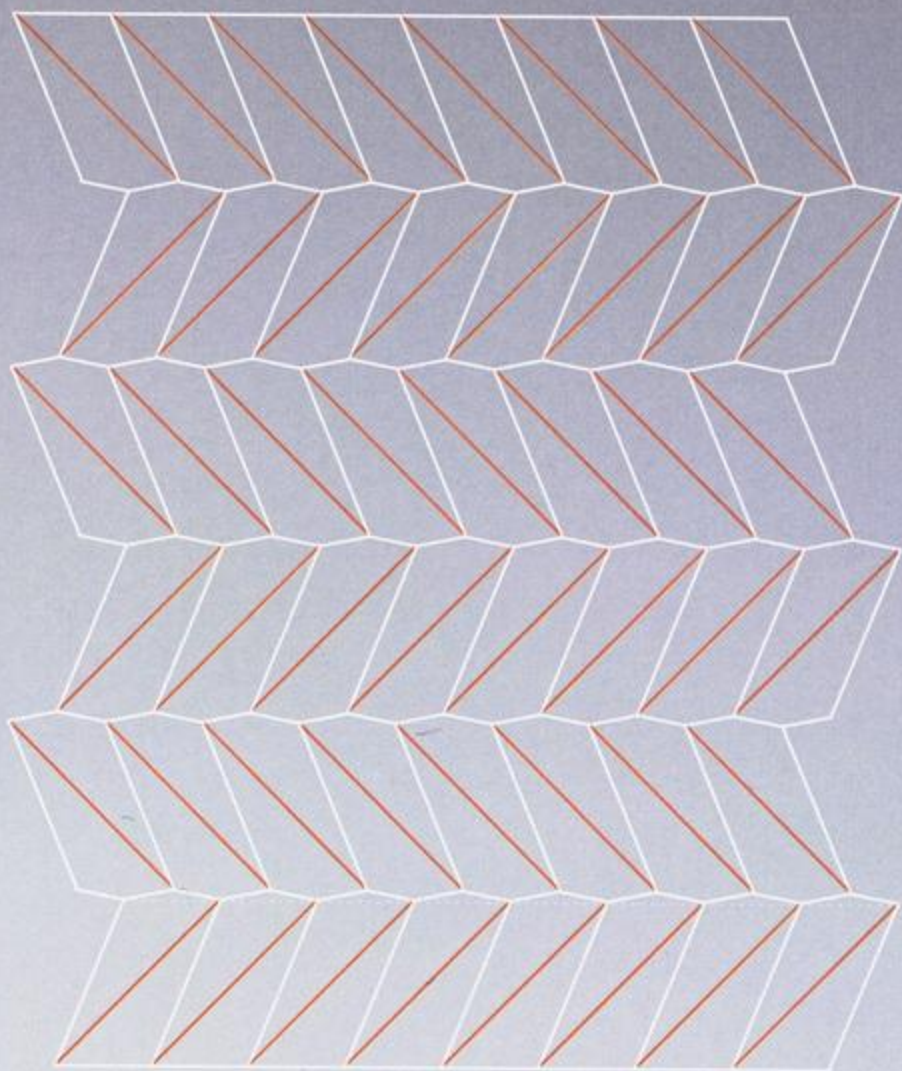




$$157.5^\circ = 180^\circ - 22.5^\circ (\beta)$$

COIL FOLD 8|45|H

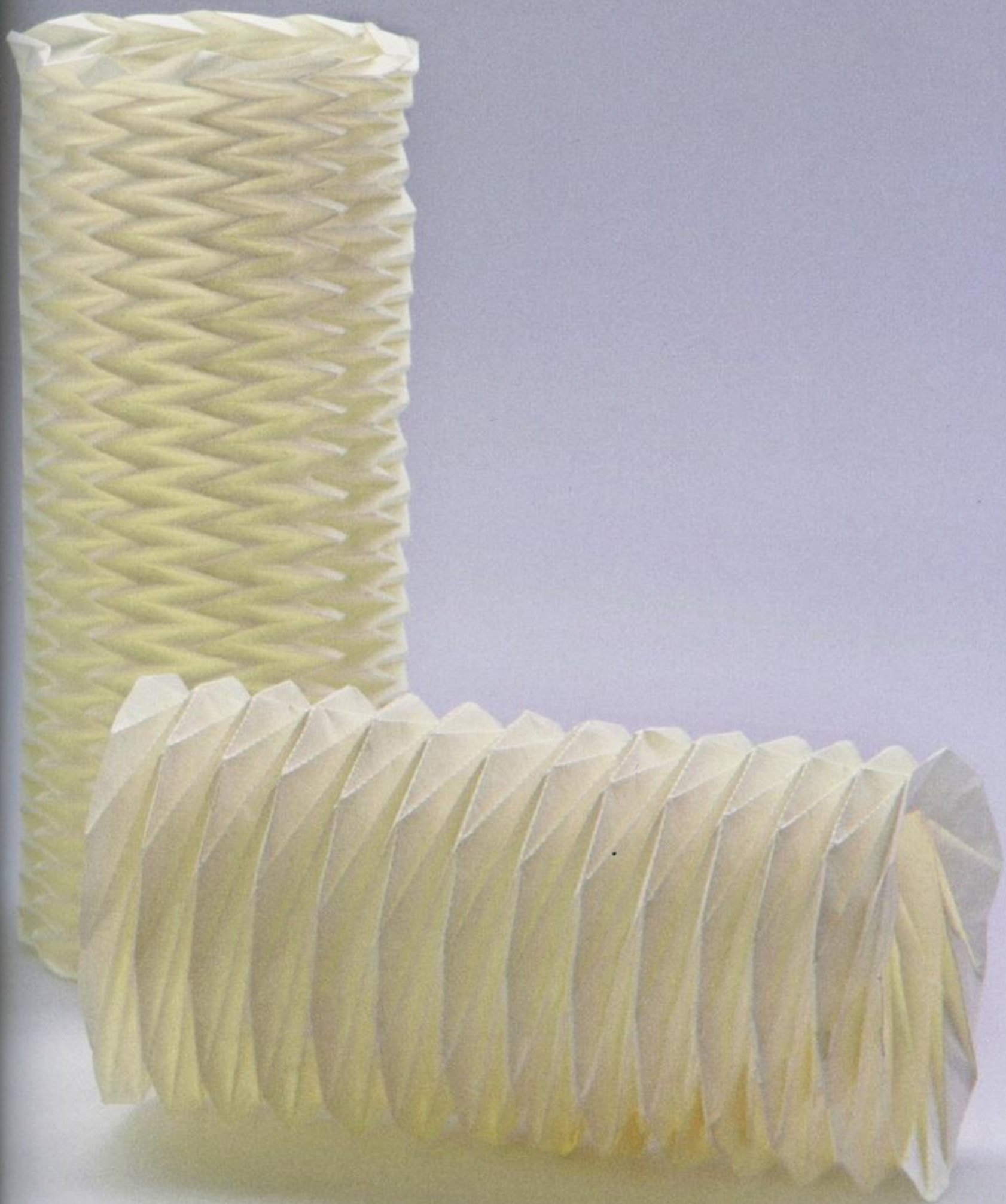




COIL FOLD 8|45|MH











ねじり遊びパコパコ



PAKO PAKO PLAY

You can make a fantastic toy from a Mirror-type (M) coil fold.

Hold it at both ends and twist it. It will make a sound, something like »pako pako«. When each row of parallelograms has a different colour, it will look even more exciting. The angles shown in the diagrams on the following pages are the best ones for the octagon or decagon pako pako, but they can be changed.



WOODCUT Taro Toriumi

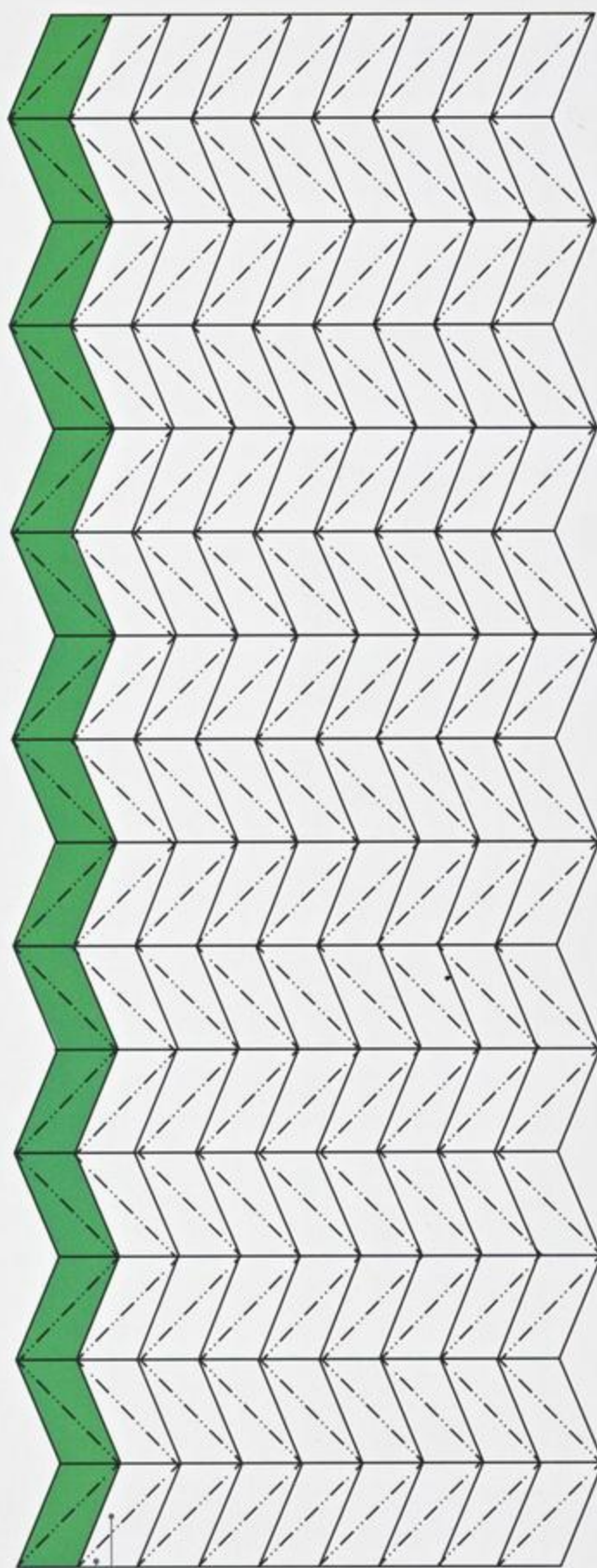
TARO TORIUMI

He is master wood-block engraver, etcher, husband of Tomoko Fuse and her artistic counsellor.

Themes of origami and Tomoko Fuse frequently appear in Taro's work. The colour woodcut by Taro Toriumi shows his wife playing with her invention Pako Pako.

The colours of this artwork have been the inspiration for the theme colours of the four chapters in this book.

OCTAGON PAKO PAKO

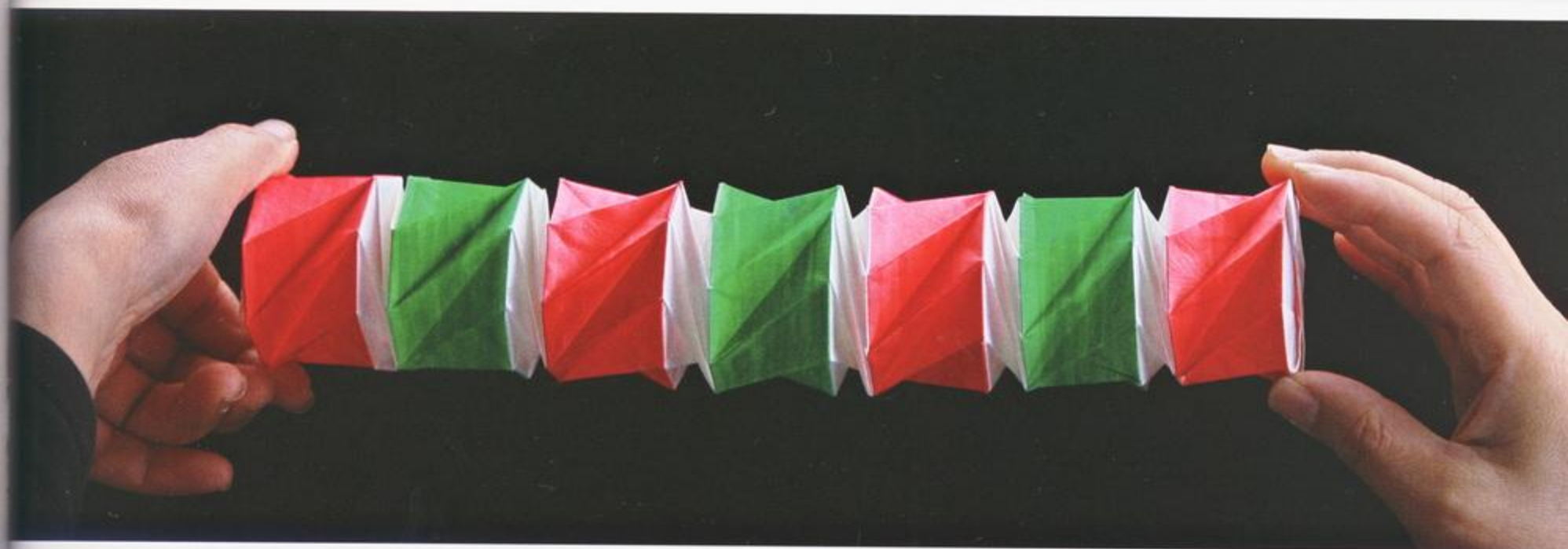
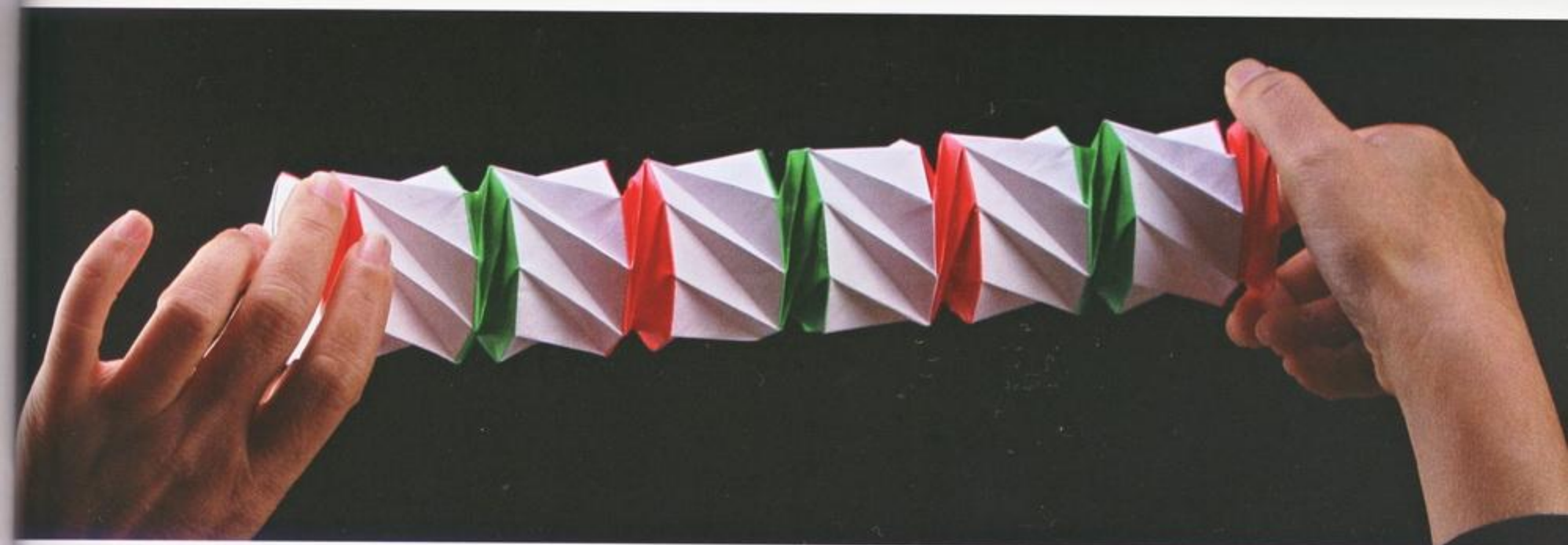


$\beta 22.5^\circ$

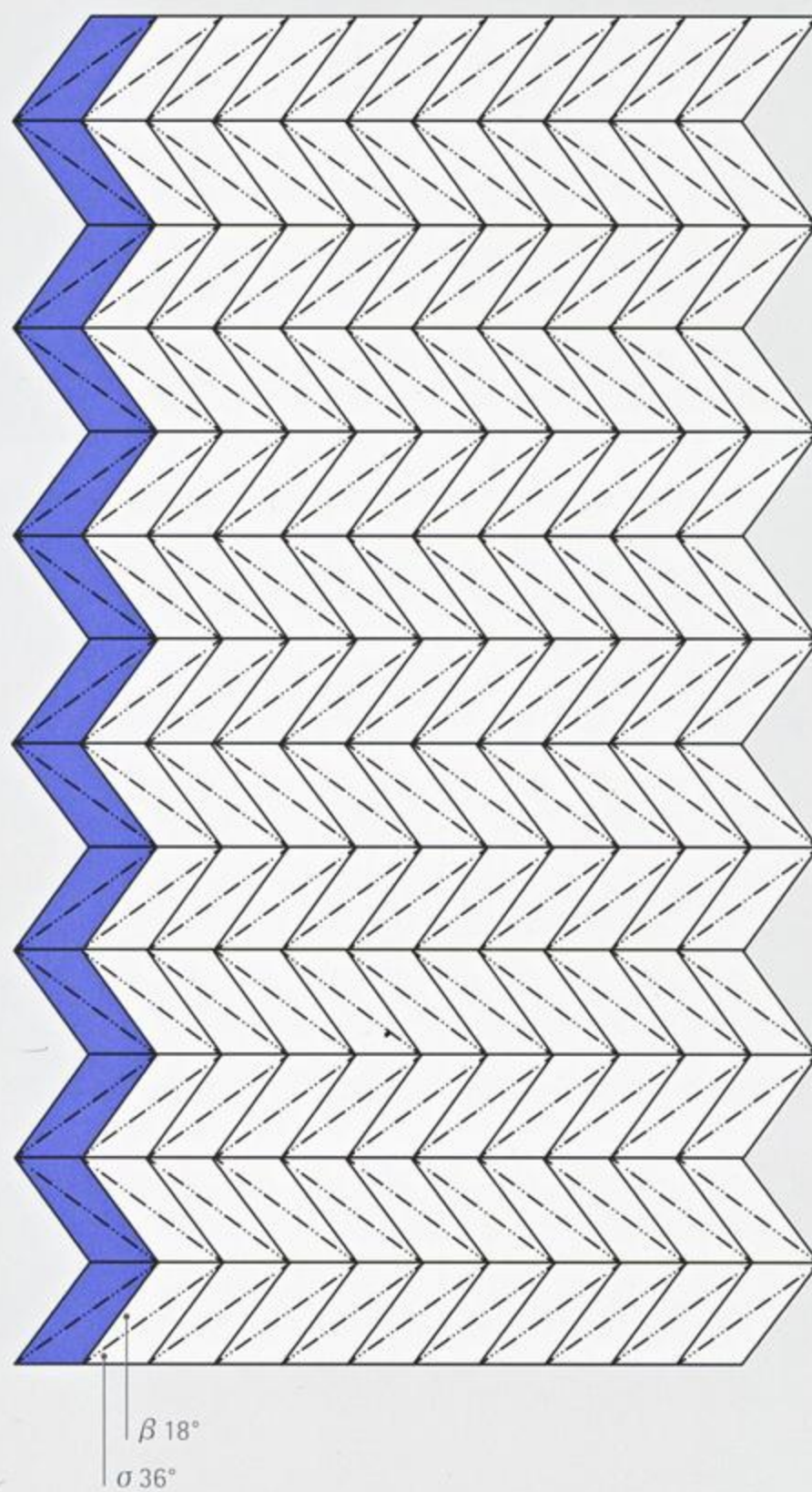
$\sigma 45^\circ$

valley fold
mountain fold
tab for gluing

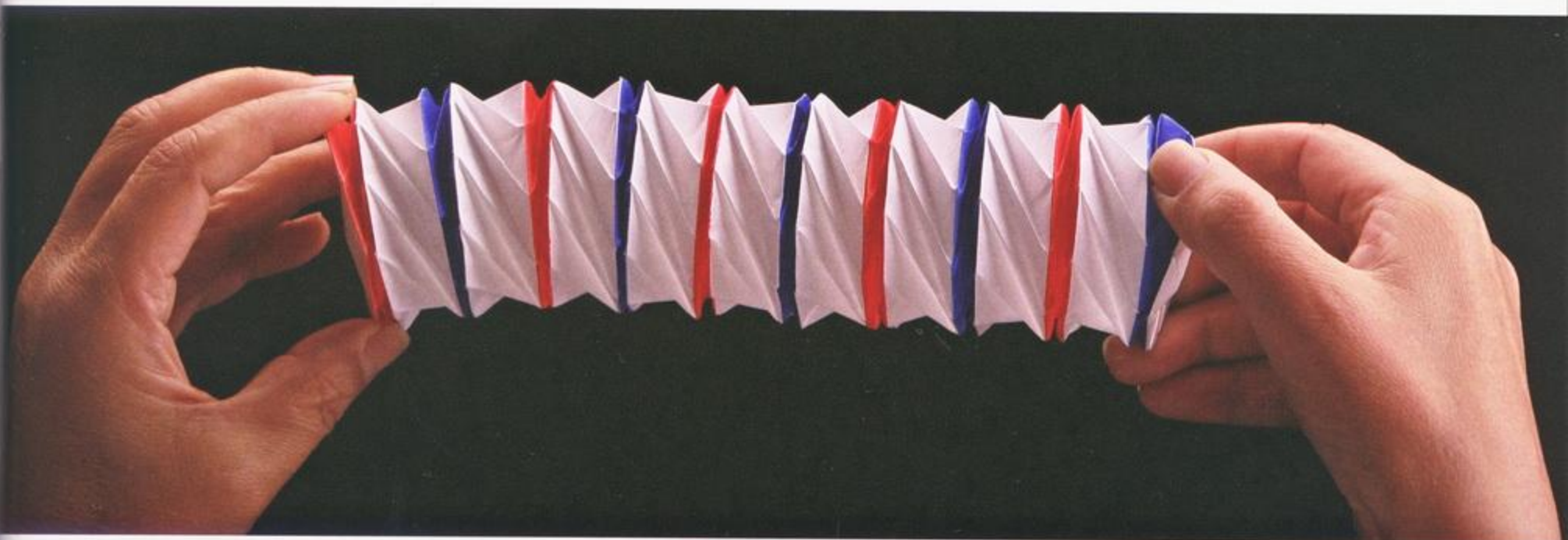
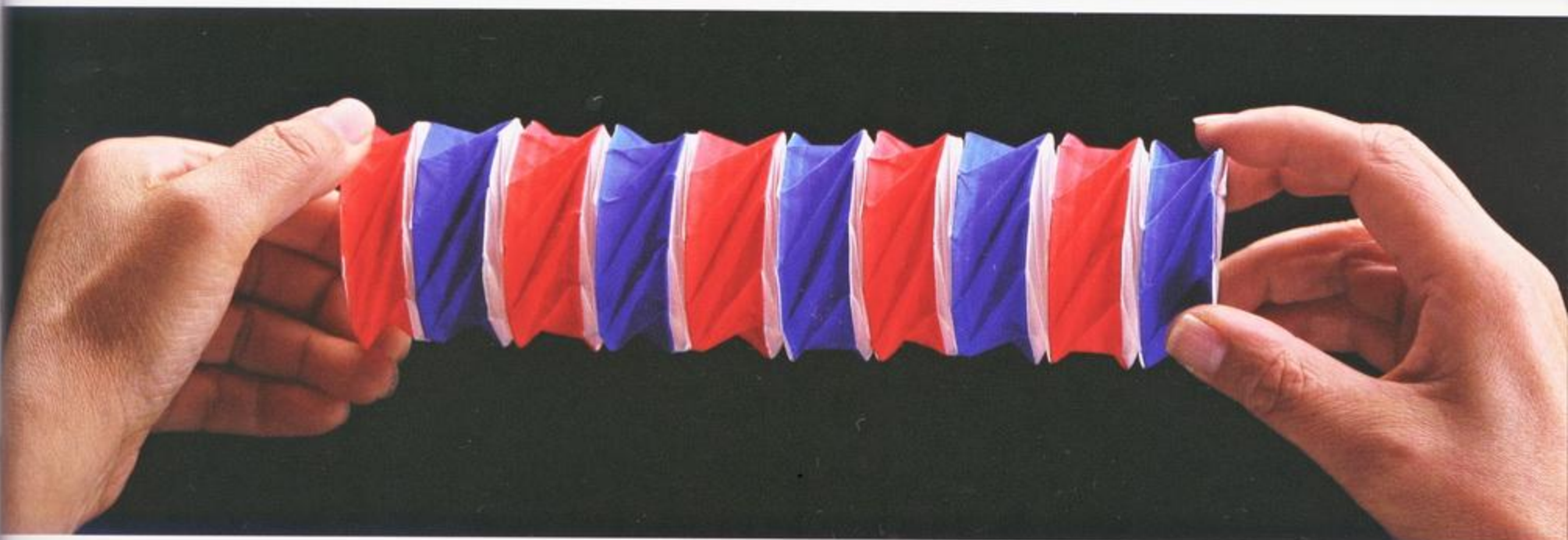
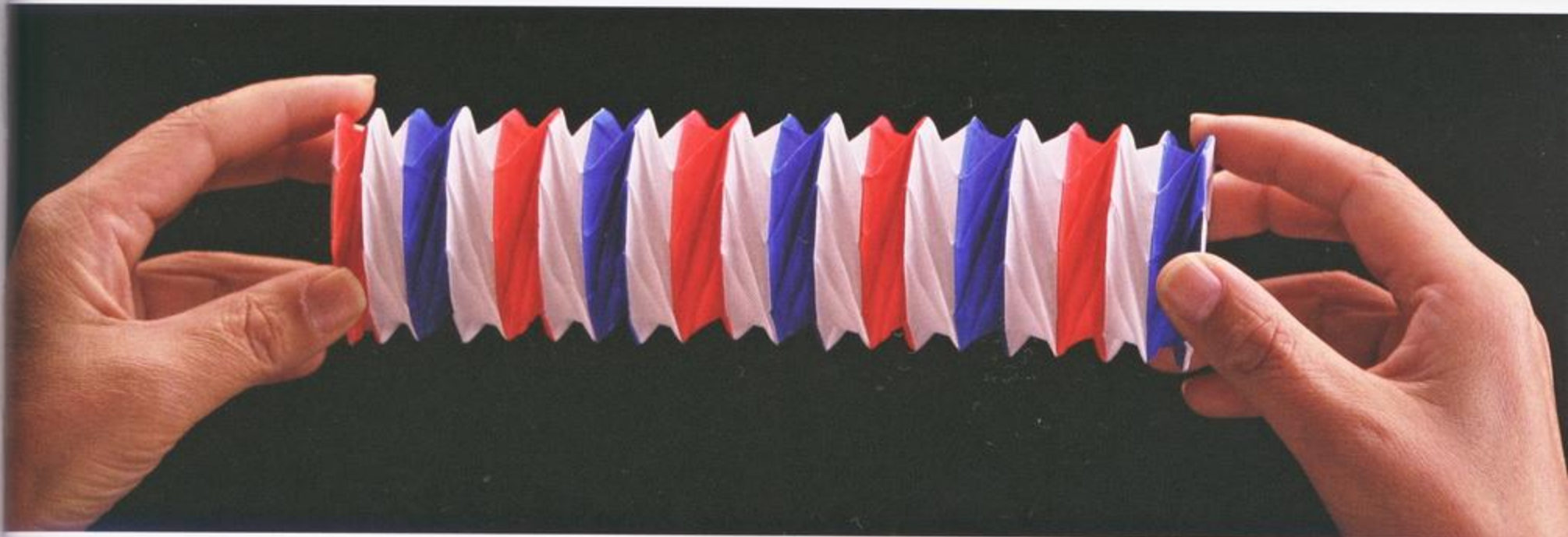


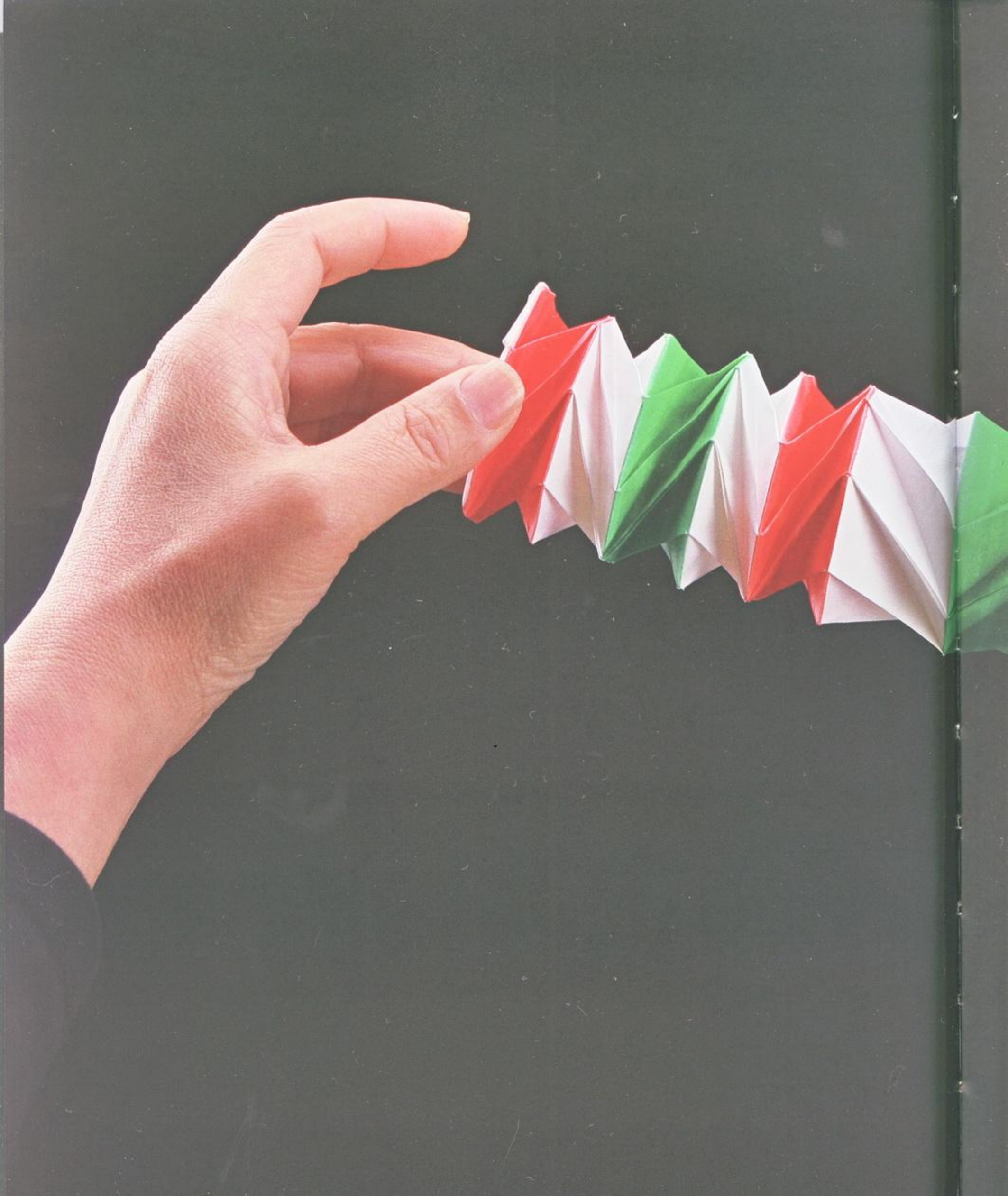


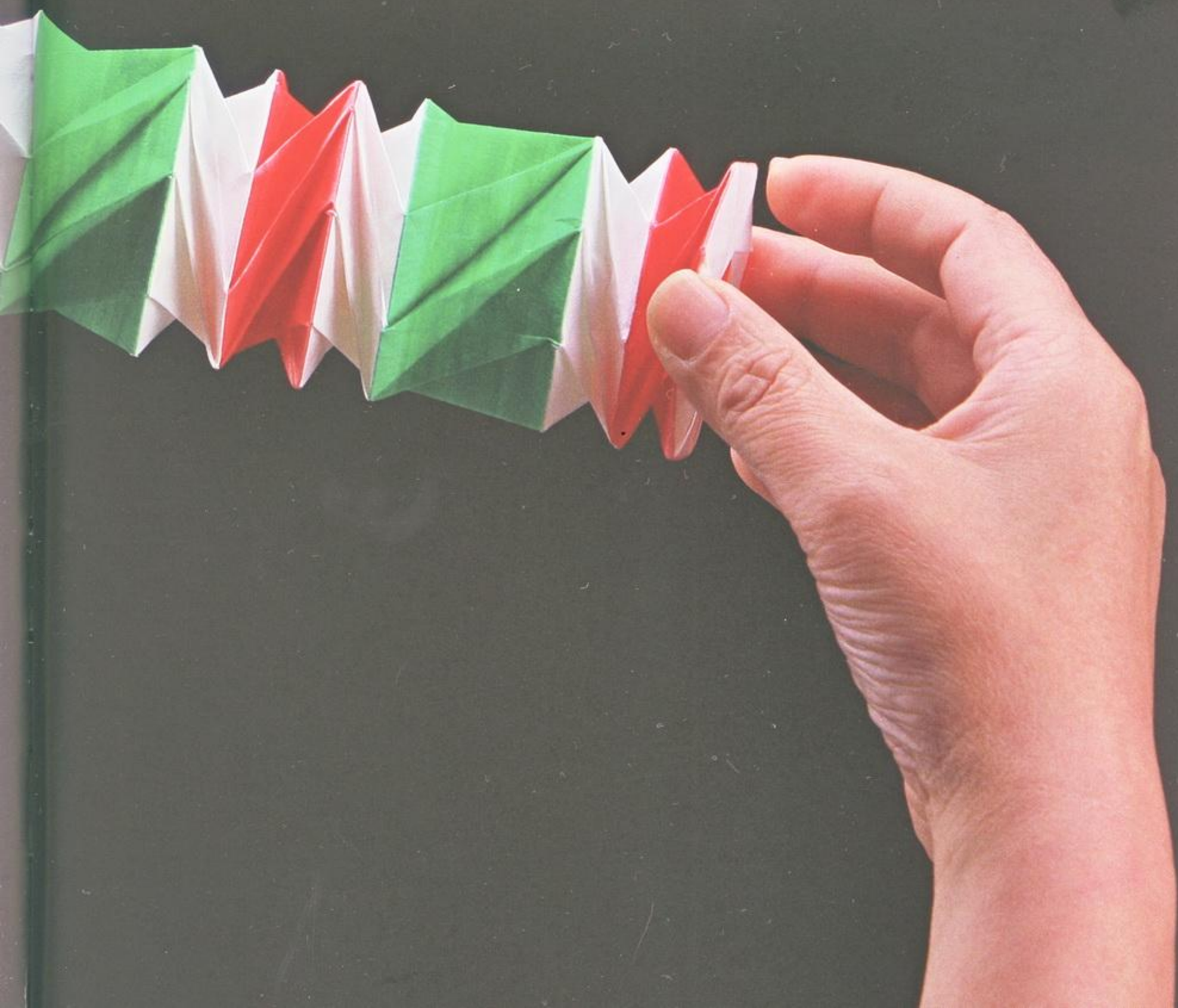
DECAGON PAKO PAKO



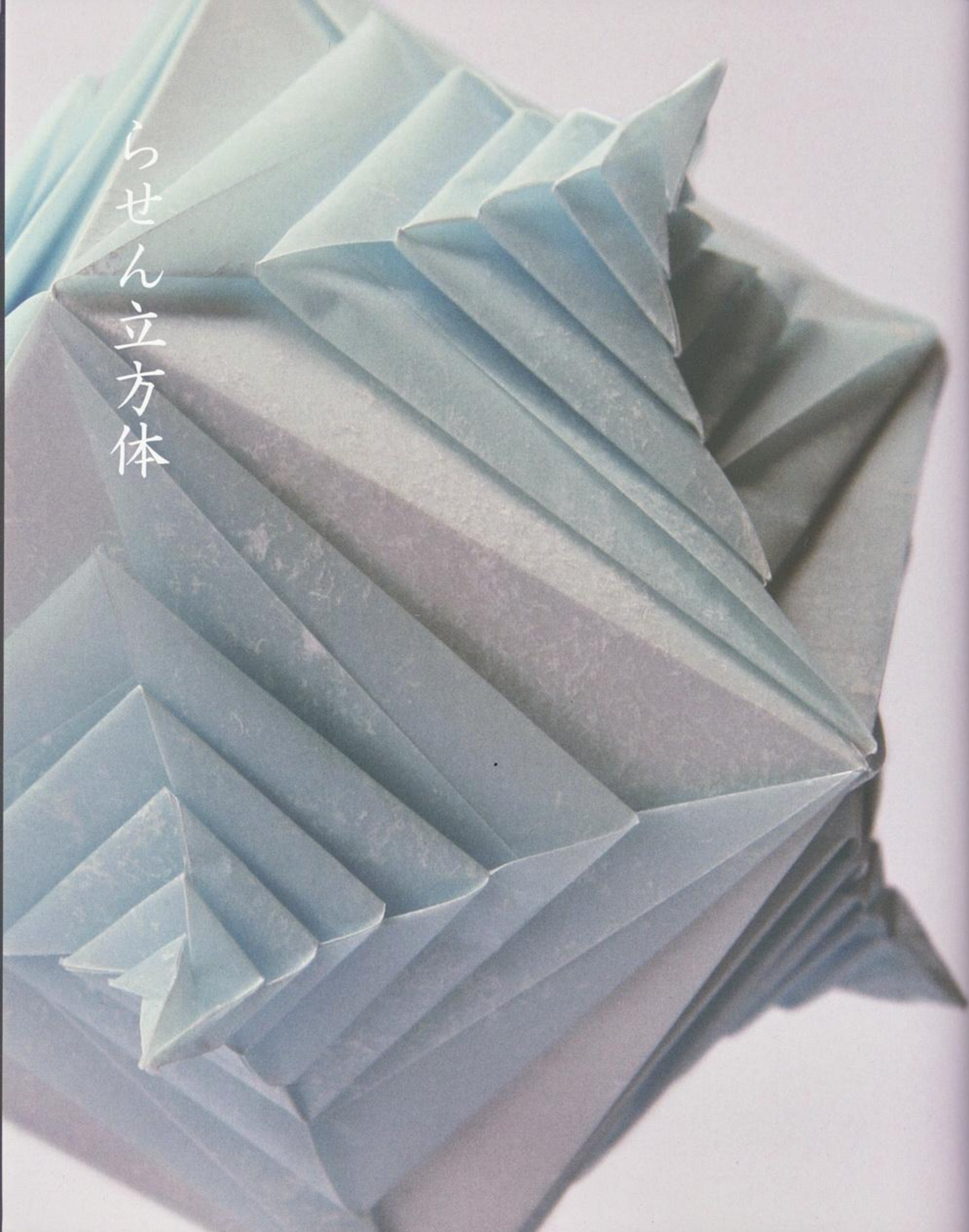
valley fold ———
 mountain fold - - - - -
 tab for gluing ■■■■■





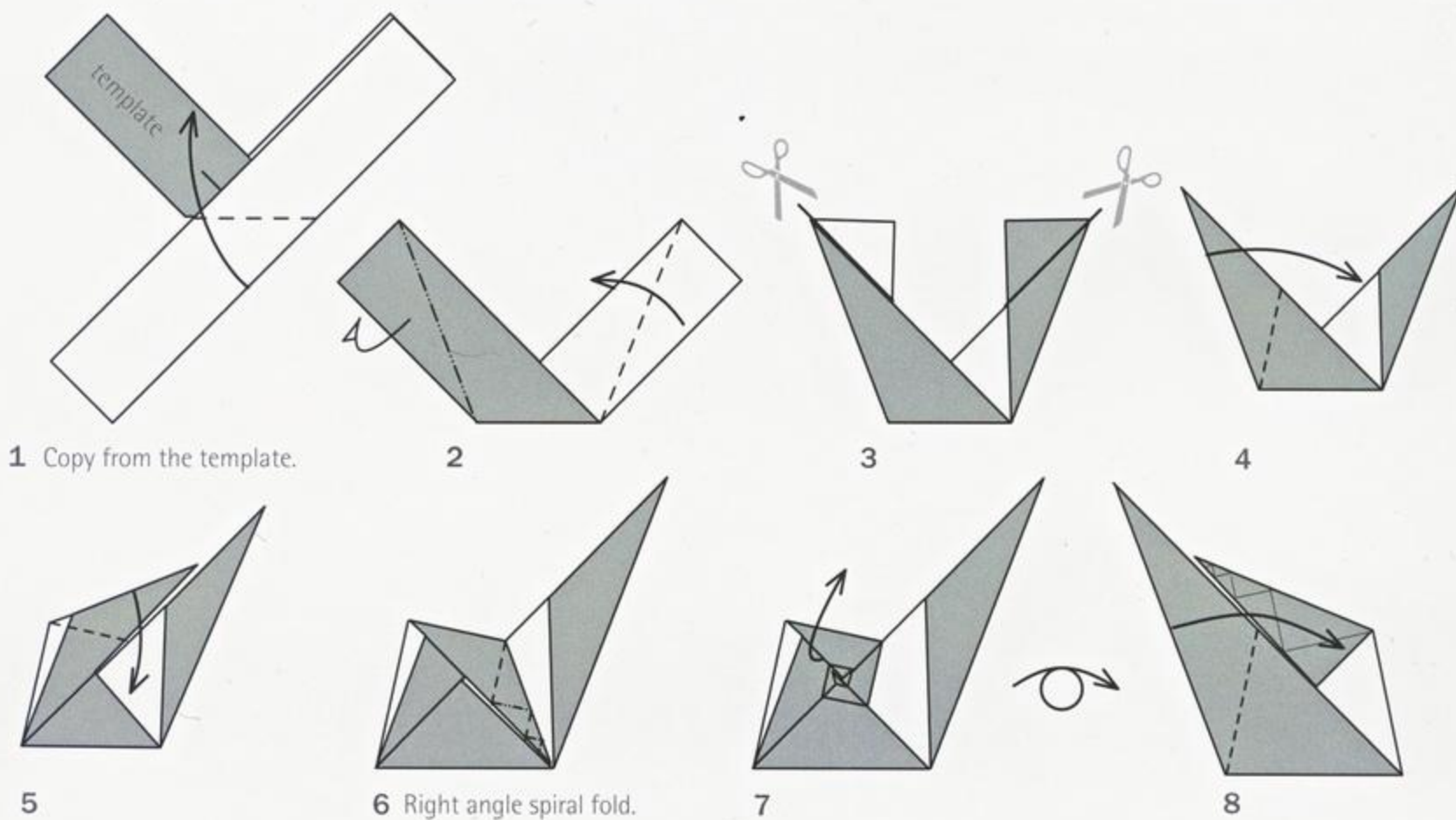
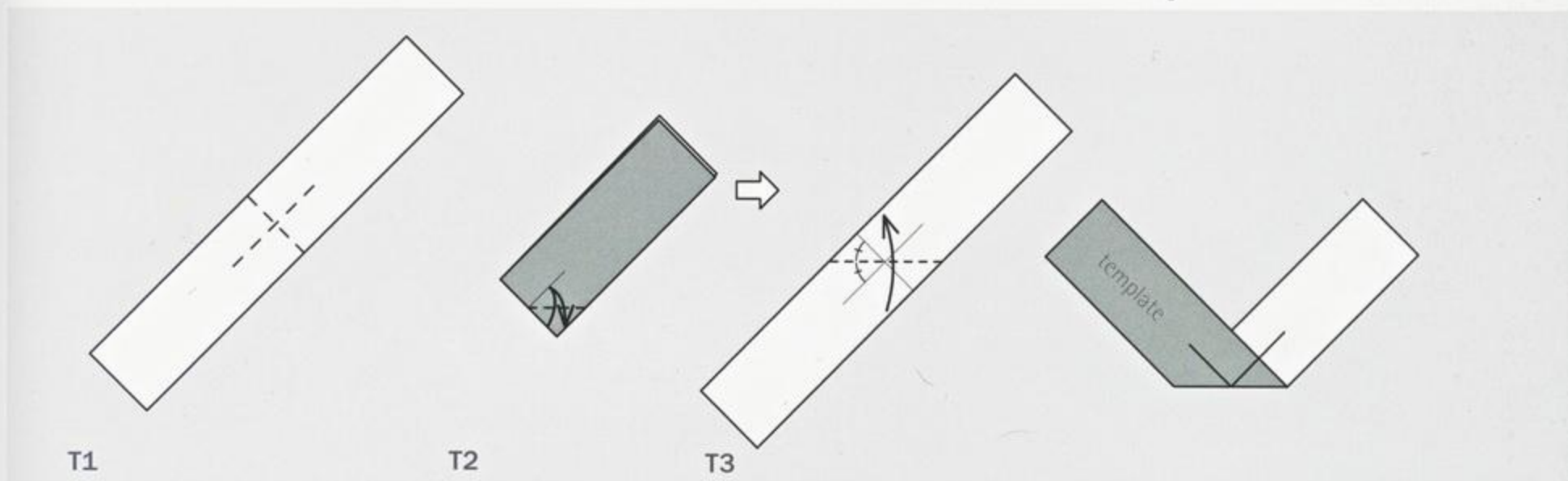


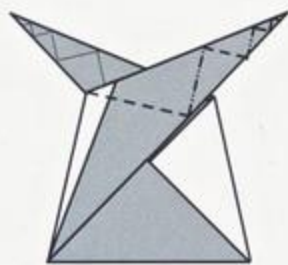
らせん立方体



SPIRAL-FACED CUBE

First make a template. In step 1 copy the first valley fold from the template. If you use a narrower strip, the spiral will get more windings. Cutting off the excess paper in step 3 makes sharper ends: this is better than folding away the excess paper.





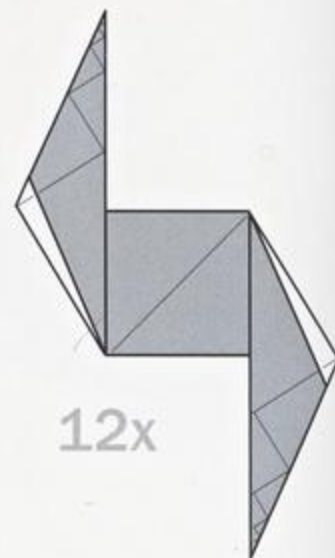
9



10 Right angle spiral fold.



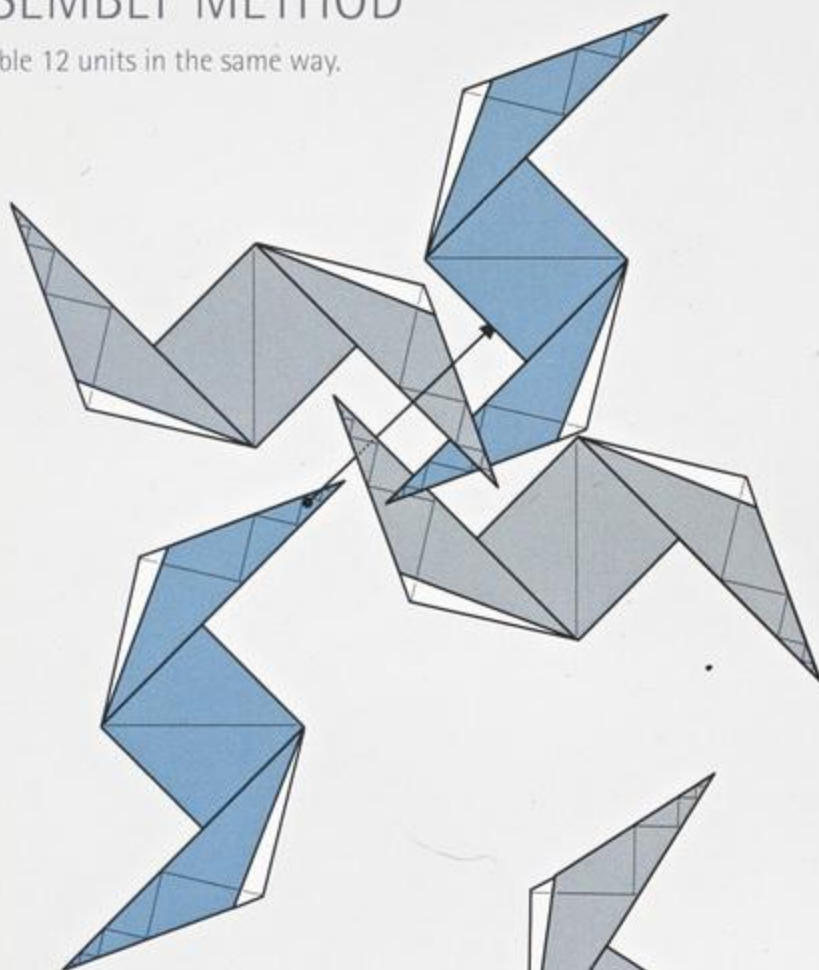
11



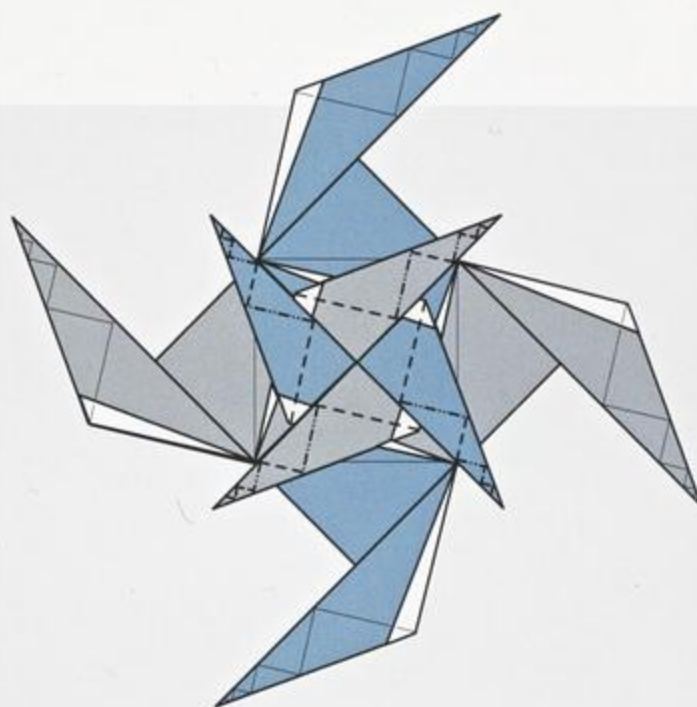
12x

ASSEMBLY METHOD

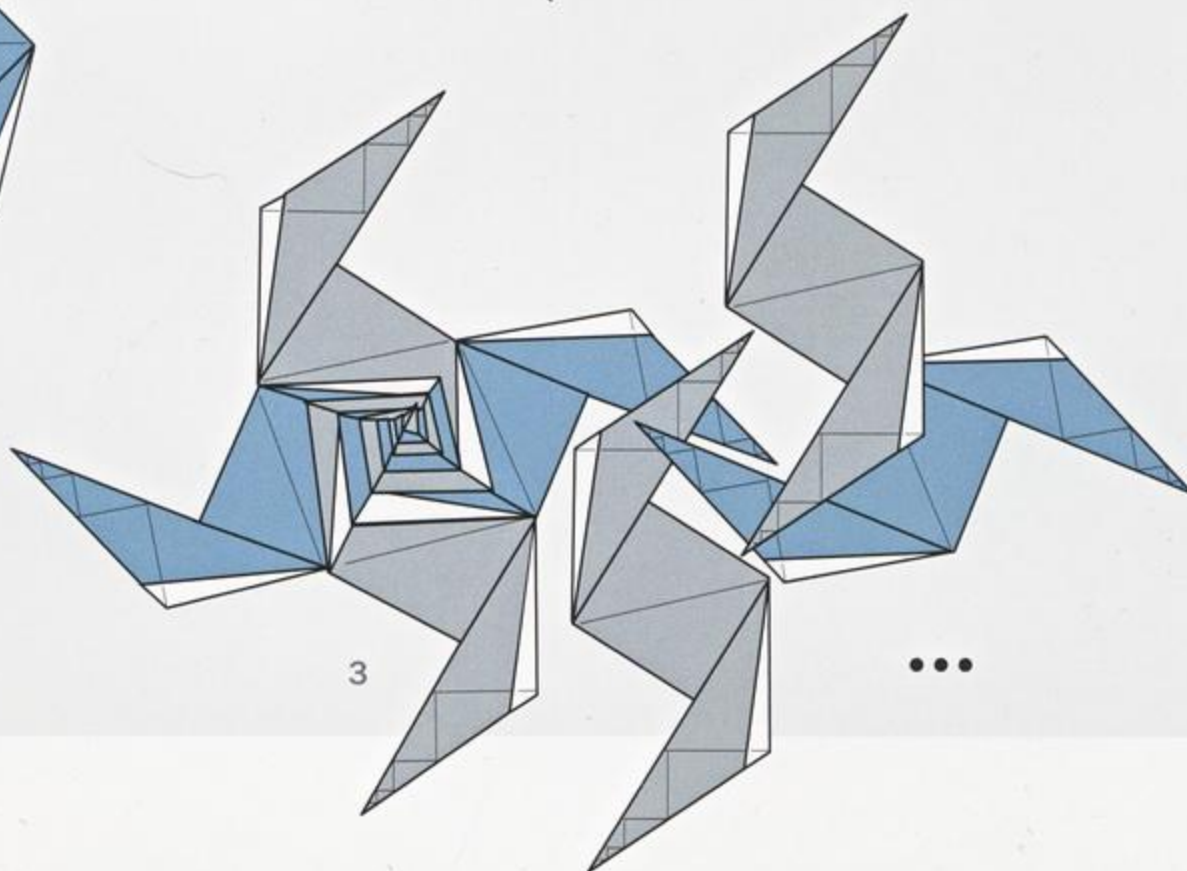
Assemble 12 units in the same way.



1

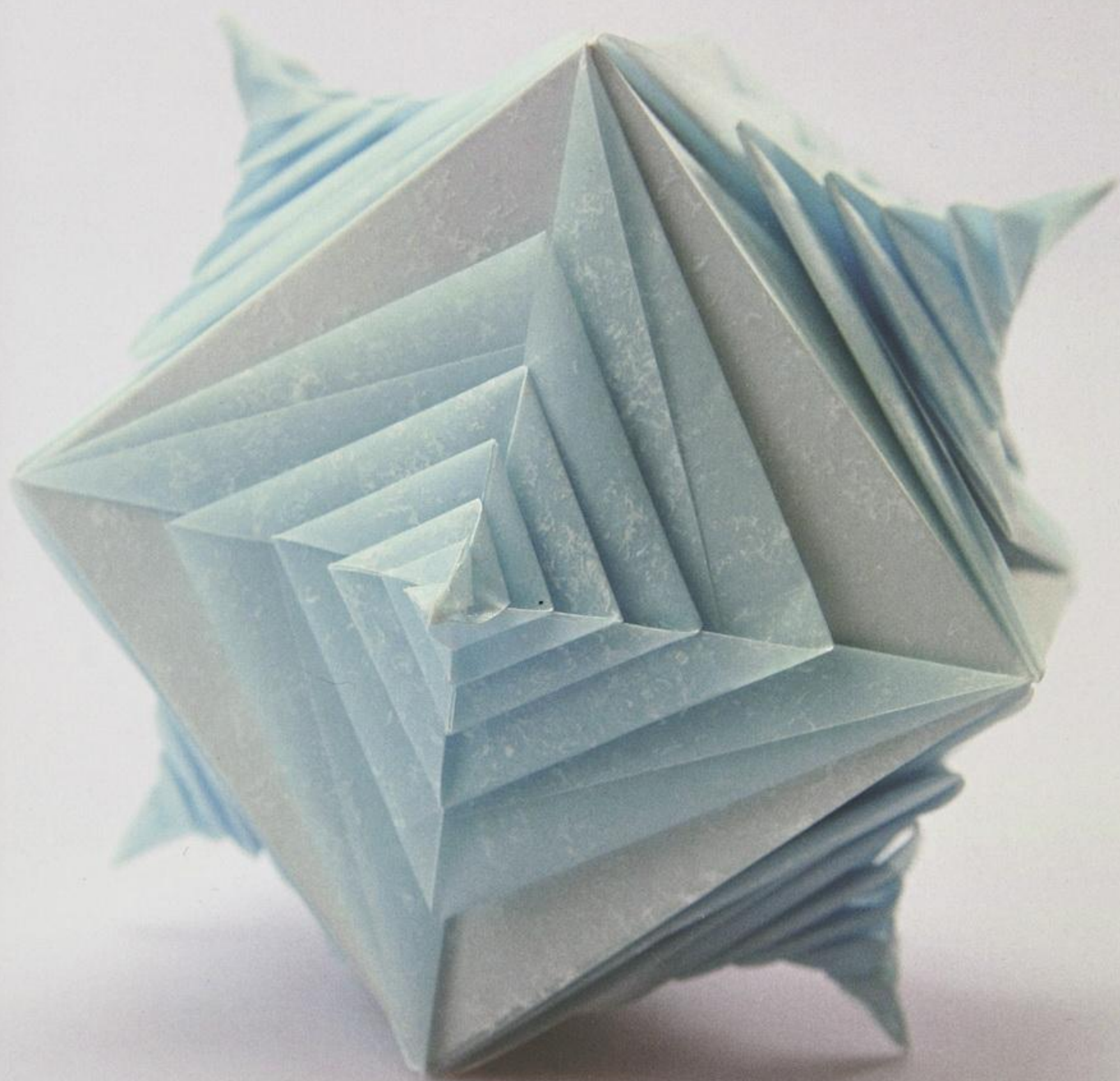


2 See also assembly method of «Decorative Right-angled Spiral» on page 134.



3

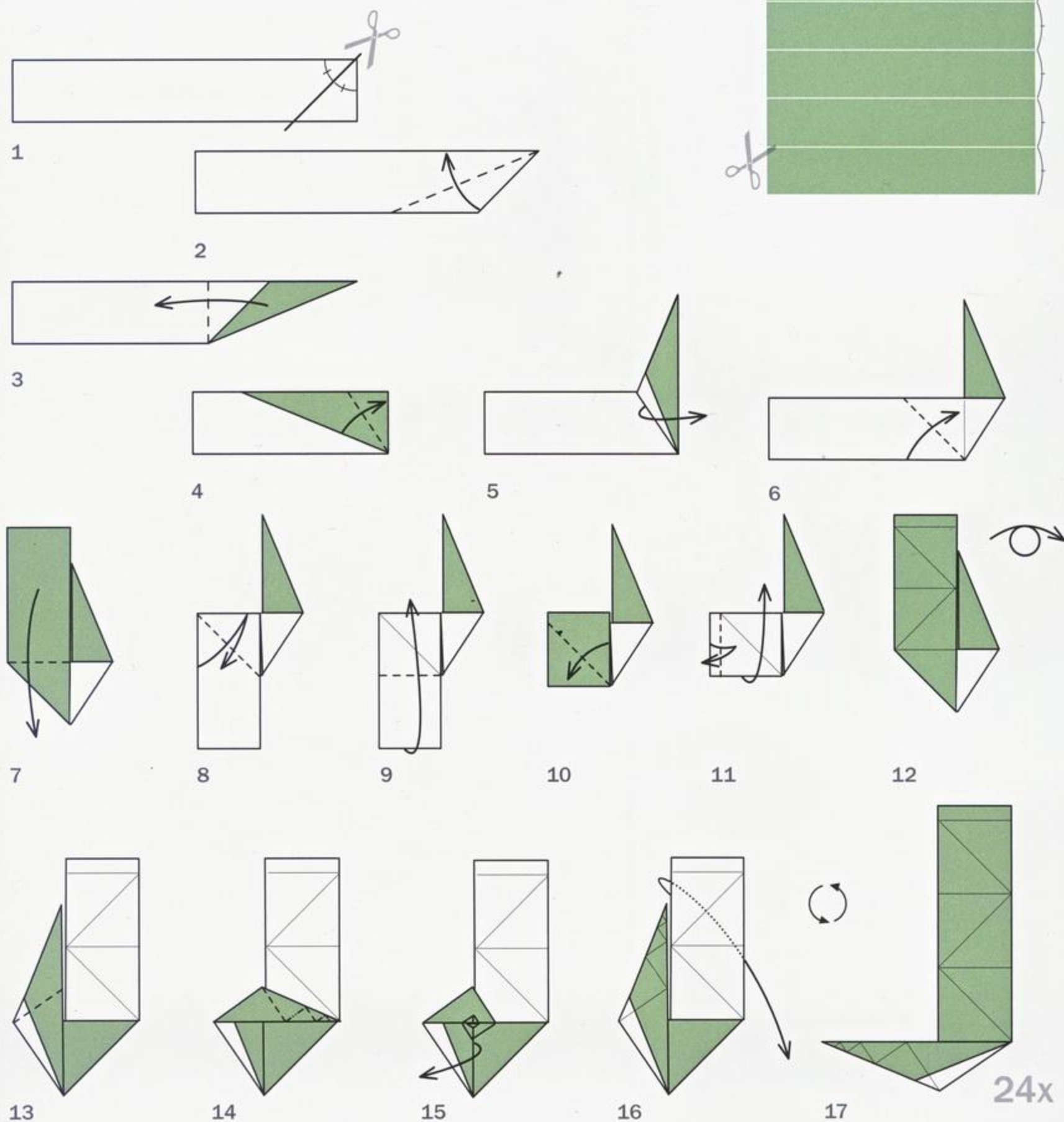
...



らせん立方八面体

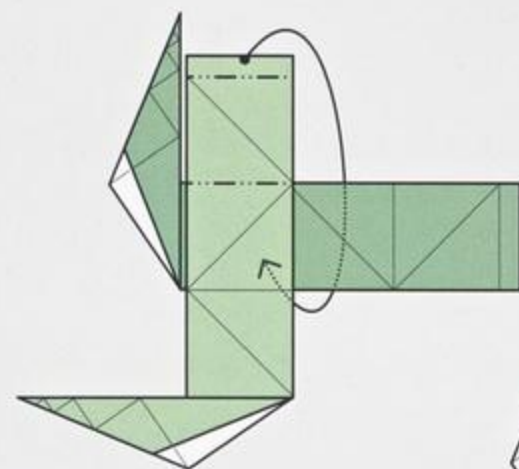


SPIRAL-FACED CUBOCTAHEDRON



ASSEMBLY METHOD

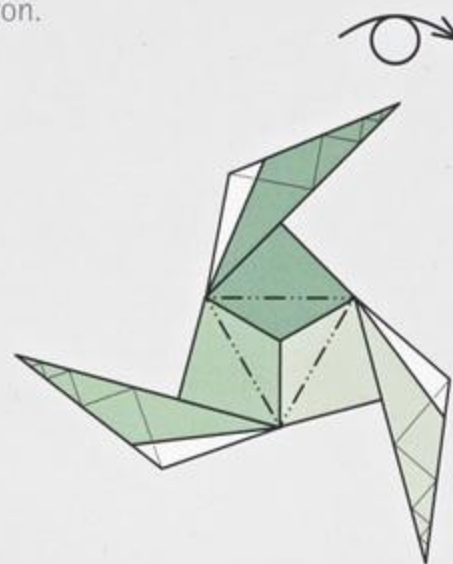
First assemble 3 units into a cluster. Then assemble 8 clusters into the cuboctahedron.



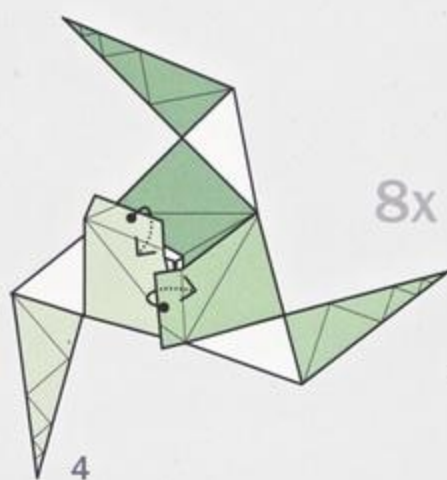
1 Wrap.



2 The marked point becomes the centre of a concave triangular pyramid

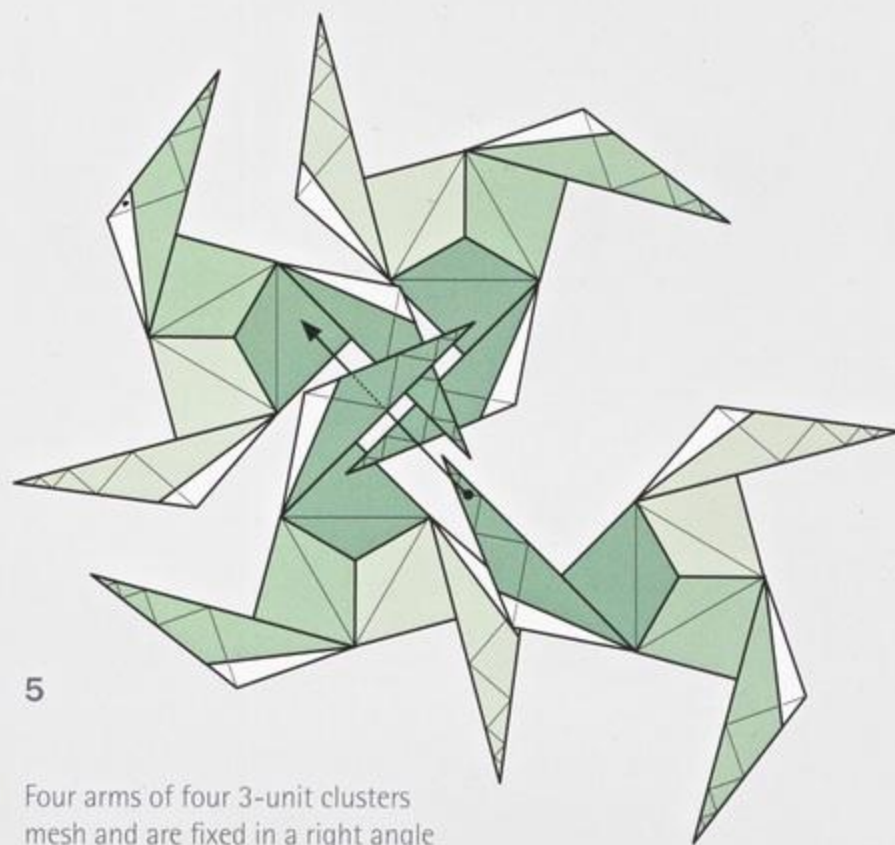


3 Make sharp creases around the concave pyramid.



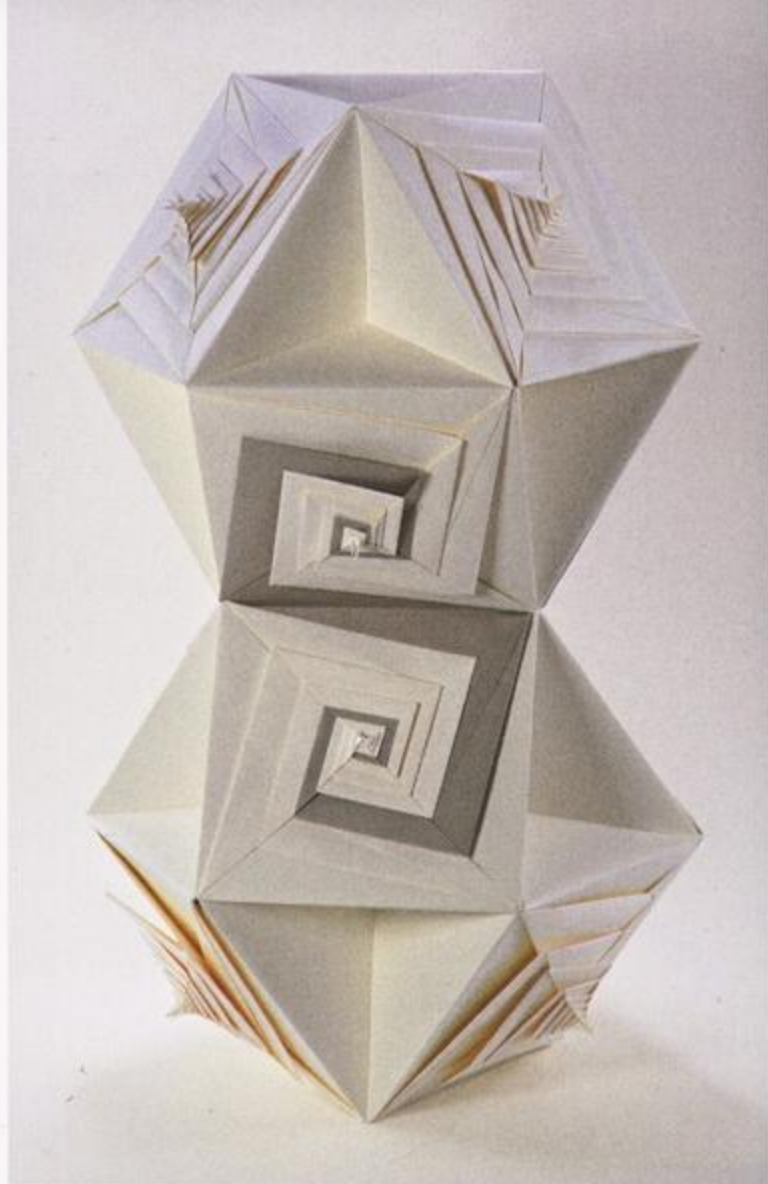
4

8x

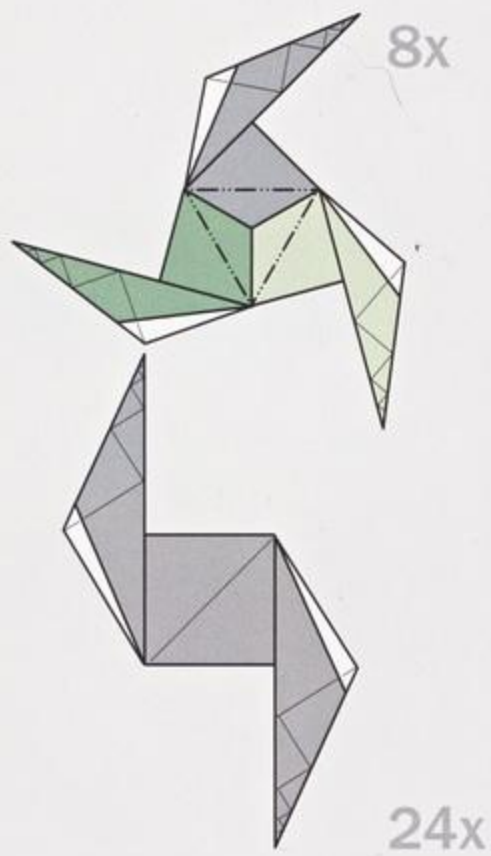


5

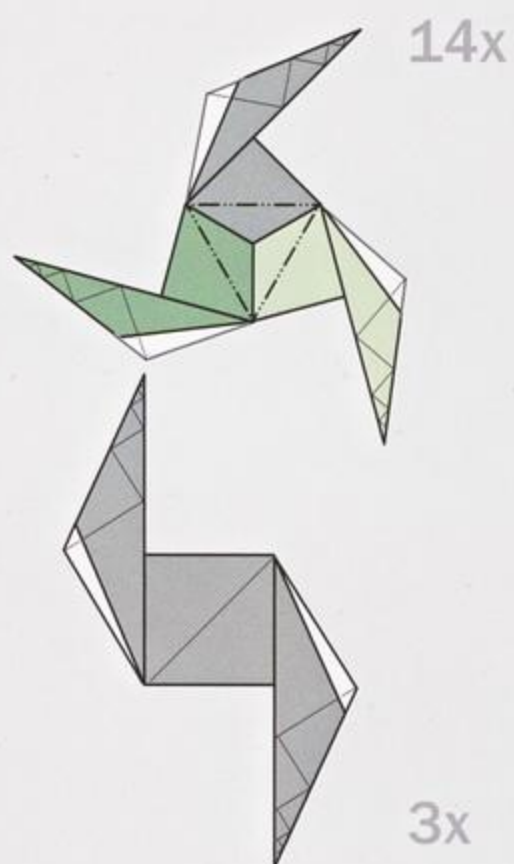
Four arms of four 3-unit clusters mesh and are fixed in a right angle spiral fold.



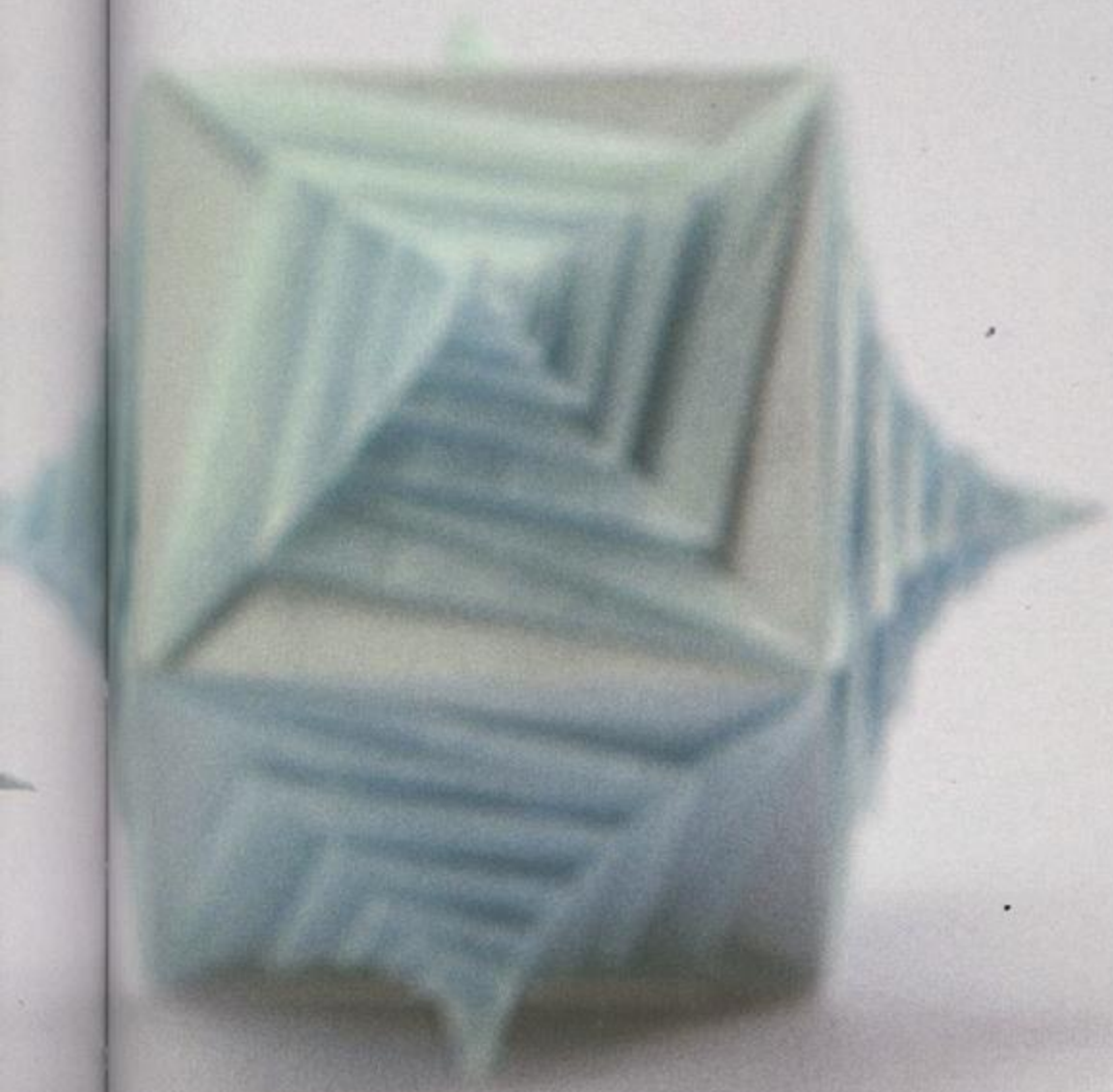
RHOMBICUBOCTAHEDRON



DOUBLE CUBOCTAHEDRON

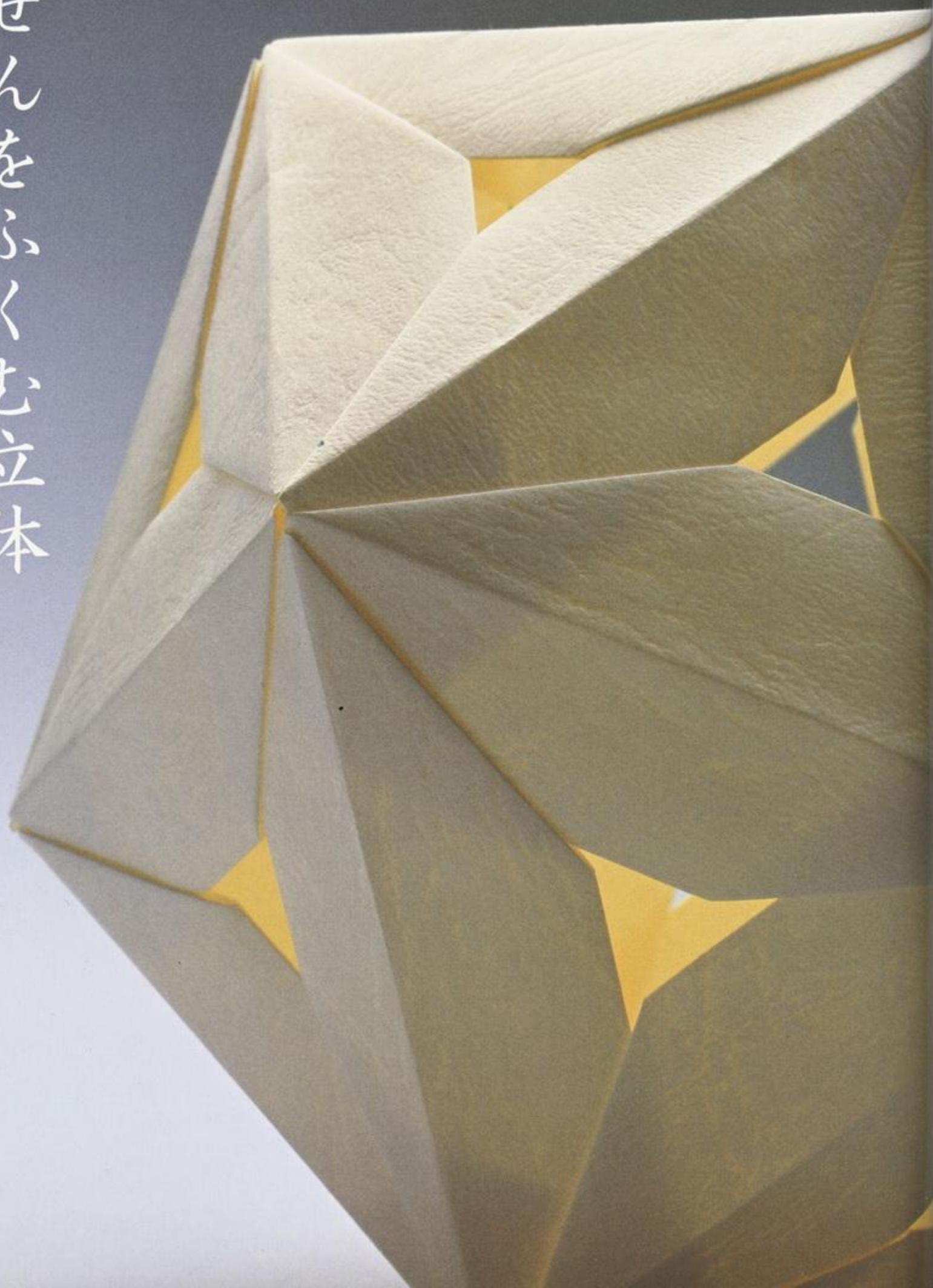






らせんをふくむ立体

花びらユニットで組む立体

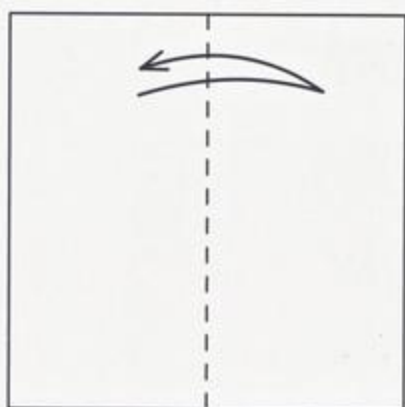


SOLIDS ENCLOSING HELICES

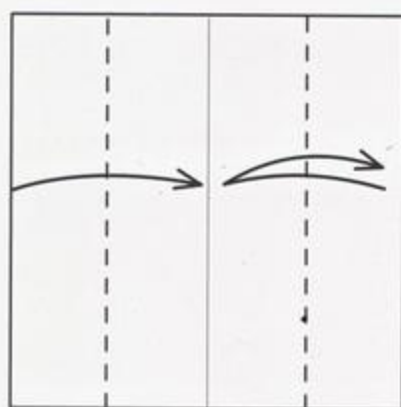
PETAL UNIT OR HOW TO MAKE THE SOLID FRAME

This section describes helices which are enclosed within open-frame solids.

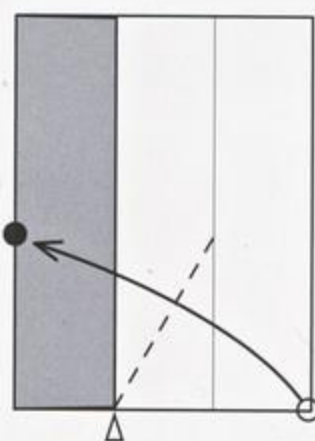
The folding method for all frame units for the solids shown in this book (icosahedron, tetrahedron and octahedron) is the same. However you can use different paper formats. Depending on the ratio of its sides you will get wider or narrower frames. Because this unit can be used for all edges with 60° corners at both ends I refer to it as *Edge 60-60 Unit*. When you use square paper for this unit, a finished icosahedron will look like a blossom when a vertex is viewed from above. Therefore I sometimes call this unit *Petal Unit*.



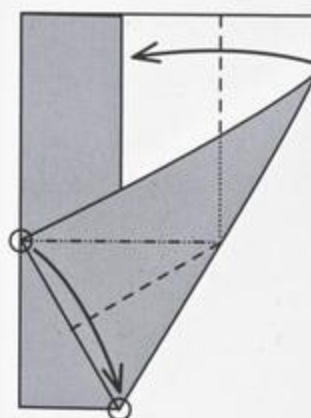
1



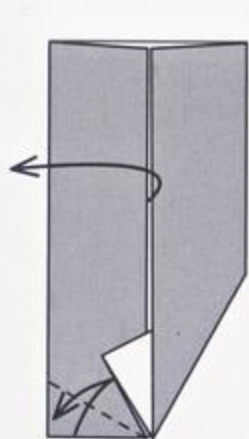
2



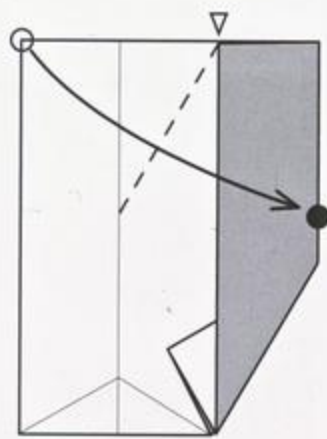
3



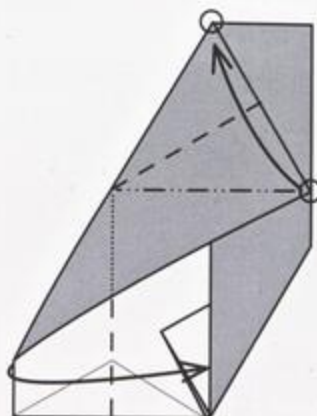
4



5



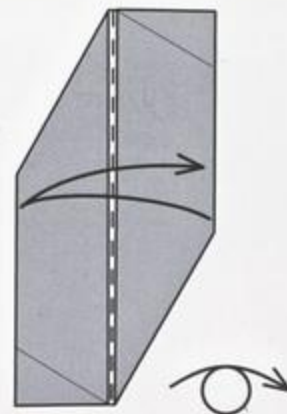
6



7



8 After creasing
hide the flap.

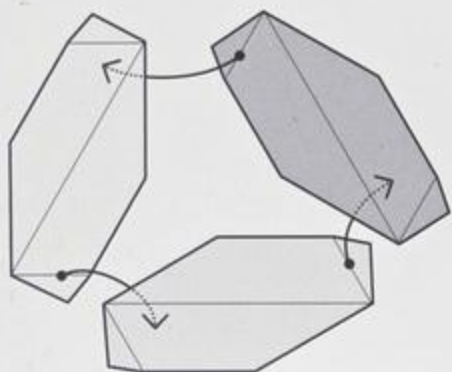


9

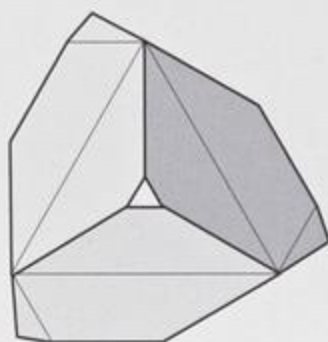


30x

ASSEMBLY METHOD

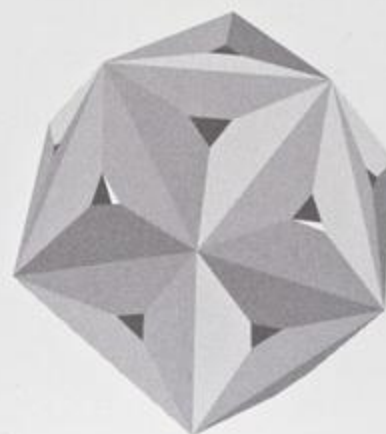


1 Put into the pockets.

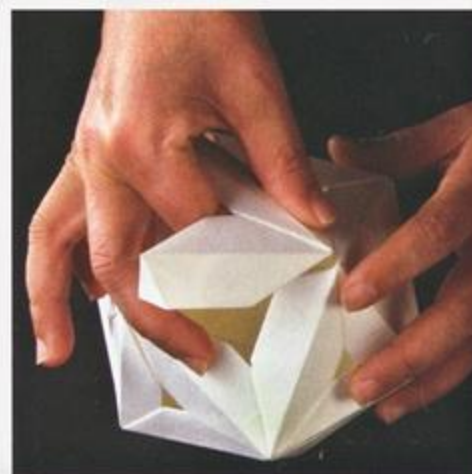
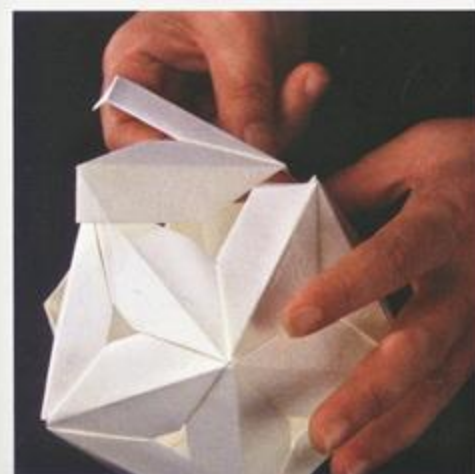
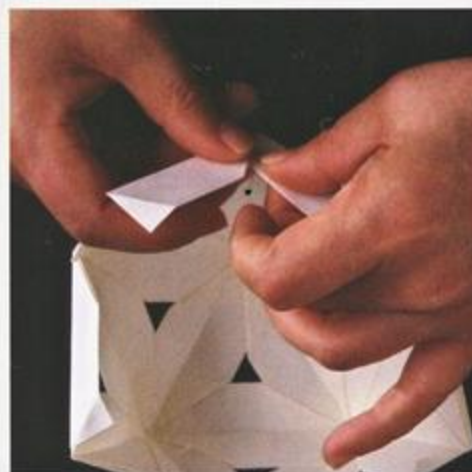
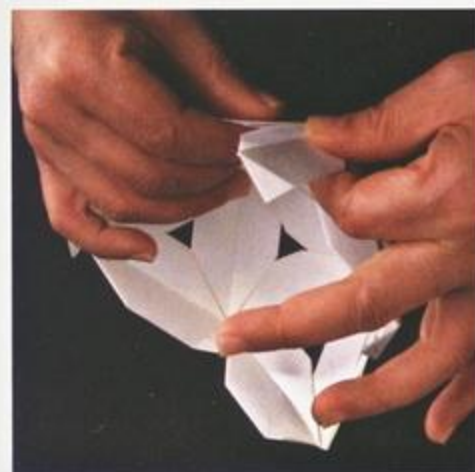


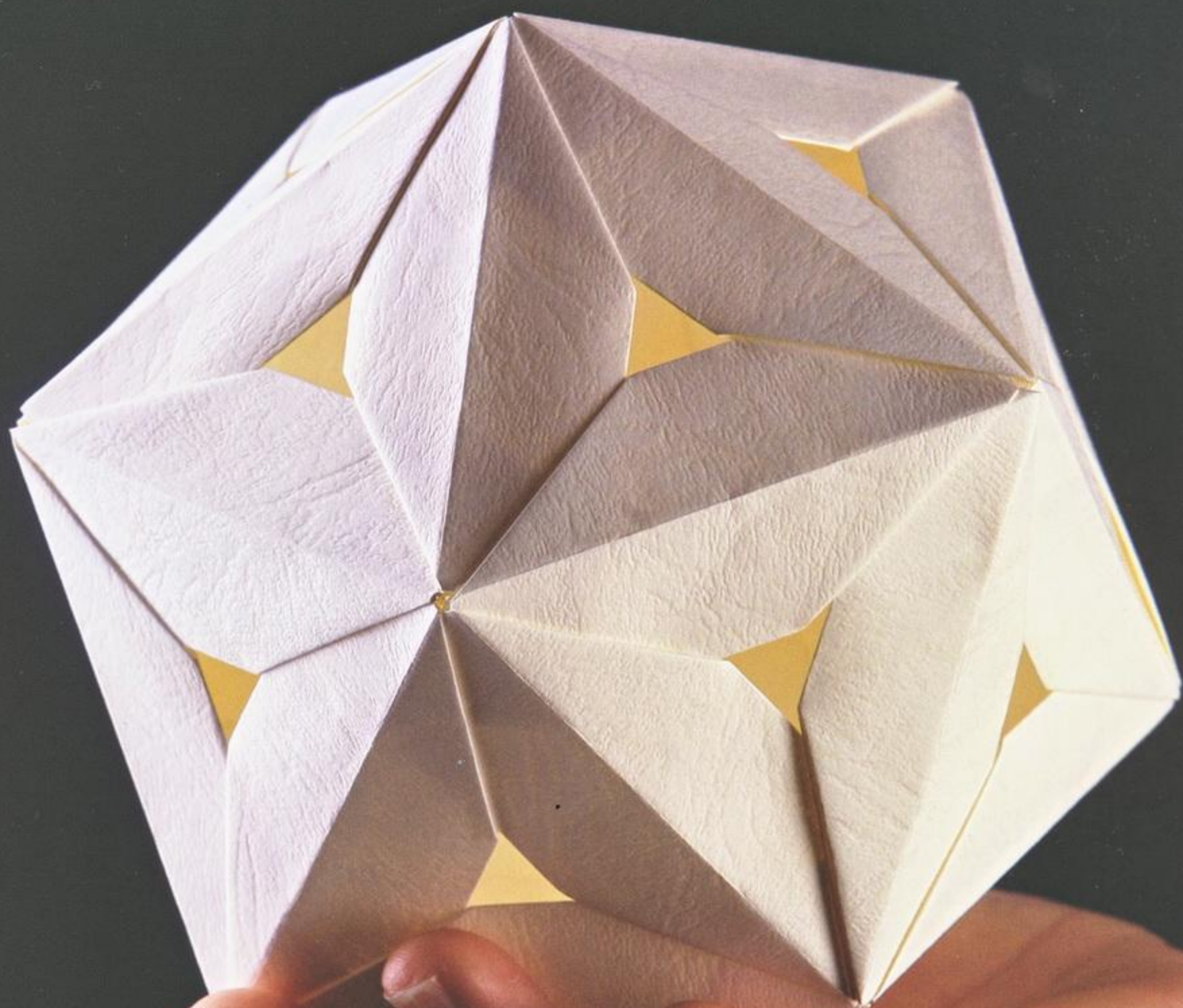
2

...

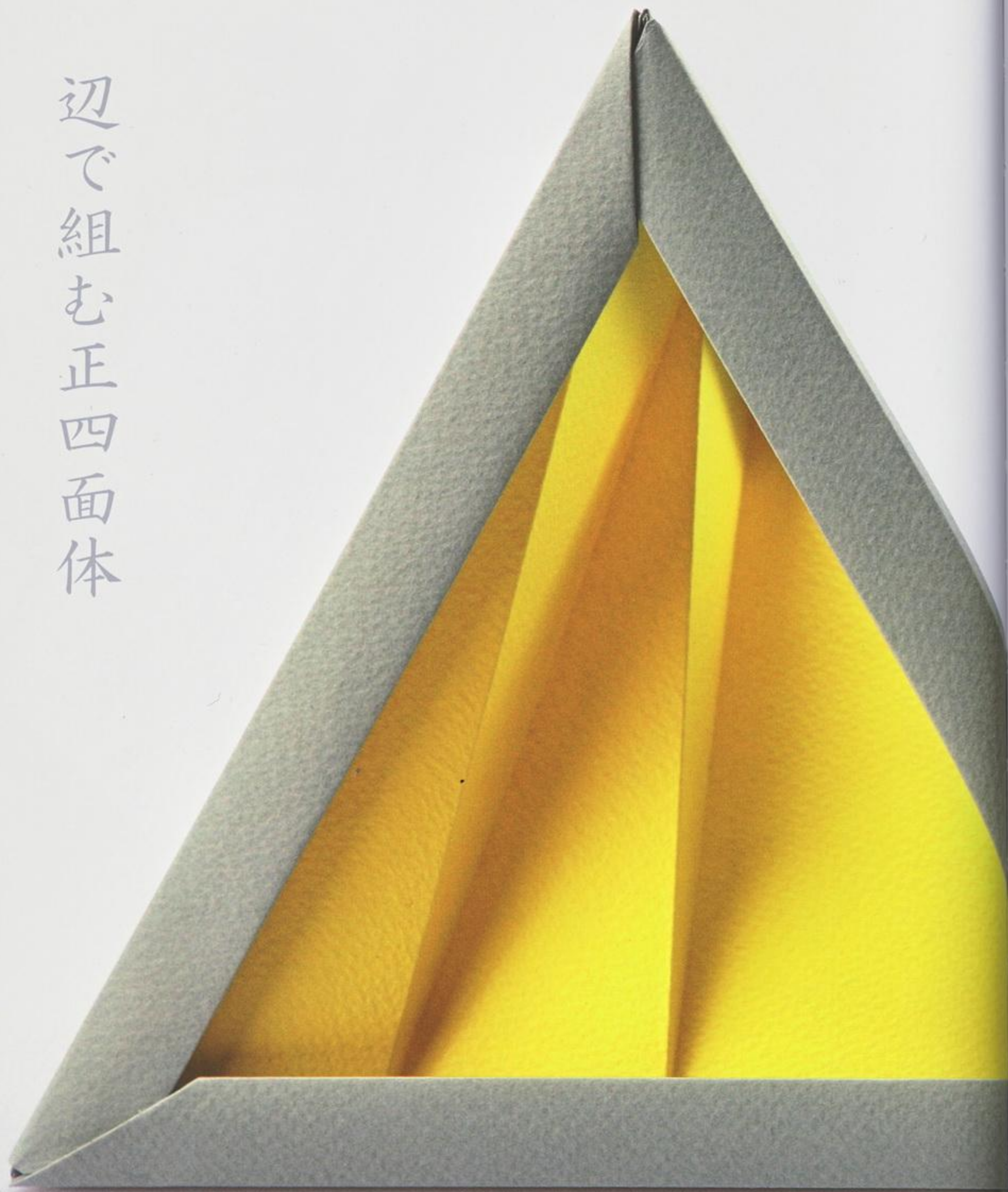


3



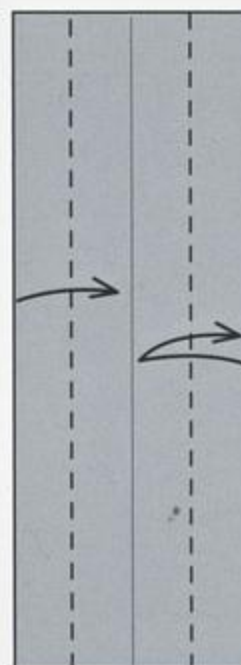
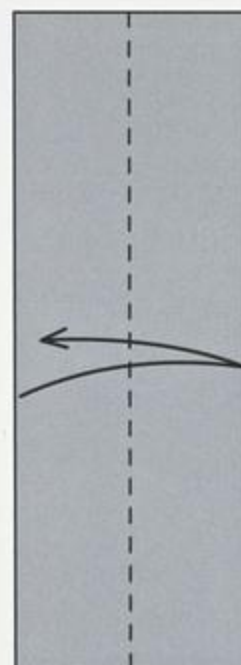
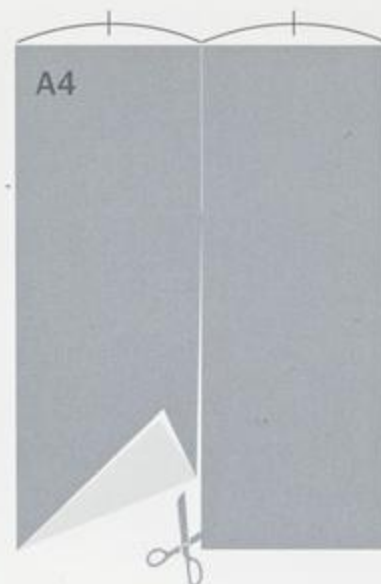


辺で組む正四面体



TETRAHEDRON – THE FRAME

To make the units for the tetrahedron frame use an A-format paper cut in half lengthwise. Fold in the same way as shown at »Petal Unit or how to make the Solid Frame« on page 289.

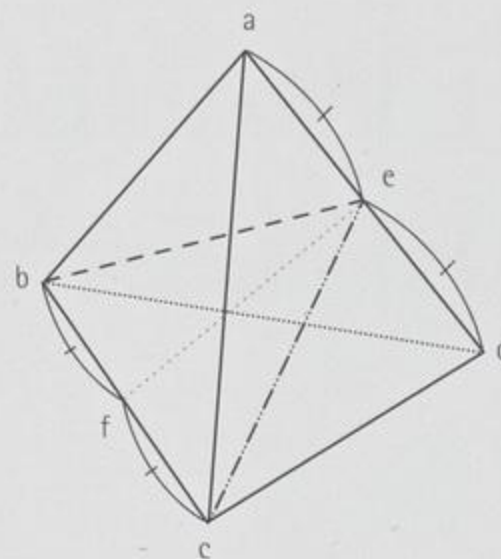


TETRAHEDRA ENCLOSING HELICES

I will show several different helices to be enclosed in tetrahedron frames. The helices divide the volume of the tetrahedron into two equal parts. Therefore I refer to them as *Divisions-A to -E*.

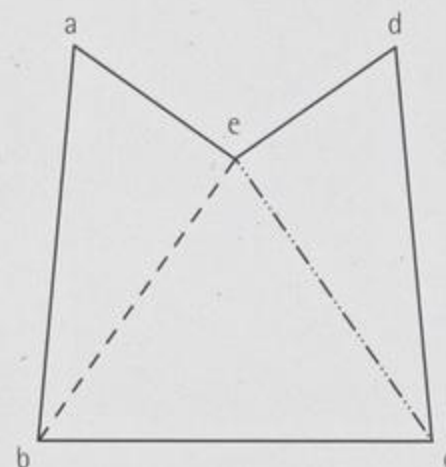
DIVISION A

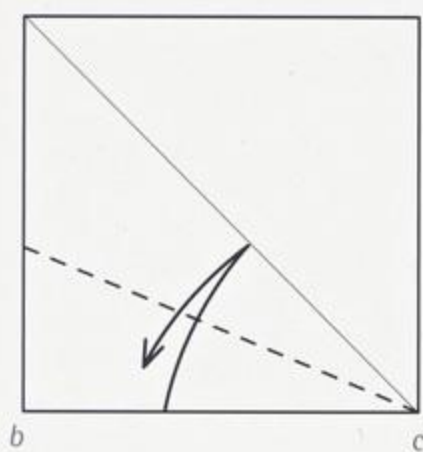
Have a look at the tetrahedron in the top box on this page. Its corners are denoted abc and d . The triangle bce is the middle part of a very simple helix that divides the tetrahedron in two equal parts. The triangles abe and cde are the end parts of the helix and lie in »opposite« faces of the tetrahedron. Steps 1 to 4 show how to construct Helix Division-A from a square. To avoid the construction creases use the result of step 4 as a template and copy the divisions you use for your models from this template. The template will also be used as a base to construct the other divisions.



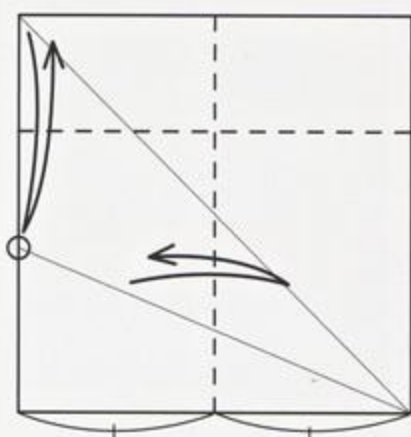
$$\begin{aligned} ab = ac = ad = bc = cd = bd &= 1 \\ ae = ed = bf = fc &= \frac{1}{2} \end{aligned}$$

A

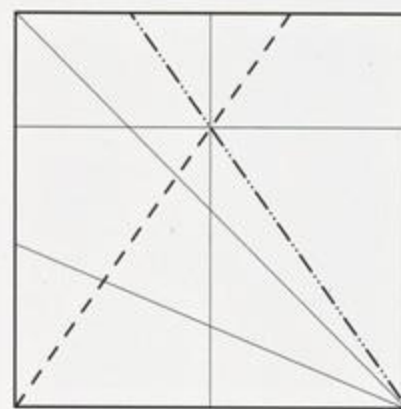




1



2

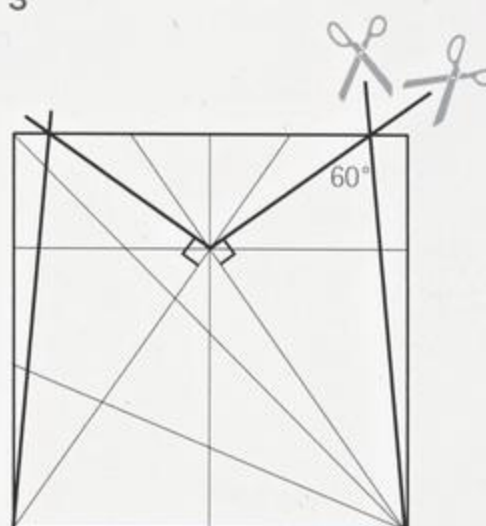
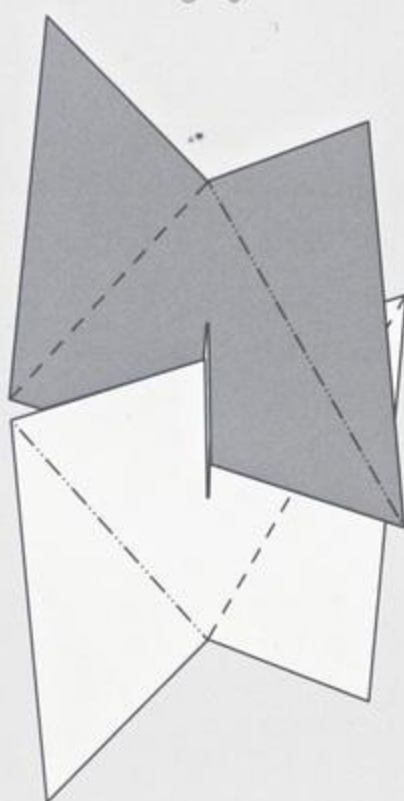
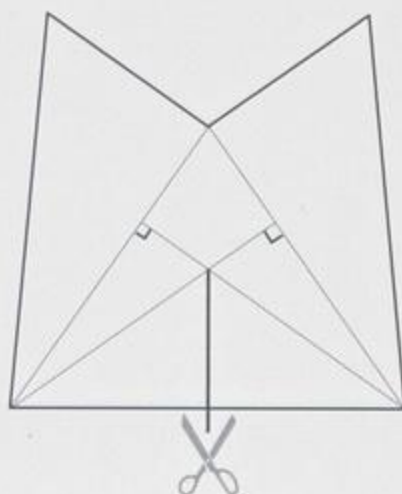


3

DIVISION B

Cut two Division-A units to the centre and interlock them.

B

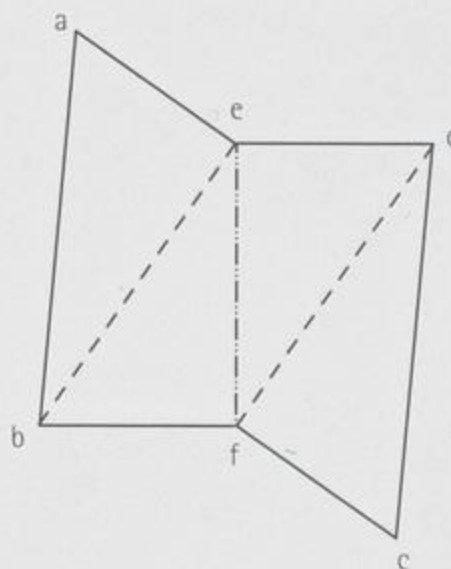


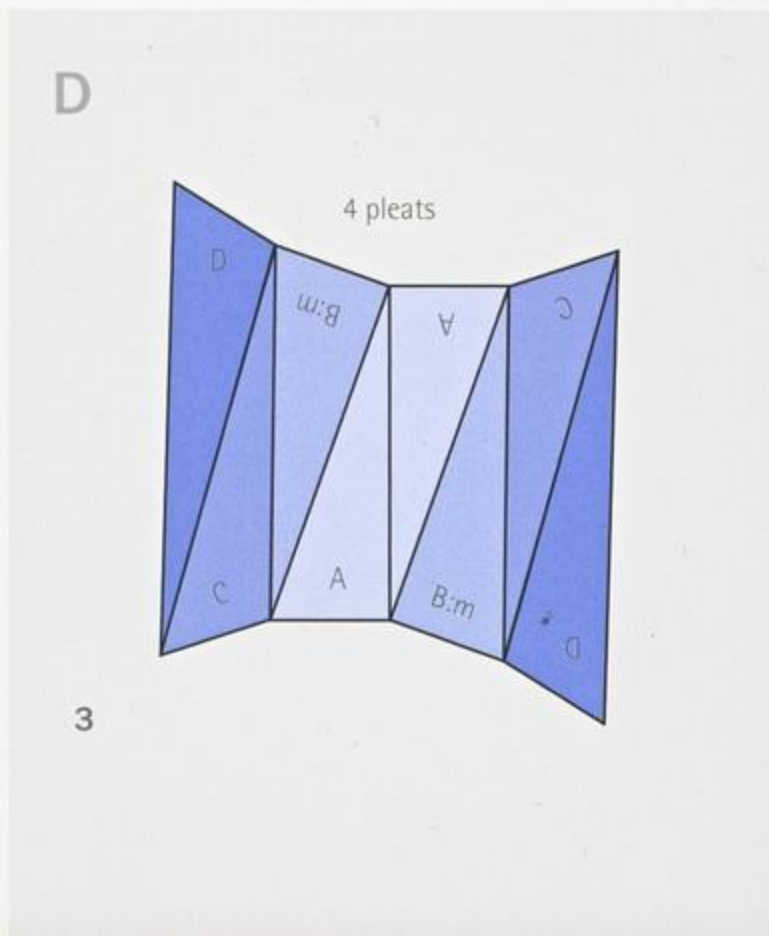
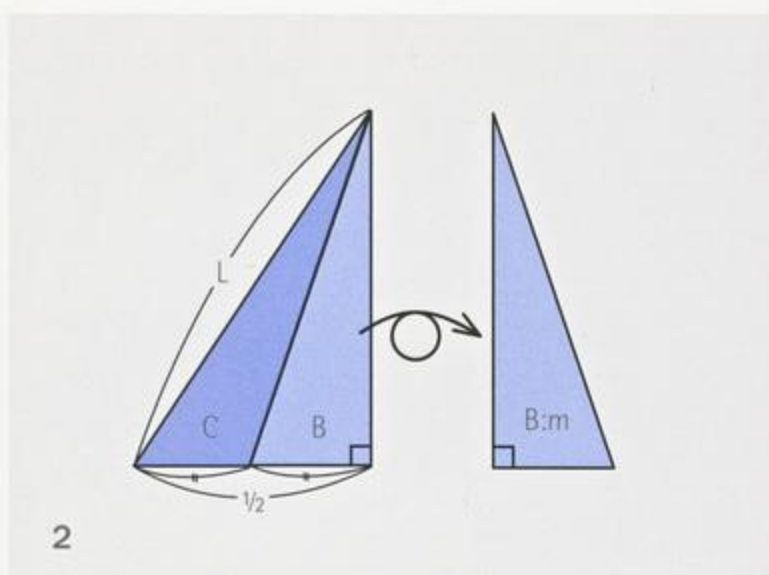
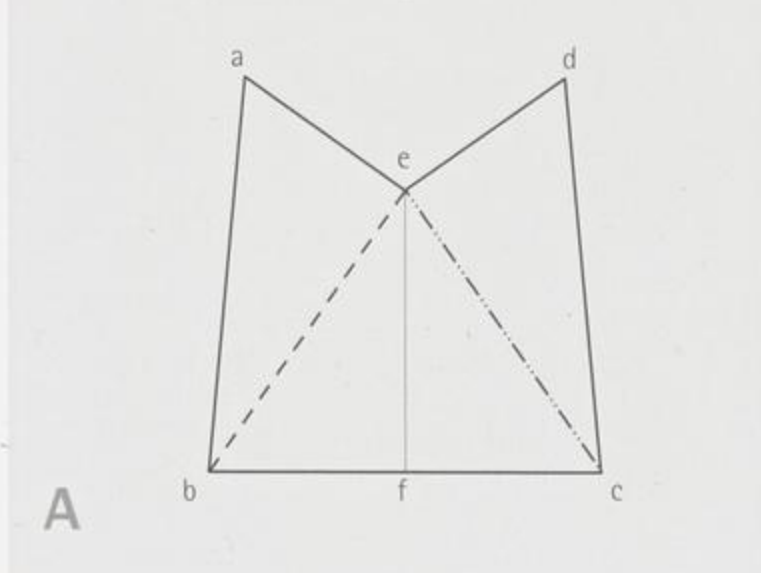
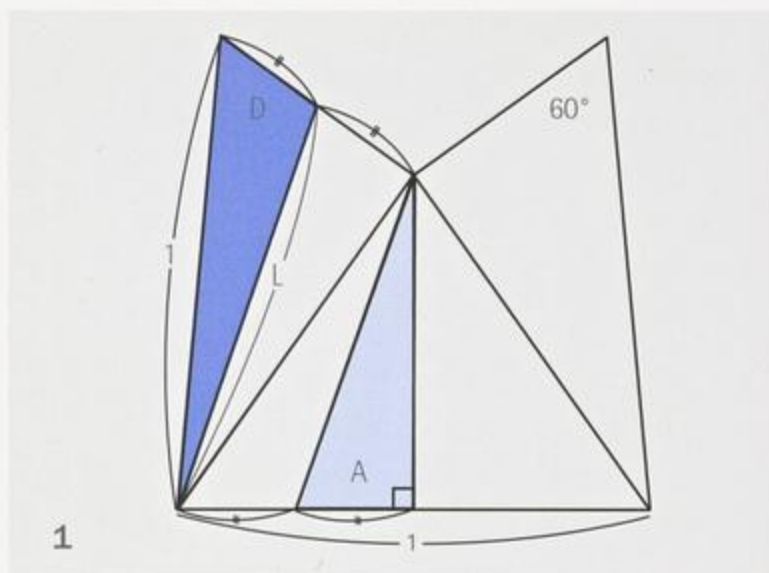
4

DIVISION C

The right half of a Division-A is turned upside down.

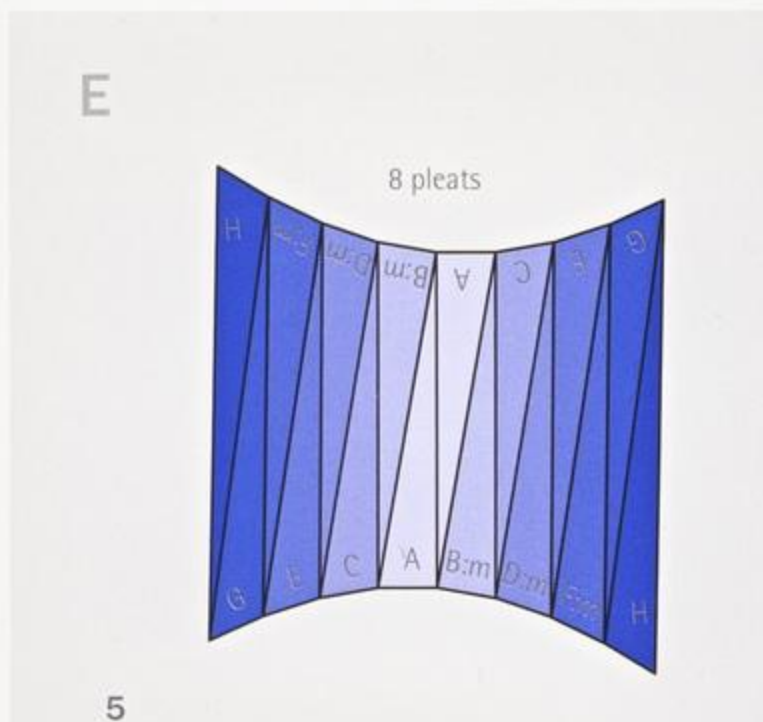
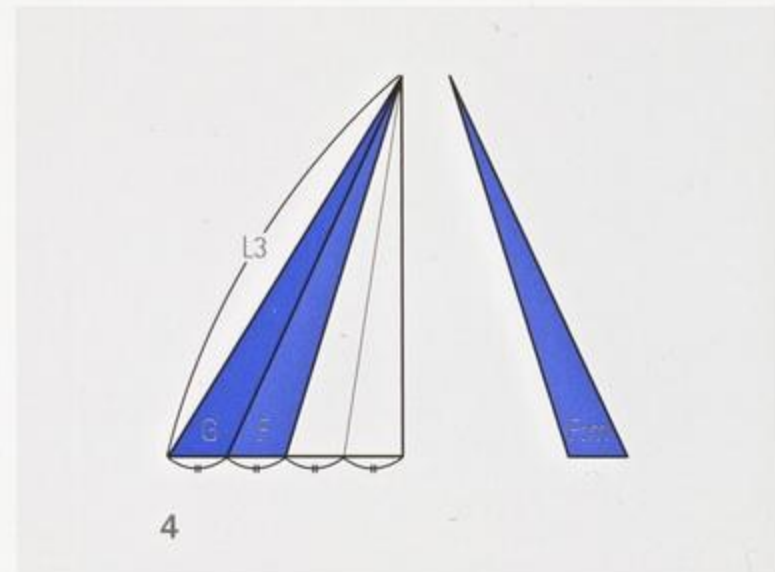
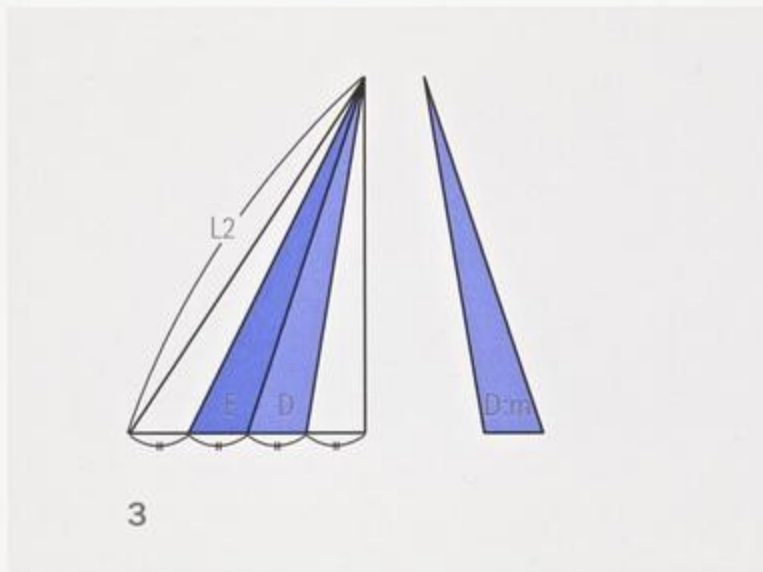
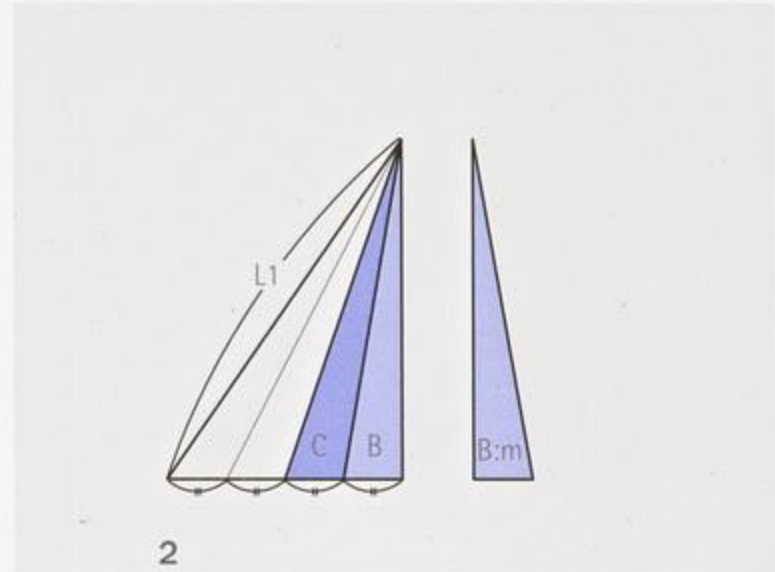
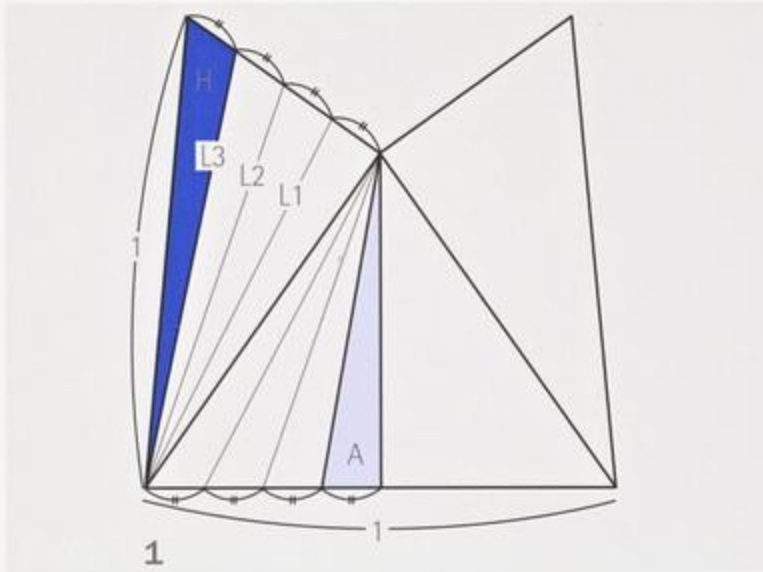
C





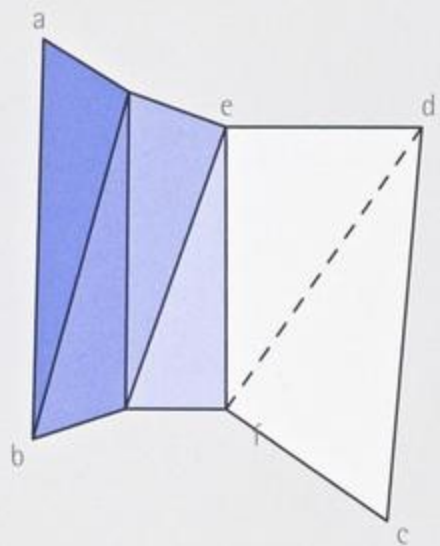
DIVISION D

Helix Division-D has four pleats in its crease pattern. To construct it, add line L to the Division-A template and take its length as the hypotenuse of a right-angled triangle (see step 2) whose one cathetus is b-f. The areas marked A, B:m, C and D make one half of the Division-D crease pattern. Rotate it about 180° to receive the other half. (B:m is the mirror image of B.)



DIVISION E

Helix Division-E has 8 pleats in its crease pattern. To construct it, add lines L1 to L3 to the Division-A template and take their lengths as the hypotenuses of right-angled triangles (see steps 2 to 4) whose one cathetus is b-f. The areas marked A, B:m, C, D:m, E, F:m, G and H make one half of the Division-E crease pattern. Rotate it about 180° to receive the other half.



D+C

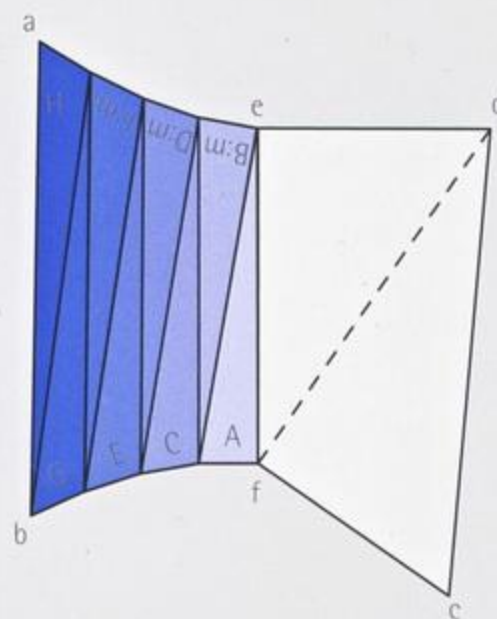
DIVISION D+C

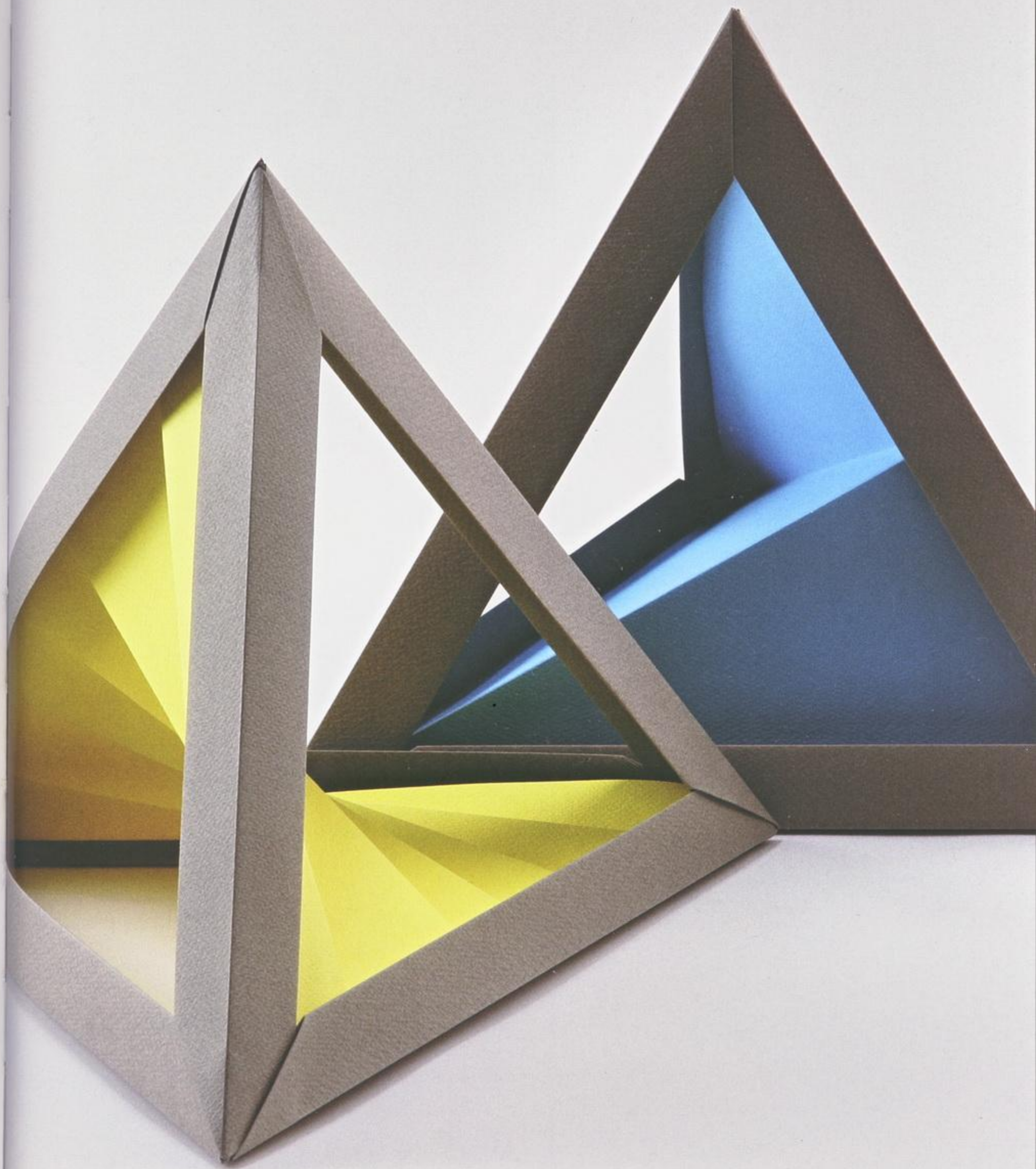
You can combine halves of D and C to get Division-D+C.

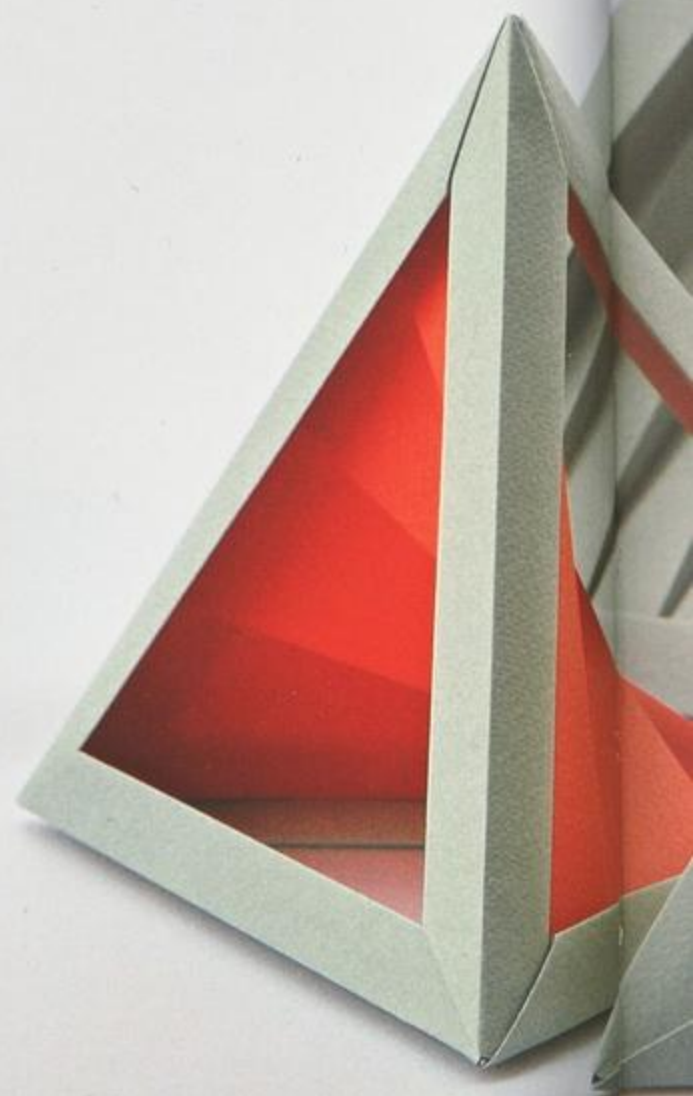
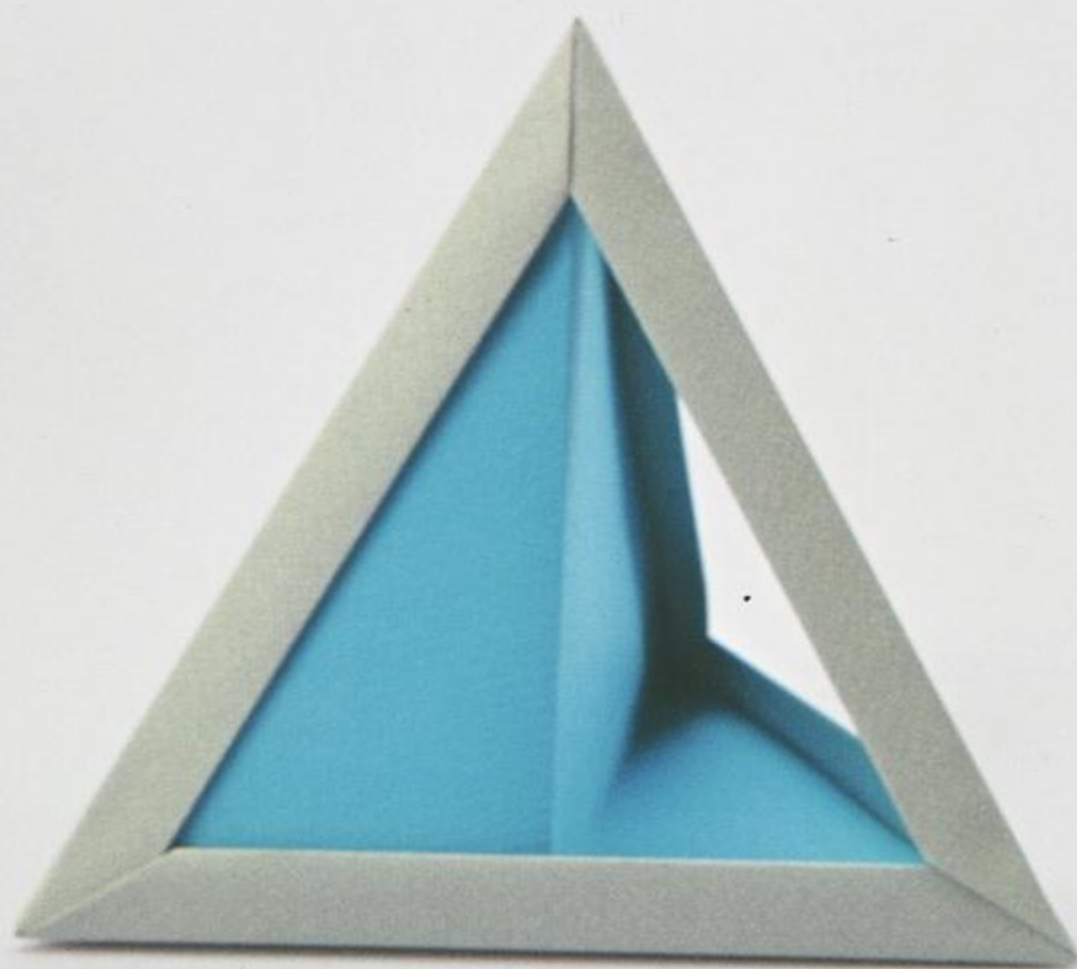
DIVISION E+C

You can combine halves of E and C to get Division-E+C.

E+C

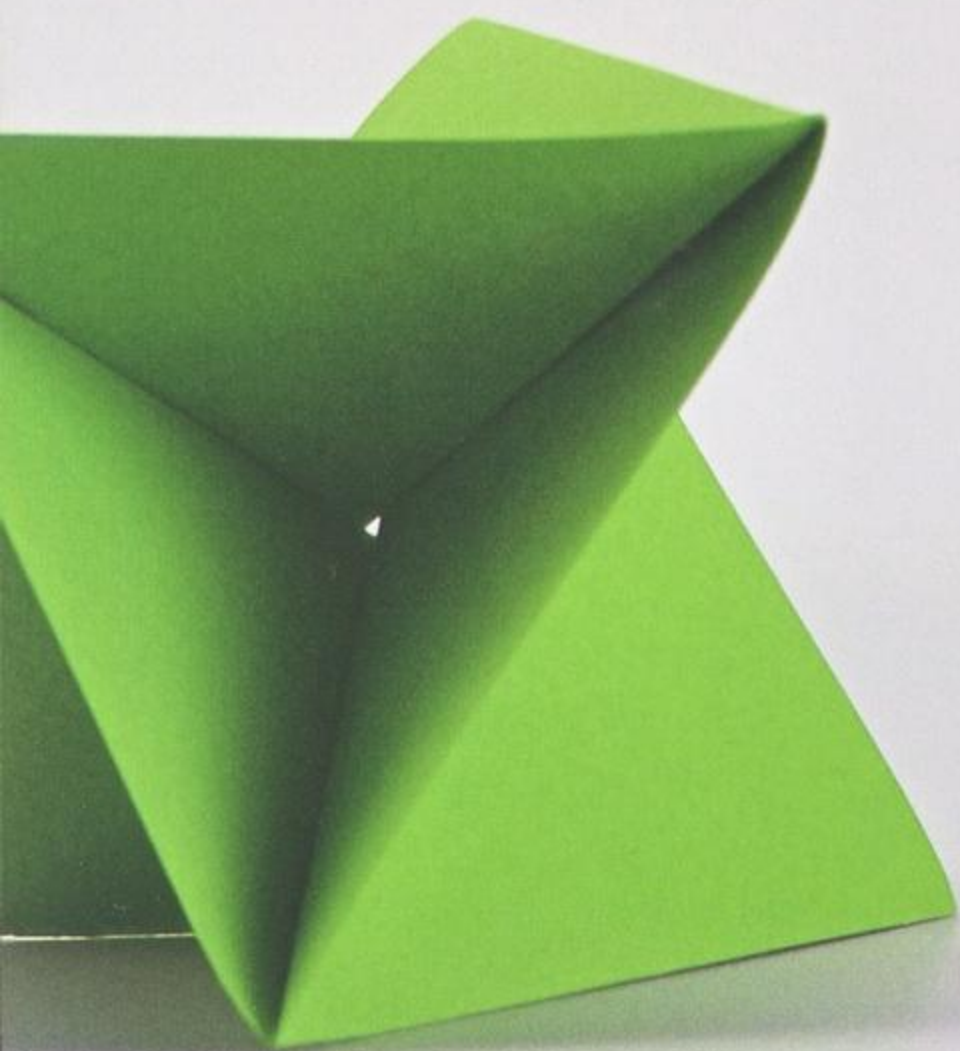








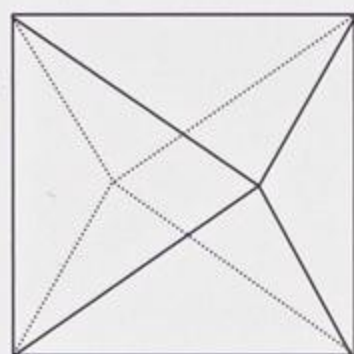
正八面体十砂時計



OCTAHEDRA ENCLOSING HOURGLASSES

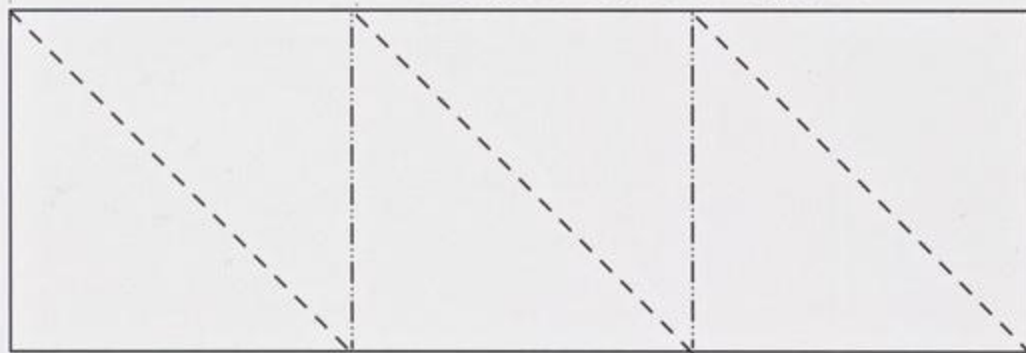
Use the same frame units as for a tetrahedron (page 293).

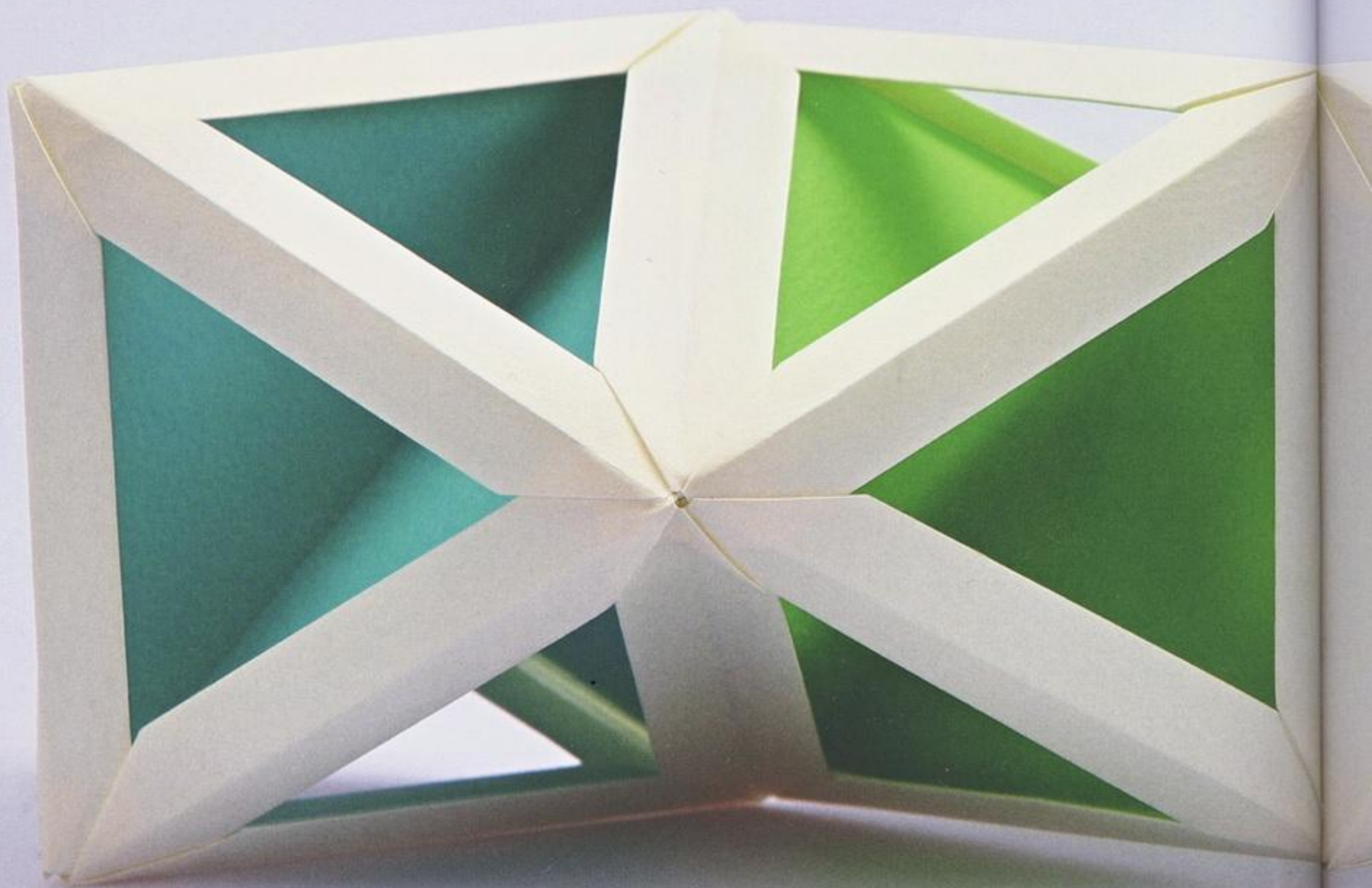
Put an octahedron on the table with a triangular face touching the table. The next octahedron is put on top of the previous on a triangle rotated about 60° . Place the hourglasses inside the pile of octahedra as shown in the photo. Take care of the orientation of the hourglasses in order to have a proper helix.

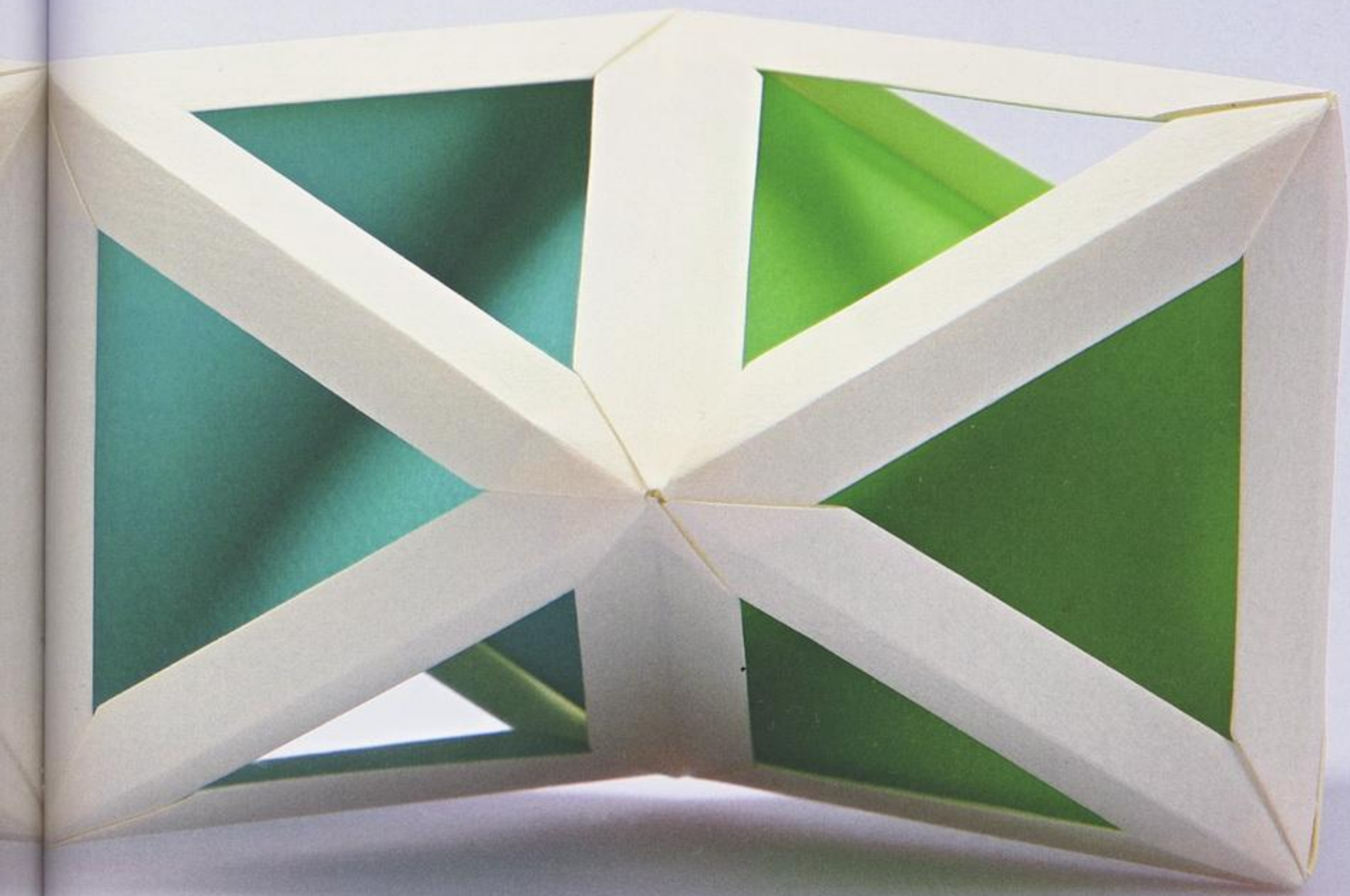


Crease pattern for the octahedron hourglass.

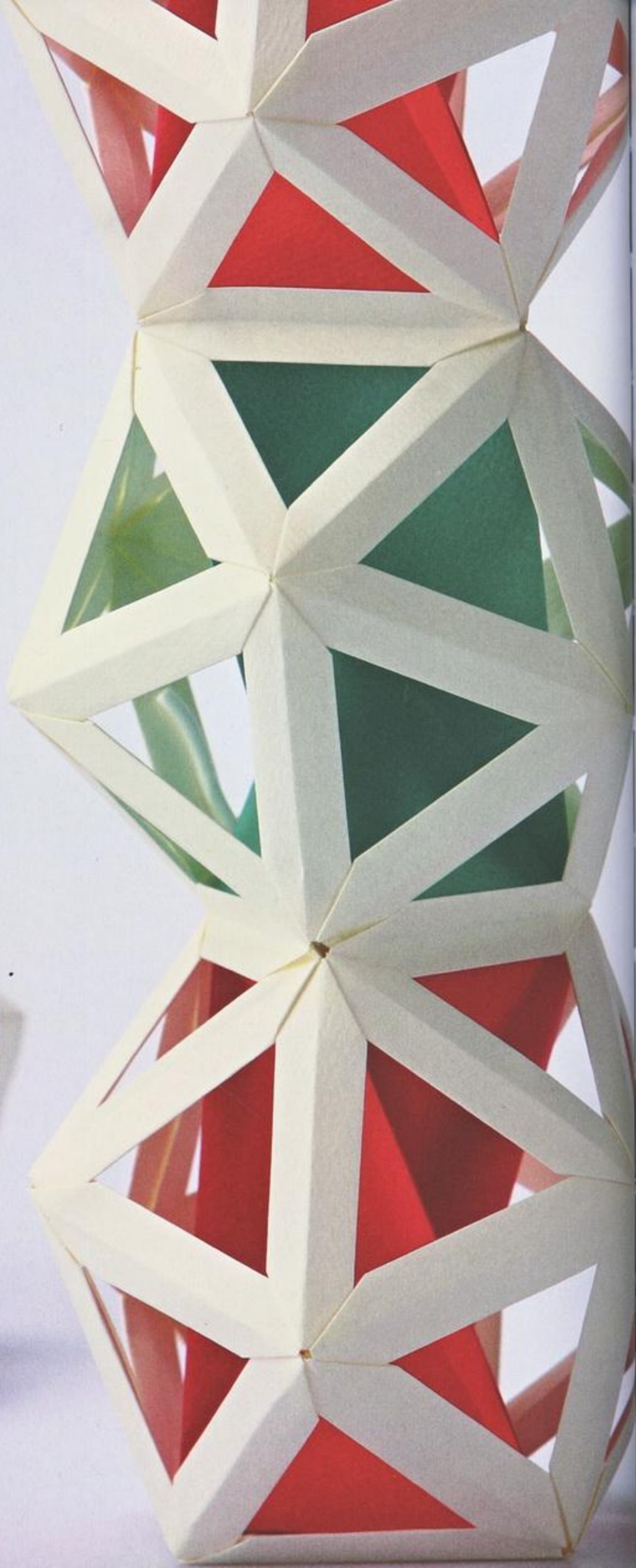
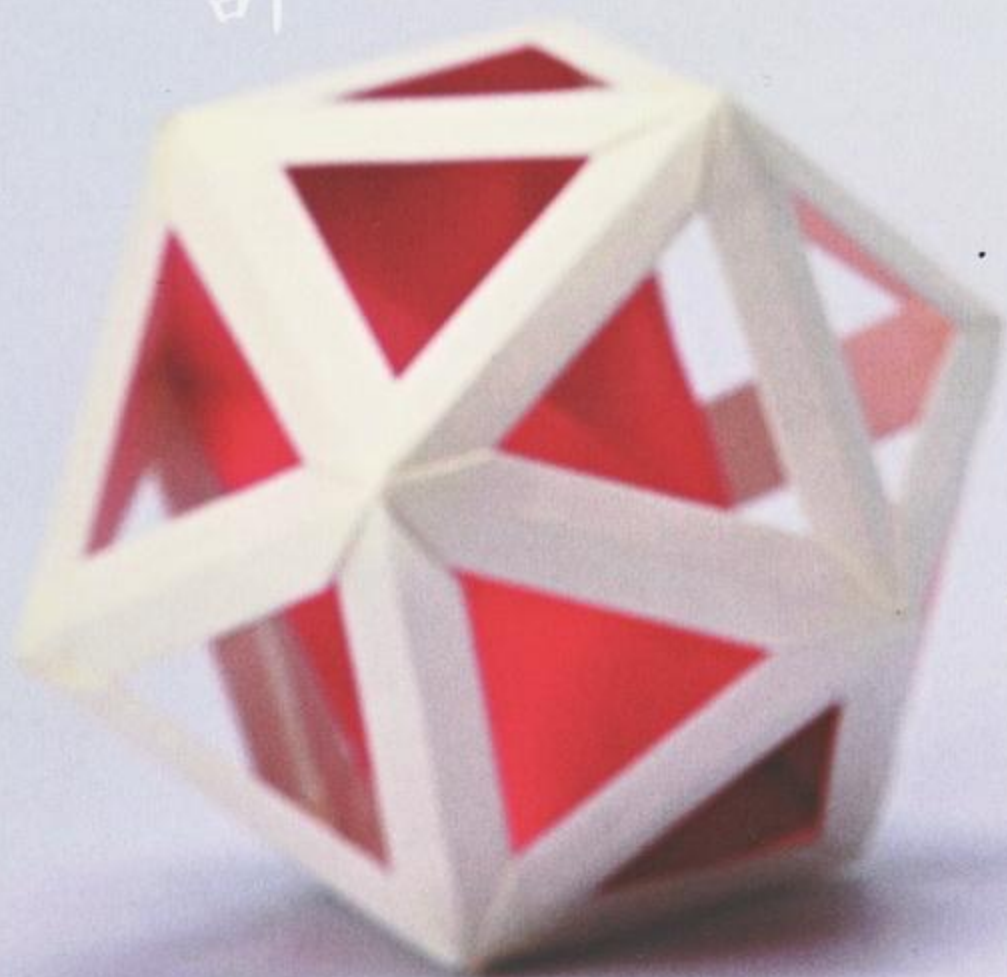
The paper format for the hourglass is 3×1 .
Length of octahedron edges = 1.







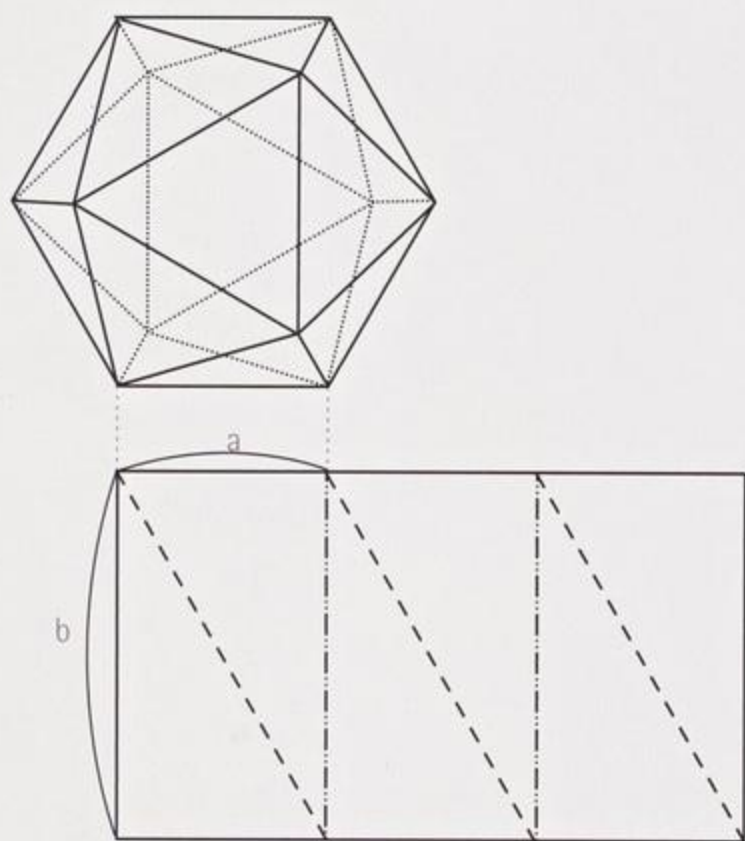
正二十面体+砂時計



ICOSAIEDRA ENCLOSING HOURGLASSES

Use the same frame units as for tetrahedra and octahedra.

Put an icosahedron on the table with a triangular face touching the table. The next icosahedron is put on top of the previous on a triangle rotated about 60°. Place the hourglasses inside the pile of icosahedra as shown in the photo. Take care of the orientation of the hourglasses in order to have a proper helix.



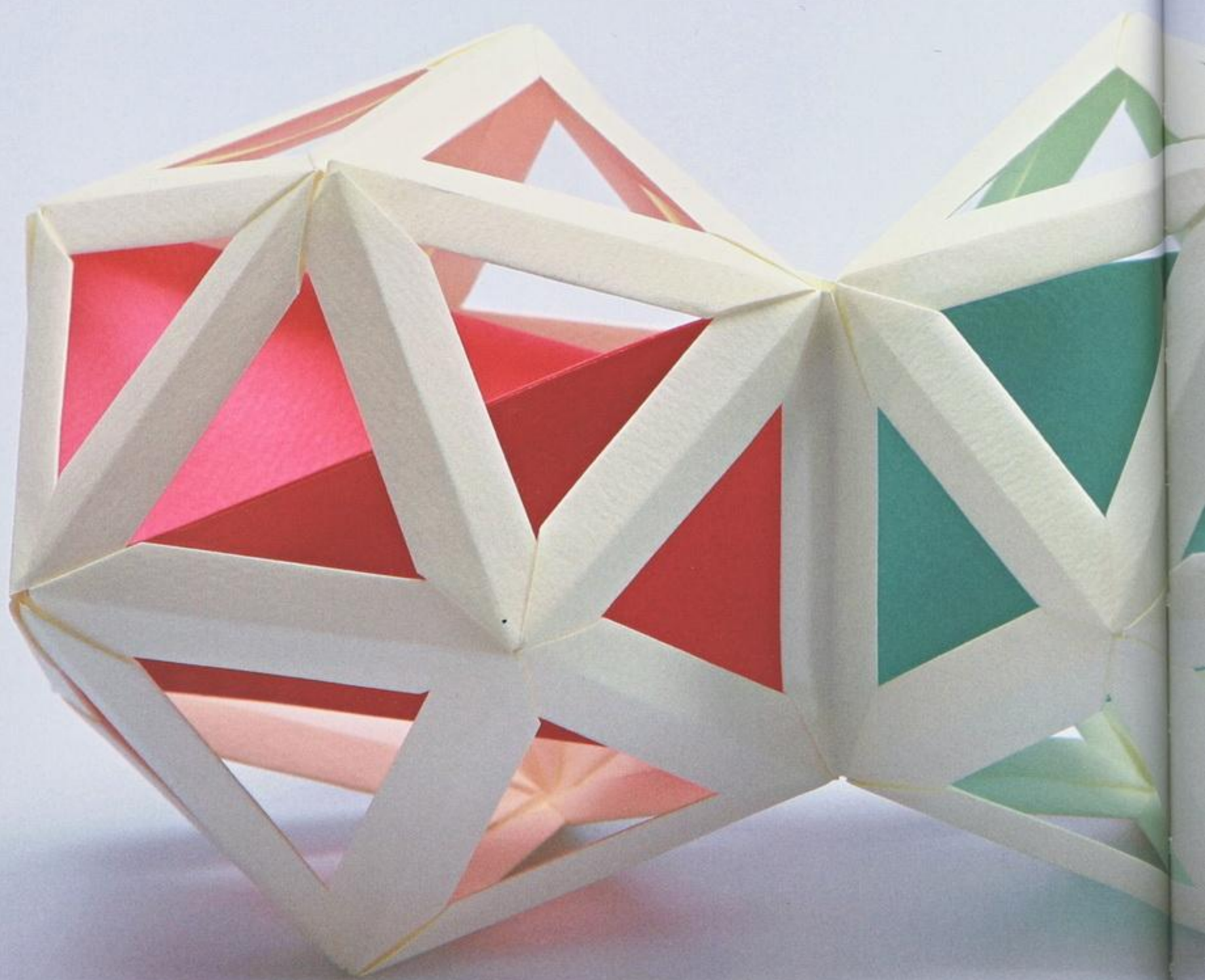
Crease pattern for the icosahedron hourglass.

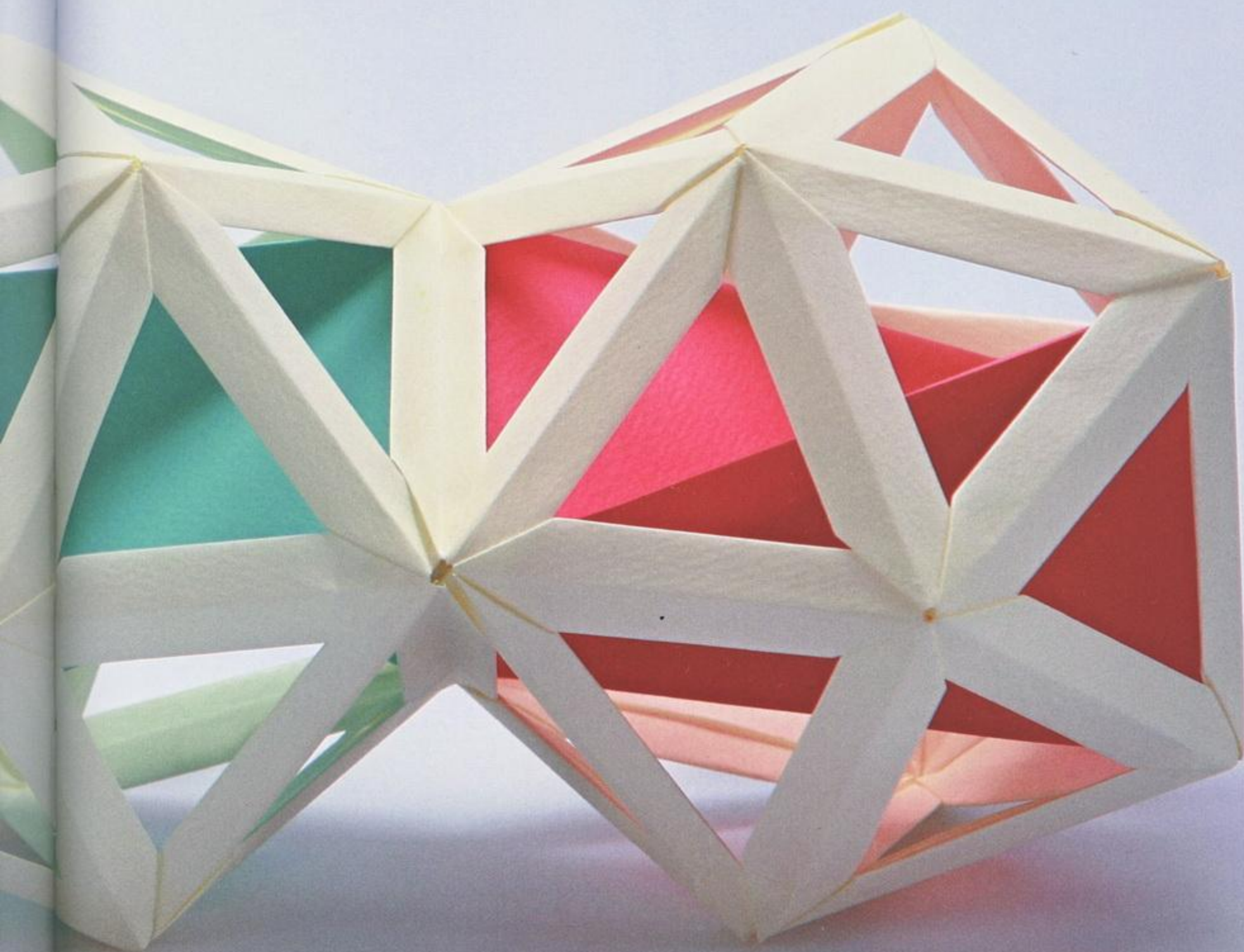
The paper format for the hourglass is 3 Golden Rectangles

$a:b = 1:(\sqrt{5}+1)/2 \approx 1:1.618$.

Length of icosahedron edges = 1.







ABOUT TOMOKO FUSE

Origami is an art with a personality, involving the hands and the head of the folder. This chapter is about the personality of Tomoko Fuse.

Every origami piece is designed, created, folded, constructed by an individual. Origami is not only a tradition, but a living culture: the fruits of human creativity.

Here we visit Tomoko Fuse at her home in the mountains to reveal this moment, and taste these fruits with the help of words and pictures.

The main text is the result of a conversation and interview, conducted by Florian Aicher in 2010 after the opening of the exhibition YOROKOBI, which took place at Holzwerkstatt Markus Faißt, Hittisau, Austria. In addition to the text of Florian Aicher, you will find Tomoko's own statements, made during a video for Kinokuniya, Tokyo.

Herbert Bungartz, the photographer for the whole book, travelled with us to Japan, to record this encounter with Tomoko Fuse.

Paulo Mulatinho



TOMOKO FUSE

布施知子

BY FLORIAN AICHER

UNFOLDING THE WORLD

It is the morning after a spectacular opening night: I'm sorting through yesterday's impressions, I run into a few other participants and, as I walk into the exhibition space - there she is, folding yet again.

Tomoko Fuse, distinguished, world-class master in the art of origami. The artist, a delicate woman, her hair still dark, alert eyes, always a whimsical smile on her lips, wearing carefully selected yet simple clothes.



Excerpt from

The Cosmos of Origami: The Great Artists in the Paper Folding Culture

Tomoko Fuse: From the Hands Releasing, Dreams

by Kinokuniya - TOKYO (Documentary 1997)

Translated from Japanese by Nobuyuki Honna and Hiroko Tina Tajima



I begin, first, by deciding on a shape to create. If it's a cubic shape, like a die, I'll think about how to assemble it. Since the units are normally made from several sheets of paper, I start by thinking about how many sheets would be appropriate to the piece I'm trying to create. If I'm working on a cube, I'll pay close attention to the corners, thinking about how they can be built up. For me, the creative process begins with operational planning, and continues with trial-and-error folding. When you look at nature's creations, the hidden structure of geometric shapes becomes immediately apparent, naked and exposed for the observing eye. The joys of discovery are infinite.



As I'm folding, I become intimate with the three-dimensional shape. I gradually build and enlarge the cube, and slowly get an image of its underlying shape. When you come into frequent contact with something, you gradually come to an understanding of what it is.

This holds true for both people and animals. When I'm building an origami construction, I experiment with folding it from the outside, or examining it from within, to get an idea of what will work and what won't. Eventually, the shape that I'm pursuing will emerge into clarity. Often I'm surprised by the interesting new shapes that reveal themselves as possibilities.

MY FIRST ATTEMPTS

A friendly remark about last night, then immediately I'm invited to join the folding. There's a vast selection of paper, single-coloured and patterned, all in the same 15 x 15 cm format. Corner to corner, crease. Edge to edge, crease. Repeat. Turn over the folds, halve the area, make a double-fold, slide the flaps into one another...

I am concentrating, forcing myself to be accurate and follow every movement, every grasp, step by step. The object begins to take shape, but still looks stiff and somewhat crumpled. My own first attempts reveal how effortlessly Tomoko handles the paper. Her hand - the fingers always in motion - is directing, covering, folding, twisting, and turning. It all seems to happen in a single movement. Gentle, yet firm.

Swift, yet never rushed. Always intentional, yet seemingly lost in thought. Just like a guitarist's hand flies over the strings, plucks, dampens, toys with them. There is no constraint, but there is a sense of gravity, a playful seriousness to her work.

She utters a few words here and there, watches our progress, but always fully concentrated. Fast as the wind, a crane, a box, and a flower emerge from her small hands. Flat paper becomes three-dimensional. »The shape is the most important part,« she says, »not how you fold it. At the end, judge the figure, only what it is. Don't judge how it was made.«

Now she begins to talk about how, in Japan, origami is a popular art, part of popular culture, much like sports, children's games or decorative handicraft. »Origami has so many faces, for children, for science, for craftsmanship, for packaging - it is a boundless force. No one can tell how old it really is, maybe as old as paper itself?

»All I know is that my grandparents knew it, my parents and my generation. All the children of Japan know it. It is a tradition, cherished and practised by everyone. An illness prevented me from learning origami in the kindergarten. One day, in hospital, a man folded a lily right in front of my eyes and gave it to me. I was amazed that a piece of paper could take on such an unexpected form. The beauty of the shape, the creases in the paper, they moved me profoundly. My father went to get me a book on origami and then I learnt it by myself.«

RULES AND BREACHES

»There are rules in origami. First and foremost: the square piece of paper may never be cut, glued or written on. No tools - only hands may be used to fold the paper. Origami also has a lot to do with geometry. It seems that this has culminated in computer programs like 'Treemaker'.

»But the basis of origami is still the process of folding. (Some think it is the square, but that isn't necessarily so.) Make a crease! Take the simple windmill model, for example: Paper, square, opposite sides to one another, geometry of parallels, diagonals, centre points, step by step, forwards, backwards and forwards again... That is how it starts.

»These are the basic operations. I went a step further. I placed the structural centre away from the centre of the paper. I used increasing and decreasing proportions and developed a dynamic form of geometry, which led me to the spirals. I am searching for shapes formed by crossing or touching lines, but which somehow result in clear and independent order. These are the things that dominate my mind while I am folding.

»I am not a mathematician and found these steps in the process of folding and observing my work - through creating. It is geometry that goes along with the folding. Some artists take a different approach: geometry and calculation as a first step. I, in contrast, start with an image in my head and start folding. I have been doing origami for so long, it seems to be in me, in my fingers. I think origami.

»The magic of origami lies in its possibilities, the discoveries and surprises. It feels as if you were painting an image in your head and then you're guided there, rather than inventing something yourself. Not only the inventor of a shape can go through this experience, but also everyone who folds it.«



Although this is self-evident, it's something I was unaware of until recently. Not explained in books on mathematics, geometry, or designing, many of the things I've discovered have come to me while I've been folding. And that's what makes it so exciting. I'm sure that anybody involved in making unit origami has discovered this kind of excitement and enjoyment.



Certain genres in origami emphasise layering, a process in which shapes gradually evolve as the paper is built up in sheets. I'm trying to construct a lampshade out of a maximum of three pieces of paper, although a single sheet would be ideal.

In any event, I'm using folds in the paper in a way that breaks with tradition so that I can design a lampshade that is both attractive and interesting. I'm not limiting myself to square sheets of paper, so I'm cutting a variety of shapes and pasting them together.





I try to avoid the constraints of timeworn methods and forms, folding with the freedom that comes with letting the environment take control of my creativity. The ideas which I hold firmly are in constant flux.

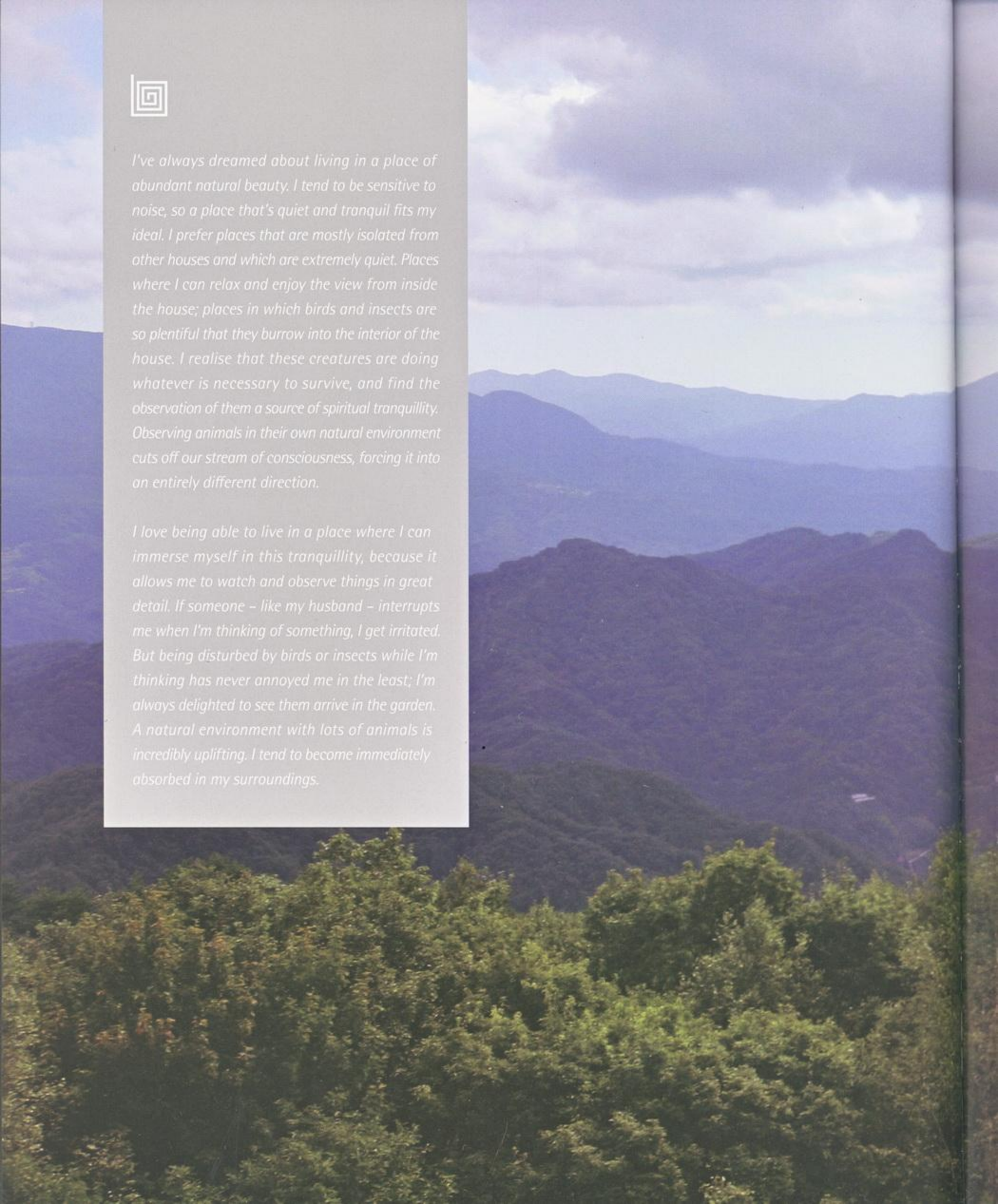
Lately I've been working on a lampshade, just the type of project that I find intellectually challenging. I've been finding that using too many layers of paper causes the strength of the light to diminish.





I've always dreamed about living in a place of abundant natural beauty. I tend to be sensitive to noise, so a place that's quiet and tranquil fits my ideal. I prefer places that are mostly isolated from other houses and which are extremely quiet. Places where I can relax and enjoy the view from inside the house; places in which birds and insects are so plentiful that they burrow into the interior of the house. I realise that these creatures are doing whatever is necessary to survive, and find the observation of them a source of spiritual tranquillity. Observing animals in their own natural environment cuts off our stream of consciousness, forcing it into an entirely different direction.

I love being able to live in a place where I can immerse myself in this tranquillity, because it allows me to watch and observe things in great detail. If someone – like my husband – interrupts me when I'm thinking of something, I get irritated. But being disturbed by birds or insects while I'm thinking has never annoyed me in the least; I'm always delighted to see them arrive in the garden. A natural environment with lots of animals is incredibly uplifting. I tend to become immediately absorbed in my surroundings.











THE VALUE OF NATURE

The Japanese culture is distinct in being open to the combination of exact observation, contemplation and personal sentiments. As a result, it has spawned depictions of nature long before the European culture could. I am reminded of this as the artist explains:

»Everything can be inspiring, most of all nature. But origami is not a depiction of nature. Origami is origami - nothing else. An origami spiral is origami, not a copy of nature. Some people are very skilled and have computer software to bring forth figures that look like sea shells. That is not my approach. Nature provides me with ideas, which inspire a figure in my head, then I fold, and the object grows step by step. The ultimate shape has sprung from the imagination and the process of folding.«

Until the early 1980's, Tomoko Fuse lived in Tokyo, where she studied Horticulture at the University of Chiba. After completing her studies, she became a supplementary school teacher. She then moved to the countryside, to the mountains of Nagano, where she lives

to this day in a small house with her husband Taro Toriumi. It is a traditional Japanese house, with sliding doors, tatami mats, thin walls, an oven, and snow crystals on the wintery windows. There is a small garden, where vegetables of the season are grown. The house lies secluded, some kilometres from the nearest village, in thick woods. The daily walk is an integral part of the day; there is a perpetual contact with nature, which includes wild animals at times.

»Before I moved to the mountains, I worked on masks, boxes, tetrahedrons, the 'normal kind' of origami. It was there that I started working on spirals. I freed myself from pre-cut paper and thus changed the accepted starting point: the square. I used new proportions, oblongs, triangles... and started folding again. A new form emerged: the spiral. The creative process is a back-and-forth of ideas, folding, examining, correcting, starting again - creation, research and analysis. I find out one thing, then suddenly see another. A new handle opens abruptly a new door. The open doorway leads on to great surprises, a new system, great diversity, many patterns - one door opens many doors. It is not always a gentle process. Sometimes I have to throw myself against a door with all my weight... boom!

»For me, every day away from my home in the woods is a loss. I miss my encounters with hornets, snakes and bears. Every day is unique. I love the day-to-day changes in nature. I constantly encounter new colours and shapes in insects, flowers, leaves: it is unbelievable! That is what I need for my work. I get many hints from plants and animals. My life within nature makes my work strong. However, if I ask myself whether something makes sense, I lose my energy.«



The moment I discover a new path or direction in a place like this, I quickly shift gears and begin experimenting, even if it leads me nowhere.

I immediately want to give concrete form to ideas that occurred to me in a sudden flash of inspiration. Being able to manage changes of tempo deftly is one of the advantages of living in beautiful natural surroundings. Here, unexpected gifts are waiting to be found, almost as if I've been kidnapped by spirits who've seduced me into their lair with a trail of delicious sweets. Picking up those sweets is a delight. Entrusting oneself to the natural continuum is like finding countless varieties of flowers on a journey, and, in the midst of picking them, discovering oneself in a magnificent flower garden.











INTELLECT AND ACTION

The modern European is easily perplexed when faced with Japanese arts – especially by the production. The word meditation often springs to mind. »Doing origami – patient contemplation, I admit, but meditation? Rather not. Origami is a free world, like a tidal wave that overcomes me, takes me by surprise.

»When I finish a piece, I experience a moment of: 'Wow, I did this!' – it is not silent, not planned. I am always astonished when I work with elderly people. I watch them, how they hardly talk, how they get all excited and have fun. To fold something, to create something precious, it is thrilling, invigorating, never calm. It is exhausting. And every day I wish for my tiny little helpers to see me through this fight.

»A big part of the excitement also lies in the material. The paper is important. Fine paper, like a good washi paper, improves the process. The touch is important. Every paper feels different – one is good for boxes, one for strong, spatial creations, an entirely different one will be good for tessellations. Tessellation is a special field in origami. Tessellation works using only mountain and valley folds. The flat folds repeat patterns,

sometimes mixes several of them. Sometimes they look like they are woven, but often these structures are made of only one piece of paper. Folding teaches us: every paper is different, every new paper is cause for pleasure and stimulation. Pressure, be it slight or hard – all manners of touch occur, and have an influence: they are all intrinsic parts of origami. Maybe the key to the future of origami lies within this tactile sensation, which makes your heart pound with delight.

»For many areas of origami, you need more planning though. Tessellations, for instance, need accurate diagrams. You need the specific idea first, then you need to draw the crease pattern. That is the difference between tessellations and classic origami. I need drawings too for my large spirals, not for the smaller ones. There, I know every step by heart.«

BOOK AND MEMORY

A Japanese haiku refers to a mill wheel: »The water can turn to ice only when you rest.« Driving and driven forces interlock, the river turns the wheel, but when the wheel stops turning, the river will cease to flow, as well. Tomoko elaborates on her understanding of the vibrancy of the moment opposed to continuance:

»Books on origami are part of my work. The publisher tells me: The next one, please! And then one book leads to another, every one of them with new models, new variations. There have been so many in the past thirty years, I don't recall the exact number. It may well be close to a hundred. I don't really enjoy making books, but it is worth it! Origami is infinite and I forget a lot. Books are my means to preserve everything, to remember, to share.«

These books and publications are in fact only instruction manuals, process guidelines, which open the cosmos of origami. You have to pick up a

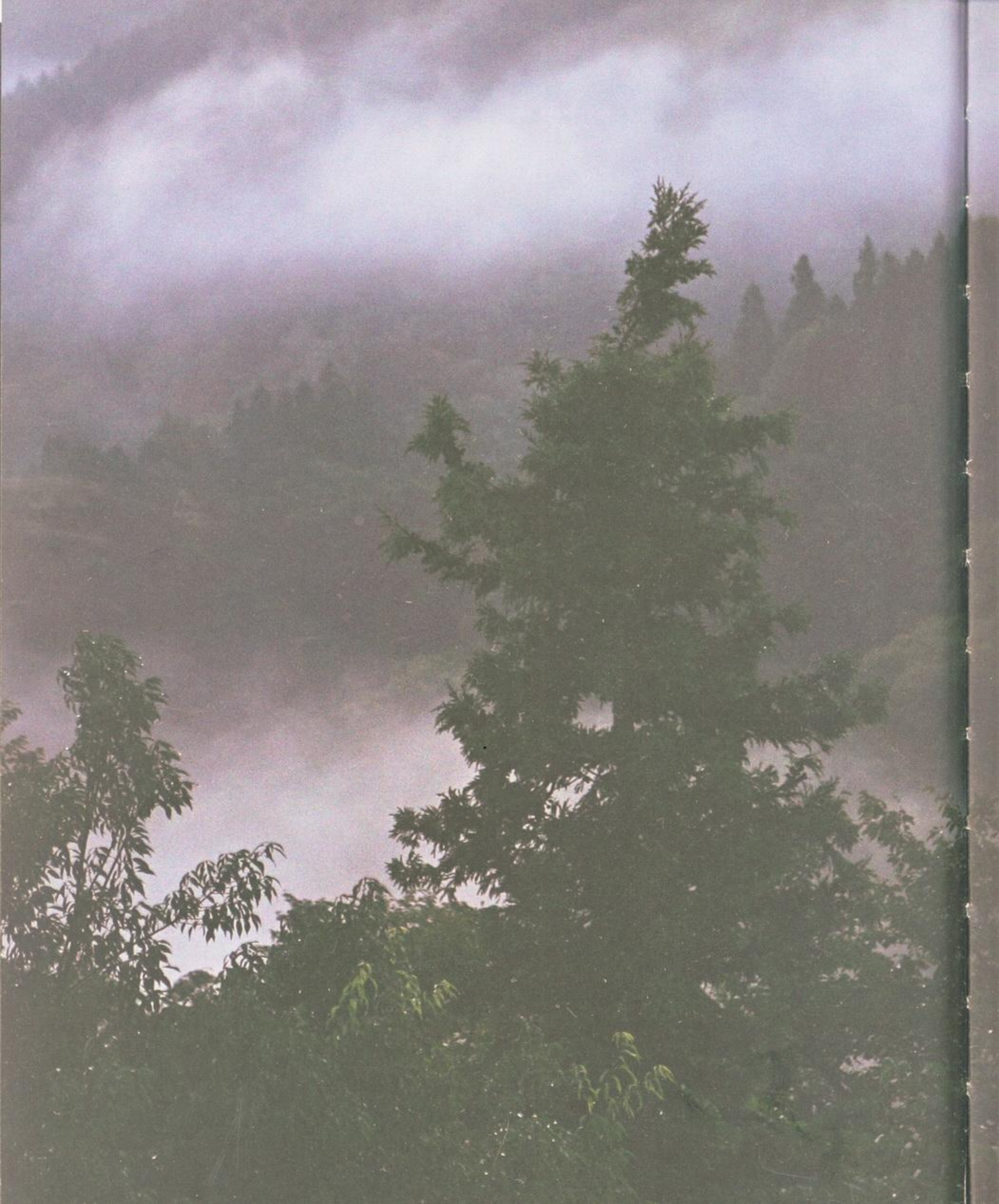
piece of paper, at least, to really understand them. These books stand well besides works which study the philosophical aspects of the fold, and the process of folding, like Gilles Deleuze's exploration into Leibnitz, the Baroque and the fold. He views the fold as a principle, which parts and connects, which relates through separation, which generates various qualities, which confines, abolishes constraints, moves - and thus becomes a principle of life.

»I don't need to remind you that water and its rivers, the air and its clouds, the earth and its caves, light and its fire, they are all unlimited folds in themselves.« Everything is a fold! No need to allude to the fact that the Baroque, with its bulging figures, found itself in the fold. Is origami, then, the far-eastern Baroque of the straight line?



While I think, I often develop astonishing ideas. For example, I decide to use a surprisingly large pattern for an object that I'm about to fold.

For me, the surprise is part of the fun. In the end, when I've finished the major structure of the objects that I had originally planned and have leftover paper on my hands, I fold other objects, like flower petals. Folding boxes and three-dimensional shapes is especially useful in inspiring me to create things with unexpected patterns. The results often catch me off-guard. I sort of find myself looking into a kaleidoscope.





Observing the change of seasons from my house, I get the feeling that you, me, and the rest of humanity are random elements in the midst of a limitless flow or flux. That puts our activities as origami artists in a new perspective.

Instead of constantly immersing ourselves in our craft, we should step back, from time to time, and examine its place in the larger scheme of things. Although not in a way that would ruin the fun. Out of sheer coincidence, I encountered origami during my life span on the planet. And I found that it was fun and enjoyable.

I happened to be at a certain place in the flux, and I happen to be going in a certain direction. Where that direction lies is unclear, but I'm willing to allow nature to run its course. I'm not one to bend things to my will, to force things in my direction, to attempt to conquer goals that I've chosen in advance.

I prefer to sit back and watch, naturally and patiently, the developments that take place.



BEYOND TIME AND PERSON

»Origami is an art that vanishes as it is made – it remains and passes. The object is fragile, doesn't endure long – similar to Ikebana – but the idea remains. I often rather remember the object than the way it is made. That is why the books are part of my work. Doing origami is what keeps it alive. It lives on through the work of others and hence is a long-lasting art. The book helps me – and others – to keep the origami spring flowing. My work lives through the labour of others, it becomes timeless, and survives me.

»The relationship between the creator and the created is similar. Every piece is personal and unique. At the same time, it can be almost the same as someone else's. Or it can become a part of someone else's work. Also, my work is never the result of solely my own ideas. It hence makes every work individual, but simultaneously part of a community. That is how I become part of a community. In some way it is like singing. It is me, it is music – I love music – and it is community. A collective action, like singing music – music of the people, music of the birds. And so, origami exists amidst nature, time and human community.«

So concludes Tomoko, and she returns to her folds.

Florian Aicher



WOODCUT Taro Toriumi

BIOGRAPHY

Tomoko Fuse began folding at the age of seven, during a stay in hospital. Since 1980 she has dedicated herself to unit origami, where multiple identically folded units are used to build geometric figures, boxes or kusudamas. As a pioneer in this field, Tomoko has published many books, starting with *The Joy of Origami* in 1981. She is engaged in the industrial production of objects such as origami lampshades or origami pots (for which she holds a patent). Spirals are only one part of her many origami creations.

1951 Born in Niigata.

1973 Graduated for Agricultural Chemistry and Horticulture at Chiba University.

1986 Moved with Taro Toriumi to the mountain village of Yasakamura (part of the City of Omachi) in the Prefecture of Nagano and dedicated herself to the creative work.

1987 (to date) numerous journeys abroad for the exchange of origami experiences.

1994 Organised the *Second International Conference for Origami Science* in Otsu, contributing significantly to the success of the conference.

1998 Exhibition *Paris Origami*
in the Carrousel de Louvre
Paris | France

July 1999 *Solo exhibition*
in the Ueda Sozokan
Nagano prefecture | Japan

2002 Exhibition *On Paper*
in the British Crafts Council
London | England

2003 Exhibition *Origami*
in the Mingei International Museum
San Diego | USA

April 2004 *Solo exhibition*
in the Hankin Gallery
Holon | Israel

September 2004 *Unit+Spiral*
in Meisterhaus Muche
In collaboration with the Foundation
Bauhaus Dessau and the city of Dessau.
Dessau | Germany

July 2005 Exhibition *Masters of Origami*
in Hangar-7
Salzburg | Austria

June 2009 *Yorokobi* with Taro Toriumi
in the Origami Galerie
Freising | Germany

May 2010 *Yorokobi* with Taro Toriumi
in the Friedrich-Fröbel-Museum
Bad Blankenburg | Germany

October 2010 *Selected work for exhibition*
in Forum Art Shop
Tokyo | Japan

January 2011 *Yorokobi* with Taro Toriumi
in Holzwerkstatt Markus Faißt
Hittisau | Austria

June 2011 Exhibition *Träume aus Händen*
in the Galerie 13
Freising | Germany

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Tomoko Fuse

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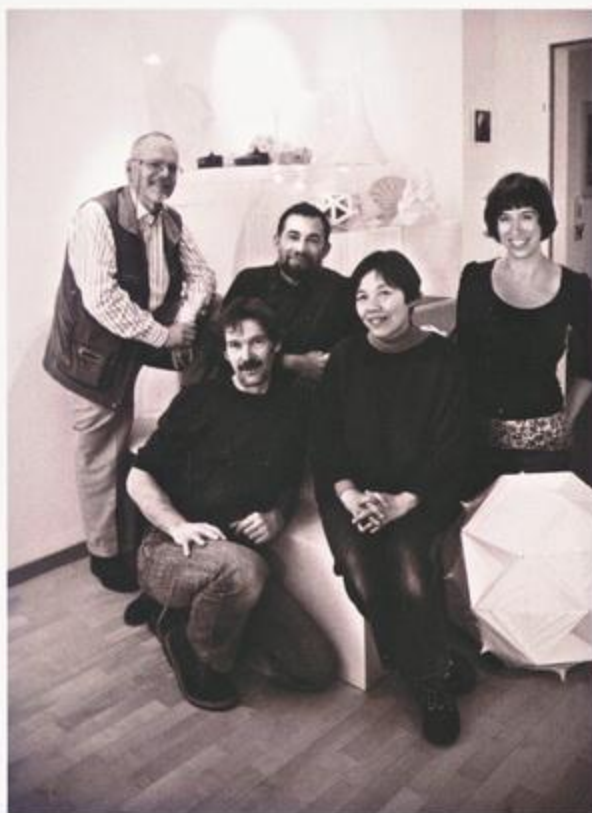


PHOTO Silke Schröder

From left to right

Heinz Strobl, Herbert Bungartz, Paulo Mulatinho, Tomoko Fuse, Nadja Weber

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Silke Schröder und Paulo Mulatinho
Publishers

ABOUT VIERECK VERLAG

Since 1992 VIERECK VERLAG has operated as a mail order company for international origami books and origami paper. Our range includes over 100 different titles, including all available Japanese origami books by Tomoko Fuse.

Our wide selection of origami paper also contains varieties that are especially suitable for folding the spiral models in this book.

VIERECK VERLAG established Origami Gallery in Freising in 2008, and has since organized various exhibitions. On the occasion of the exhibition Yorokobi with Tomoko Fuse and Taro Toriumi in 2009, VIERECK VERLAG published a catalog with the same title (ISBN 978-3-941327-30-0).

The publishing of origami books supplements the activities of VIERECK VERLAG. This book SPIRAL is the first of our own publications, with more projects to follow soon.



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SPIRAL BOX | Tomoko Fuse

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らせん

Tomoko Fuse is one of the world's leading origami artists. She has widely popularised the style of unit origami, where identically folded units are connected, by folding alone, to build geometric forms, boxes, or flower balls. The author of many books describing her origami work, Tomoko Fuse is now the subject of this book by VIERECK VERLAG.

This book describes another of Tomoko's preoccupations: the Spiral. It is a lavish banquet: a feast for our eyes, our senses and our intellect. Our appetites will be whetted by the delicious sights inside: shell forms, helices, whirlpool spirals, even playful toys such as the "Pako-pako".

Tomoko Fuse's experimentation with folded paper spirals is prolific and inexhaustable. We can explore many of these experiments ourselves, thanks to her detailed diagrams and instructions in these pages. They will help us to recreate myriads of beautiful and unexpected spiral forms.

In the final pages of the book, we see Tomoko at home in the mountains of Nagano, Japan. Thus, we are allowed a glimpse into her private world, and understand some of the sources of inspiration.

Open the book: now you can savour Tomoko's spirals, as well dining on Herbert Bungartz' breathtaking images of her unique artistry. Bon appetit... and happy folding!

David Brill



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