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'Pattern':

12. REFERENCES ………………………….

AUTHOR

What brings a person into the world of art? I think everyone on this account has its exceptional reason. Perhaps it is the desire to express themselves, discover a uncharted worlds and live in them countless illusory "life," or the desire to make the world a little better and give mankind another "2nd concert" Rachmaninoff or "Sistine Madonna" by Raphael. Origami this is no exception - as any kind of high art, it is also infinitely for the study, as infinitely everything it touches the human soul.

As soon as new to origami begins development of the first models, it immediately begins to ask yourself: "What am I going to put in the next time?" Or "What will be my next step in the study of origami?" Because the person is able to devote a rare study of a model all his life. Typically, these issues do not cause difficulties in his early years - enough to buy a new book or magazine with origami diagrams (however, recently published a chart freely on the Internet.) But at some stage experience, the question of choice is extremely complex and ambiguous. Are more and more similar to each other and the model that recently was considered a masterpiece, no longer seems so attractive and interesting. More rigorous assessment of appearance becomes the finished result and less often have a desire to put exactly the model that is in the public domain. Creative pursuits, a desire to improve so many leads into the wonderful world of "patterns" and, of course, the author's design.

Unfortunately, in the national origami literature on the subject of information you can find very little. Which is why most origamistov virtually no chance to learn the author's own design, of course, if they have acquired special themed foreign editions Japanese or American masters, or if someone does not teach. That's what I try to do with the book, describing the basic structure of origami models.

This book will be conditionally divided into two parts. First half - theoretical, consisting of six chapters, which detail the basis of the linear methods, such as: «Box Pleating», «Hex Pleating», «Mix Pleating». Many of the theoretical aspects of design, as well as some algorithms to simplify and structure transformation patterns, will be published for the first time. Examples of specific models will be described in a continuous process of creating models in different methods from the the beginning to the end. The second half of the book - the practical part, which presents a chart of the models created in the period 2009-2011, with a total build time of about 90 hours.

Perhaps not all will turn out at you at once, not all methods will seem easy to understand, and not all models will emerge from the first. No problem, I'm sure - it can! Road by walking, as the Chinese say, and every journey begins with a small step. His step you have already done so, there was the first crane. I hope that the book is to help you move forward in the development of the laws of origami and give the opportunity to put even the most daring artistic imagination.

For questions or suggestions please contact us at: anermak@mail.ru

LEGEND

Before proceeding to describe the material in the book, you should learn the basic symbols, which are commonly used to describe the process of origami assembly.

INTRODUCTION

As a child, almost all made of paper airplanes and ships, knowing the sequence in which the need to fold paper. This sequence of actions can be represented in many ways. The most convenient form of this sequence for the novice origamista - diagram. The diagram is drawn step by step all the way to build the very beginning - a clean sheet with no lines or creases, to the end - the image of the finished result. Of course, this way of writing displays all the details of the build process models, however, by adding the chart, it is difficult to imagine the structure of the model. In this regard, it has recently become popular to portray it as a pattern * .1

"Patterns" are the result of natural evolution and origami, as an object of research, there were some 15 years ago. Not all authors origami was time to create a chart of models, because to create a chart, you can either draw well, or possess special skills in computer graphics editors. Origami found alternative recording process of the constitution of the model. They found that it is much easier and faster to depict the structure of the model by drawing lines that form the model itself than sequentially describe each step of the assembly. The press began to appear first CP, as the master and the first who began to explore their structure. From this point on in the world of origami, a new era! It took only a few years of hard work origamistov around the world, and at trade shows began to appear paper animals, insects, human figures, which looks no different from the living! Masters started creating models whose image was originally planned, thinking even the smallest details. Thus, origami has reached a brand new, until then unimaginable level - especially since the author's design models could only result of a long investigation known basic forms. The process itself was wearing a more random, since the image of the finished result, as a rule, is determined only at the final stage of folding.

In Russia, the promotion of patterns started about 5 years ago, and before that the information on them was of very superficial and, of course, of any study could not be considered. Those who began to study CP and

1 * Pattern, CP or «Crease pattern» - a method of recording the structure of the model, in which the basis is not a sequence of actions that form the fold, and the lines themselves, which is based on the base model.

legal structure of origami, had to be translated from foreign languages and literally bit by bit to gather information from different sources. Over time, people began to share their acquired knowledge in the origami club, or on the Internet at specialized origami forums. Little by little, "Every little helps" information blockade was broken, and the domestic origami went global.

'Pattern' model origami

Let's take the example of the classical paper cranes, which many familiar from childhood, and consider its composition in terms of the block diagram model.

Diagram of the classic Japanese crane

If the folding deploy ready-made model and eliminate lines that do not form part of the final result, then we kind of picture will appear, * composed of many folds, differently oriented himself to the plane sheet and overlapping soboy.2

2 * The dark circle in the left figure indicate the sections of which will later be folded core of the model: two wings, head, tail and back.

Pattern of the classic Japanese crane (left - a clear, right - implicit)

This scan is called a pattern. Many world-famous masters of origami been investigating this base. Based on it, created a large number of cranes wings or heads, with the legs, horns, change the proportions of the body and much more. And all this was done not only as a result of improvisation, but also thanks to the discovery of various methods of design, such as «Box Pleating», «Hex Pleating», «Mix Pleating», «Circle Packing» etc.

All known methods of creating models differ from each other and, as a rule, each technique has its own unique characteristics and nuances. However, a closer look reveals a number of general principles that make it possible to present the design process as a holistic world inside which has its own rules and laws. They, of course, you can ignore or do not know about them, but they still have an understanding, of course, will help answer the questions: "How can the author could create a masterpiece! 'Or' How is it possible to make a single sheet! ? '. But such questions asks himself each, at least to a certain level of their professional maturity. So, the theory presented in this book, in part, may help to answer these questions and provide a good starting point for designing their own models.

WHAT IS COPYRIGHT Origami?

I think that not every author can specify exactly all the details of this issue, because there are a lot of overlaps independent factors. As no two people are alike, every expert have their

unique handwriting. Individual approach to every work sometimes forces to make unusual, unexpected solutions. So is the opening of the new elements and techniques of folding. Personally for me the essence of copyright origami comes to the ability to properly break down list for the area, which will be created out of parts of the model and the ability to connect "clean" these parts together, and then add the colorful image of the valves in accordance with the creative idea. It is believed that the model can be done on a whim, but purely to connect sites do not necessarily. Well, why not? In this book, I will describe only what is put into practice myself, and this is just my personal view of author origami.

In order to better visualize how to use the techniques are models, consider a simple example - the figure of a man.

The main parameters of the model we choose: two arms, two legs, torso and head. Obviously, for the folding of each of them will need a domain on a sheet of paper material. Using different techniques, you can select these areas and to distribute them in a way that all the elements were formed purely by adjusting it to a flat view. Original worksheet - a square (although the special role it does not play, because divided into such areas can list any form).

Block diagram of human figures

As you've probably realized from the figure, the area of "1" and "3", we chose to fold hands, "5" and "6" - for the feet, the area "4" - designed for the body, and "2" - for head. Composition in a model, schematically represented by a system of segments (Fig. right), with the top of the exit point of the three segments, from the bottom - two. If the specified field to crush so that the selected areas form a mobile elements, we get a set of branches, figuratively resembling human figure. * 3Skladyvat individual processes can be arbitrarily and in any sequence, the main criterion is to obtain the desired composition of the valves. In our case, for the formation of the body, we will wrinkle the middle part of the original sheet, hand and foot - corner to the head - the upper center.

Obtaining human figures

The result, of course, will look a little "crazy", and about any flat shape out of the question unless the smooth branches of the iron. But this simple example shows that the places on the sheet for the specific details of the future model, you can add anything to the increasing size of the sheet of sufficient magnitude. Now we give some examples of patterns, which in their structure will meet the same figure of a man, but in different methods of design. * By the way, among the modern masters origamistov is using this type of bearing parts models for certain types of paper. And, despite not quite standard approach itself is quite effective technique to give the finished result more realistic texture and shape. Particularly interesting results are obtained when the final model processing wet, when the material is softened. Despite the fact that in such cases, the process is more like sculpting than folding, do not forget about these techniques to extend the range of means of artistic processing of the final model.

Patterns of human figures in a variety of techniques

At first glance, these patterns may seem quite different, differing greatly from each other, both in structure and form of the final result. But do not jump to conclusions - all of these patterns as a result of folding forms flat shapes with the same proportions and what is more, every Wed can get one from another by means of some simple manipulations. "How?" - You ask. Now it does not matter, but by the time you finish reading the book, it is likely that the issue will disappear by itself. Will be discussed later and more complex configurations.

BASIC CONCEPTS AND DEFINITIONS

Before proceeding to describe the techniques themselves, let's go with the basic concepts that will be used in the theoretical part of the book.

1) The Mountain and the Valley. As there are two types of origami folds: convex and concave with respect to the plane of folding. They are called "mountains" and "valleys", respectively. These names are used in specific circumstances. Thus, the mountain is the valley, if look at it from the reverse side of the sheet, and vice versa. Most often, the more important lines of orientation relative to each other - it is necessary to model the folding pattern.

Orientation of the folds on the left - "mountain" on the right - "valley"

2) The explicit and implicit patterns. If the CP shows the relative orientation of the model lines to each other, the different folds represent different types of lines (mountains and valleys may vary in color, shape, lines, etc.) These are called Wed - clear as to seek the mutual orientation of the lines in them required. If the orientation of lines are not shown, and the lines themselves are not different from each other, such patterns are called implicit * .4

3) Node. The point on the pattern, which is crossed by several folds.

4) Basic frma. The result of adding a pattern, all of which are owned by assembling a plane.

5) flap. Movable element base, the build preselected. Flaps are single or compound. A single leaf is composed of 1st moving part, the composite wing consists of several movable appendages or branches.

6) tree leaves. Schematic representation of the structure of the model, which has the same proportions between the doors as the basic shape after folding pattern. It serves as a kind of benchmark, based on which, step by step, the proportions and shape of the model is translated into the language of patterns.

Wood shutters

Examples of "explicit" and "implicit" patterns look at the example of the classic crane Wed.

7) Field. Plot on the pattern formed after folding the flap, having a pre-selected properties. The fields can be simple or complex. Prime field image of the unit leaf without branching structure, a complex field (block) - compound leaf with branching configurations, fan shutters, etc. Different methods for the formation of the valves of the same length, the field can be used in different shapes.

Margins: left - simple, right - the complex

In order to refine used fields, comparing leaf and field often use landmarks that are located in the nodes of the tree leaves. For example, the complex field (box) on the right can be called a "field sash {0; a}», where a brace of the first number - the base valve, the second number - the first node.

8) River. The molecules are made of atoms, so the fields are composed of rivers. Rivers in the fields carry the integrity of the structure and determine its final form. The structure of the fields is an infinite number of rivers that have their own parameters and trajectory. At the final image of the pattern of the river can be closed and open. Closed river merge themselves on her, open - stretching from one end of the sheet to the other.

Rivers in the area of folding

9) The method of design. The way to create a flat model according to some algorithm. Techniques are divided into three main types - linear ("VoxRleating", "NexRleating," etc.), sectoral ("Sircle packing», «22,5deg», etc.) and angle (" 15 deg »,« 22,5 deg », etc.). This book is almost entirely devoted to linear techniques and issues of their features, which will be discussed in further detail. Any technique in origami is needed in order to simplify the design process and to help the author to get a pattern that would meet when putting creative ideas. Of course, both methods describe only a small step in the design and processing of the final model, they are unlikely to help. However, the

very stage - is extremely important and is the foundation for a well-deserved future base and, indeed, the entire model.

In fact, all linear methods are very similar and differ only in small nuances. But, despite this, before moving on to the development of sophisticated techniques, you will become familiar with the most simple of them - «Box Rleating."

Rules Kawasaki

All methods described in this book, operate flat pleats. They are mostly built and withdrawn from the study of a number of conditions, without which the unit and held by him in the line can not be folded flat shape. This so-called "rules of Kawasaki":

- From each node leaves an even number of lines

- The difference between the valleys and mountains on each node in absolute value equal to two

- In each node the sum of angles, standing on even ground is the sum of the angles, not even standing on the ground and up to 180 degrees. Kawasaki rules themselves are actually used mainly for testing the accuracy of docking pattern elements in their design. It happens that after the manipulation of the rivers and fields found that some lines are not as necessary: moving from the fields in the field under the wrong angles, cross each other, etc. Then there is the need to control the right actions in the design of their own works. You can not do without the use of rules Kawasaki, if there are difficulties identifying the orientation of lines on the patterns of foreign models. In such a situation, you should check all of the problematic sites for errors, which may not be noticed by the author in creating the model pattern.

Although, after getting some skills in the folding patterns, most of the models will be determined "by eye", and increasingly will fall like the items you previously added or met them in a certain way. But inevitably come across these models, patterns are formed from the complex elements which are new for you. In these cases, without an analysis of sites still do not get along, and even experienced origamistam sometimes have to spend a lot of time on selecting the right combination of mountains and valleys, leaving the hosts.

Patterns of interest is growing every year, as well as expanding the boundaries of research in their structure. At exhibitions appear supercomplex model published various mathematical algorithms to simplify the design, etc. But I think it would not be all that, if at the time masters of the past did not open design techniques, and I hope that in this book, specifically in its theoretical part, I can "plain language" to describe the basis of some of them .

«BOX PLEATING»

"Vox Pleating» - the first of the linear methods, which will be discussed in this book. In my opinion, it should be with her and to begin development of the author's design origami models. Over the last decade it has gained particular popularity, largely due to its simplicity. With it you can easily develop the skill of separating sheets on areas intended for the model elements. It is essential for further professional development and just need to study more complex techniques such as «Hex Pleating» or «Mix Pleating».

Designing in the «VoxRleating" (BP) is very similar to the game "Tetris," which figured elements, the building blocks are joined at right angles, completely filling the plane with no gaps. This happens because of the small number of limitations that determine the final shape of the fields and by which the assembly of BP-final elements in a flat base is simple and quite an exciting experience. The process of joining fields practically does not require any additional calculations, so the very design of the models generally do not cause any difficulties. This allows you to realize creative imagination origamistam quite far away from mathematics and unwilling to improvise with basic shapes. Gathering on the pattern several BP models, is becoming clear how to add even the most complex of them, as virtually all of BP-elements are made the same way.

Would still like to clean «Box Pleating» is one important drawback - the loss of a substantial part of folding, which accumulates in the wings and greatly increases their thickness. Accordingly, the quality of the result, as in any other method, depending on the quality of the selected material: have to increase the size of the original sheet or purchase superfine paper. Despite this, the minimum time required to make the design BP's favorite technique for new authors, more passionate process of the constitution than the creation of patterns, easy to assemble, which is optimally used work surface sheet. Enjoying some skill and having at hand a regular graph paper and a pencil to create a pattern for future

"BP model" is likely in a few minutes. Although, of course, it all depends on the complexity of the tree leaves. Unlike the "BP", in other methodologies for quality completion sometimes take weeks or even months. Not surprisingly, while BP "bribes" for its versatility, and after the development of many cease to expand the range of techniques that can be borrowed from other techniques, and, unfortunately, stay on the study of the theory of origami. But this is, as they say, "a private matter." Indeed, even among the great masters of our time, there are those who have a basic structure of patterns to choose exactly "VoxRleating" already mastered other techniques to perfection. In any case, knowledge of BP is very useful for anyone who is serious decided to learn the author's design.

1.1 models, designed in «Box Pleating»

Several features, which will be detailed below, BP very well suited for the design of models with a large number of single flaps (Photo 1.1). Lovers of spectacular models (insects, crustaceans, etc.) she will have to "taste." But, no matter how golovokruzhitelen success of your first models, do not stop there, because the method of BP - is only the first step. This is equivalent to playing a musical instrument in the range of one octave or even more so, one note, one sound ... But there is more! In this chapter, we will contact you to learn the basics of designing BP methods for transferring lines, folds to the area of folding and more. But let's start with the study of the elementary constituents, based on the linear methods - "Rivers" and "fields."

RIVERS AND FIELD «BOX PLEATING»

Consider a few paper strips along the length of "jagged" lines folds (Figure 1.2), perpendicular to the boundary * .5

1.2 Set open river of the same width

Master once observed that if the strip, inside which there is a fold line, perpendicular to the sides, fold along them, then a kind of accordion. The length of the bellows will be equal to the width of the original strip, regardless of the trajectory of the "movement" of the channel. The figure shows the trajectory of black dotted line with arrows. The result of folding in the plane is always the same as for the direct channel (ris.1.2.1) and for broken (ris.1.2.2-1.2.3). Moreover, if the bandwidth is constant, then the accordion channel itself is always going along the borders

Such channels are called "rivers" and the lines along which the river's edge are added to the point - "the banks of the river." Opening of the river and marked the beginning of a new "era" of origami - the appearance of the first linear model design techniques. In modern origami "river" - the main component of a pattern in any method. Thanks rivers formed elements involved in

5 * on the pattern in Figure 1.2: dotted line - the valley, the solid - the mountain.

6 ** A border strip, indicated in the figures in gray, as a result of the assembly would meet in one point, respectively, the boundary marked in black - in another. the design process. It serves as a dividing strip between areas that are on opposite sides of its borders. In other words, if we place any items of arbitrary shape on the perimeter of the channel, after the folding of the river still arise in the segment, which will divide the opposite shoulder area, equal to the width of the river.

The obvious question is: "What if we take an arbitrary river and close it for yourself? '. The answer is simple: basically nothing will change, the only difference is that the shoulder is separated from the interior of the exterior. In this case, the river itself and the whole inside area will be the unified field, which forms a flap (Figure 1.3).

1.3 Formation of a flap

Figure 1.3 shows that the black beach, after connecting all points of "0" on the perimeter, forms the base of some leaf. It can be both single and composite, * 7no segment itself "0-1" as a result of the assembly will always shoulder is mounted to the inside of the folded. Similarly we get all kinds of BP fields. Due to the fact that each new river, built on top of the previous one, will increase the flap on the "width" of the reki8 **, it is easy to retrieve the length of leaf. For clarity - imagine an ordinary umbrella. If we increase the radius of its dome, it will increase in length when assembled. If we cut off the edges - on the contrary, decreased. The situation is very similar, with the only difference being that the folding of the river may have a different trajectory. It should be noted that if the river is not closed within other elements, she becomes the prime field - gate length equal to the width of the river (Figure 1.4).

7 * It all depends on the structure of the inner region.

8 ** width of the river - the shortest distance between the opposite shores.

1.4 Closed river forms a simple field

Figure 1.4 presents the fields that make up the same length sash «r», obtained from closed rivers. 1.4.2 In the case of the river closed in by four successive rotations of 90 °, with the entire inner beach - it's just a point, and the outer - convex geometric figure.

In origami, such fields are called "base" and BP is only one - a square. On the other fields, the basic techniques you will learn in the following chapters. We only note that, for ease of assembly, and of the design basis for the formation of single leaf should be just basic fields. * 9

By and large, linear design techniques differ from each other only in the angles at which the river can rotate as they move. In "VoxRleating" this angle is 90 ° for the "one step", which implies that as the fields are used arbitrary figures, all angles are equal to either 90 ° or 270O (Figure 1.5).

1.5 VR-field left - simple, right - the complex

9 * It allows to avoid unnecessary difficulties when putting the final pattern, which arise due to the fact that no "basic" fields significantly increased leaf thickness assembled.

LINE BP-FOLDS

BP-fields are formed from two types of lines, wrinkles. To describe them, let us consider the underlying field - quadrilateral (square), in which all sides and angles are equal (Figure 1.6).

1.6 Orientation and connectors fields

In Figure 1.6.1 marked gray solid lines (in this case, the diagonal, since the inner side of the river is a point), which passes through the inner river carried turn and continue their movement * .10 These are called "Orientation lines," and they describe the shape of the field , directing the further design process.

In Figure 1.6.2 shows another group of lines, which are one of the main features of the linear methods - "connectors." With their help, ensured the compatibility of elements of the model.

Direction of the trunk, and rivers within a field are always perpendicular to each other, but at the same time and they both reflected through Orientation lines. At first not easy to get used to these features, and then in confusion: where the river where the connecting lines, but I'm sure - you can handle, the main thing to get used to.In the process of folding the classical BP neighboring trunks in the fields, as a rule, have different directions relative to the plane of the sheet bend. So, after building BP-element connection

10 * The arrows in Figure 1.6.1 shows the flow of the river. Further, if the leaf after folding pattern directed us to the top, the rotation of the river will be counterclockwise. If the door directed us to the top, the rotation of the river will be clockwise.

lines always form a kind of accordion (ris.1.7.4). Through all parts of the accordion model attached to each other along the border and form a coherent whole.

1.7 VR-square assembly polya11 *

LENGTH BP-VALVES

Because folding is on a particular form of a sheet, not on an infinite domain, the length of the valves can be changed using its boundary.

You probably noticed that almost all models are such valves, which are formed on the border of the sheet. As a rule, they are more subtle, they are easier to stack and handle. In this case, if we consider the field itself may give the impression that its structure is somewhat different than in the central parts, then Orientation lines are directed somehow not familiar, they do not exist. So: in fact, these areas - just a few of the fields that were designed originally. The rest of the mere outside of folding the edges of the sheet was removed all unnecessary. In other words, the whole of the river remained closed Open only river flowing from one border to the other sheet.

Location leaf on leaf margins saves paper material - in BP to 75% (for the base to the center of the field within the box compared to the field, located entirely on the page). In general, the gate length is equal to the maximum width of the part of the rivers of the field, which is within the fold. For example, consider the different locations of the simple rectangular fields with respect to the boundaries of the square (ris.1.8).

11 * In Figure 1.7, "a" - the width of the field, which was mentioned earlier. It is equal to the total width of all its rivers, as well as the length of the wing formed. For the square is half the side.

1.8 VR-location relative to the boundaries of fields sheet

In cases of "1-4", when the centers of the squares are inside the leaf area or are located on the boundary, the length of the flap will be half of the square. This is due to the fact that in each case the part of the river from the center of the field (the "inner coast"), and to the border ("outer coast"), is within the fold.

In the first field, the river is not interrupted at all, and the entire area will be used entirely. By the way, because of the central wing hardest to finishing. Excess material is especially critical for large valves, resulting in the assembly thickness sometimes do not allow accurately process model. Therefore, if it is possible, it is recommended to have a field of the longest leaf border leaf, if it does not interfere with the general structure of the model. The second field material savings was 50%, in the third - 75%, a quarter - 25%, while gate length remained unchanged. Please note that the "5" is positioned so that the center of the square is outside the area of the sheet. In this case the length of the flap is the length of the rectangle at the intersection of the field with the area of folding - is, of course, smaller than the width of the field. Although uses only 25% of the material field, gate length will be the half.

In the case of "6" box is rectangular in shape, partly goes beyond the area of folding. Here, the same rules, and the gate length is equal to the maximum width of the river within the sheet.

Naturally, all this is true for complex fields, where the shape and structure of the valves will determine the river, located in the folding. Note that the location is just on the border of the fields list is not necessarily the main thing that they form part of the required elements of the base.

In general, all types of BP-like wings folded, as in Figure 1.7. First outlines the connecting line, then formed flaps according to their orientation with respect to the plane of the sheet. For example, to build a rectangular field is as follows (ris.1.9).

1.9 Build a rectangular field of VR-

Note that the width of the valves depends on the distance between adjacent connecting lines. Form fields is not important, therefore, defining the distance to the design, you can get the right wing parameters. Of course, the width of the wings is not always as important as the length - it is possible to reduce the width and after folding doors. However, in some cases, one can not do without determining the width of the valves in the project.

Returning to the lines on the pattern zzametim that in most cases there is no need to portray BP pattern explicitly, since the orientation of the adjacent trunk alternate. As for determining the orientation of themselves wings to the plane leaves, you can use one simple rule, effective for the components:

Which side of the plane of the sheet more mountains than valleys, to the side door and directed.

In other words, if you're looking at a node that has more mountains than valleys, sash, which it forms, will be sent to you. If more valleys than mountains - door will be sent to you. Thus, we can take as a reference point any field of implicit patterns and easily restore the orientation of lines and at the same time learn how to aim doors to each other.

When designing your own models, all these issues will be addressed as they come. It is important to remember that if the structure of the model has flaps in different directions from the plane of the folding, the assembly may be significantly more difficult. This is especially critical if the "reverse" wing located in the central part of the leaf. Such situations should be avoided, especially if they are not related to the creative idea.

DOCKING BP-CELL PATTERN

Design models in accordance with the basic rule of docking elements: If doors have a basic form come from a single point, then the corresponding field on the pattern should touch each other or any of the common border. Let us examine how the coupling elements in BP by example. For this, consider the following tree leaf (ris.1.10).

10.1 Wood shutters

In general, the compatibility of elements of the design in two ways: "consistently" and "block". In the first method, the procedureperformed sequentially, from one item to another. Modular docking involves a preliminary partition of the tree into large, main wing, already includes a number of elementary constituents are incorporated into any logical reasons. After drawing their patterns (blocks) these parts are interconnected whole system of fields and rivers.

SERIAL DOCKING BP-ELEMENTS

In serial dock work begins with the selection of the first element, to which the rest of the dock to the tree leaves.

Sequential docking will be quite in detail in the chapter «Mix Pleating», as required by the specific methods described therein. In our example (ris.1.10), the first series connected three fields of the left wings of the fan, and then joins the average river, and finally, field by field elements of the right of the fan. The left fan is exactly the same three doors, which "grow" from one point. Based on the rules of joining, the fields corresponding to the valves, the pattern must be docked to one another on the perimeter. Form fields can be anything, but, as mentioned earlier, it should be possible to select from among the base. Therefore, arrange on a sheet of three square field width «r», touching each other on the perimeter.

Next, attach the stream width «r» for shoulder "0-1", then right-wing fans. He's done the same as the left, but will cover the river from the opposite shore. Thus, combining all the elements in series with each other, we obtain the following sequence (Figure 1.11a).

1.11 Docking fields and rivers

As shown in Figure 1.11.2, gray river after the assembly of all the connecting lines will meet at "1", black - at "0", forming the shoulder "0-1" on the tree leaves. Fields related to the total surface of each other and, therefore, after the folding of the left wing of the fan base will come

(To have a common base) from the point of "0", the right of the fan - from the point of "1", as required.

Before you choose the position of the squares and the river, it must be remembered that it is necessary to determine the width of the valves, which we want to see in the future based on the model. The width of the valves controlled by the amount of trunks in the fields.The more lines that share a side of the field, the thinner leaf. Take into account the continuity of the lines in the transition from one region to another. Of course, you can make dock, connect the field in places where the connection lines. However, BP's much more convenient to carry out the procedure by means of so-called "single grid" (Figure 1.12). In practice, you can use when designing ordinary notebook "in the cage" or graph paper on which to visible landmarks easily cause the image lines, wrinkles.

1.12 Joining two simple fields on the unit grid

Single network plays a very important role in the process of folding models, designed in BP. With their help, the coordinates are put all backsight line pattern. Also eliminates the need to carry the

trunk, as they are part of the grid itself. The main parameters of single grid on the sheets are the size and pitch.

The grid size - setting the final pattern, equal to the number of unit squares, which were separated by a rectangle folding grid lines. The grid size is referred to as the product of two numbers («a» x «b» - a rectangle, "a" x "and" - square), where "a" - the number of points along the axis of «X», «b» - axis «Y ".

Grid spacing - defines the thickness of the flaps, which is equal to the distance between adjacent parallel trunks.

In our example, we chose a unit grid increments «r / 7." This means that the folding pattern in the plane (Figure 1.13), the thickness of the flaps will be the same and equal to «r / 7."

1.13 Assembling the pattern

In our example (Figure 1.13) we got three doors, oriented in the same side of the plane of the sheet, and three - in another. This orientation is used when you want to get a different colored sash when folding of two-color paper.

It should be noted that the final size of the pattern and, consequently, the size of the grid can not be determined in advance. In the design process, when docking perform various manipulations with fields and rivers. The nature of these actions and the final appearance depends on CP. Fields and rivers - the elements that behave very unstable in the design. Very often, the resulting pattern is so transformed after optimization, which found in him the initial layout of the fields is very difficult - so much can change the shape and location of the fields.

Optimization - to transform the pattern of events in order to simplify it and to build a more efficient use of paper material. These usually include the transformation of the form fields, and rivers in the movement in relation to each other. Optimization of BP will be described in the last chapter, so now we will not dwell on this. We only note that in this example, the same set of fields and rivers can dock more efficiently (ris.1.14).

1.14 Docking pattern elements

In general, the field should be possible to have so that river bends as small as possible. This will help distribute more compact field on the plane of the sheet and fold well optimized patterns much easier. In understanding how important it is, the best teacher is your own experience. Personally, I very quickly realized that the patterns still be simplified, especially after the N-th of hopelessly spoiled paper.

Back to our wood shutters (Figure 1.10). Now consider the docking block pattern elements - the most commonly used method of joining in the design «Box Pleating».

BLOCK DOCKING BP-ELEMENTS

The process begins with the selection of a "point of reference" with respect to which the tree is divided into the complex structure of the wing after the analysis of the model.

Suppose we have chosen a point "1" (Figure 1.15) and broke tree (ris.1.10) on leaf "A" and "B".

1.15 Expansion of tree leaf on components

After splitting starts docking simple fields in each block separately. Elements within the blocks are joined in series.

Leaf "A" consists of three simple leaf length «r» and shoulder "0-1." That is, the structure of the block "A" will consist of three simple fields width «r», surrounded by the river "0-1" in the same width «r» (Figure 1.16).

1.16 Building Block "A"

According to the selected "benchmark" docking complex valves "A" and "B" will occur at "1", and the units themselves - along the outer bank (Figure 1.16 left). Now, no matter in what place along the banks of "1" we place the block "B", the tree is to be built, even if the blocks have just one point of contact.

The length of the top of the "A" block is «6r» (Figure 1.16 right), which is three times greater than the width of the square of the field «r». It follows that the unit "B" should be composed of three square fields (for reasons of rationality docking) (Figure 1.17 left).

1.17 The final docking blocks

The merger of the blocks can only carry trunks, keeping their orientation relative to the plane of the sheet (ris.1.17).

BP-BOG

One of the main problems that arise when docking block elements, the so-called "swamp."This "void" on the sheet, which may be formed in place of complex joint fields between their boundaries. It is easiest if you think again, "Tetris" - the game becomes more complicated when the neighboring blocks do not fit together. If the pattern of simple models can easily reach without wetlands, for complex models, especially beginners, it can be a real headache. And then have to adjust the structure of the blocks to get clean connections, or get rid of extra flaps during assembly. And these lessons are not pleasant. Of course, in order to avoid such problems can be docked elements in series, it is reliable, but very long. Fortunately, there is an easier way - change paths of rivers, located near the marsh. Consider, for in this case is to get rid of the swamp, a simple example. Suppose, on the site of the junction of two rectangular blocks formed a kind of swamp (Figure 1.18.1), which is maintaining the integrity of the usual lines forms an unplanned flap (Figure 1.18.2).

1.18 marsh in place joint blocks "A" and "B"

To get rid of the swamp, you first need to try to move the adjacent field at the place where the void - may turn out to fill them without disturbing the structure of fields and rivers. This activity is something like a game of "tag" - the field just as well move along perpendicular guide *. For example, in this case, you can move the bottom field block "B" (Figure 1.19) .12

1.19 Elimination of wetlands offset the neighboring field

12 * As a rule, the real design often have significant limitations for such maneuvers.

But, more often, a simple shift of the field can not do, especially if the terrain boundaries abutting blocks does not allow them to "enter" into each other without disturbing the structure. In this case it is necessary to change the trajectory of the river or rivers that are adjacent to the marsh.

Thus, for the lower field unit "B" (ris.1.18.1) if we transform the extreme river fullwidth single network, then fill the swamp with no displacement of the center of the field. The manipulation is as follows (ris.1.20).

1.20 Elimination of wetlands due to the transformation of the river

Of course, this example is only a special case of the many options for changing the direction of the river. Similarly, one could alter the trajectory and other rivers, such as at the top of the field unit "B" or the River "0-1." If you want, you can try different options for yourself. In each case, the decision depends on your choice and preferences that can develop with practice. However, despite the wide range of possible changes, to get a "clean" pattern without increasing the size of the unit mesh is not always possible. Sometimes it is still necessary to fit side doors, and if the final processing, hide them for the available land. In the worst case, we must and does go back to the very beginning of the design for a more rational distribution of the fields at the planning meeting model.

BP WHEN TURNING LEAF

When creating «Box Pleating»-models are also useful single grid, not parallel to the sides of the square (ris.1.21.1).

Similarly, do a large number of outstanding models of well-known artists of our time. This is done to make the edges of the wings of some specific properties or to facilitate the distribution of fields and rivers on the surface of folding.

1.21 BP when turning the unit mesh

The very process of the distribution of fields and rivers is no different from the standard "VoxRleating" for a square grid with a unit that is parallel to the sides (ris.1.21). However, all of the flaps, the field that crosses the boundaries of the square, take a slightly different form (Fig. 1.22.2) than in the classical BP (Figure 1.22.1). Thanks to various variants of color change (Figure 1.22.2) or the creation of additional valves on the main (ris.1.22.3).

1.22 Connectors on the boundary of the folding

Quite often when you create symmetrical models use a grid to turn 45 degrees. The choice of this angle allows us not only to give the flap of the desired properties, but also facilitates the transfer of a single grid. Speaking of symmetric models, the use of a rotated grid so helps save paper material on the side leaves, fields are located in the corners of the square. In this case, the creation of flaps spent only a quarter of the area of the field (and the Orientation of lines in the structure of the field is not present). So often the master of origami to create models of animals, dragons, dinosaurs and stuff, just use the diagonal symmetry. In this case it is much easier to fold and drill head and tail part because of more paper material, not overloaded with unnecessary turning trunks. As to the distribution of areas, all done in the same way as a normal grid orientation, just within the area

turned fold (Figure 1.23). Black and gray arrows denote the parts are separated by the river, chosen for the folding of the tree leaves.

1.23 Obtaining BP pattern at turn 45 º grid

Sometimes, to make the valves of different properties, it is more convenient not to make a complete U-turn across a single network, but only part of it. Carried it to an already pre-selected lines. As a result of this reflection, we obtain the projection "VoxRleating" - "bunching" on the lateral surface of the sheet. For example, here is the system of rivers and fields (Figure 1.24).

1.24 MP - box connectivity to a "bunching" of trunks

After reflection from the selected grid line, we get the side surface of the leaf, which has the required properties. Wing will also be part of a closed river, but its description is beyond the scope of BP. More the issue will be discussed in the chapter «Mix Pleating».

SINGLE BP-MESH

As discussed earlier, all areas involved in the creation of VR-models are connected to each other by lines having their fixed position on the unit grid. By the time the single step of folding model is already known, and there is a problem applying grid itself. From the point of view of practical application, this means that you want to divide the side of the square to the desired number of equal parts. How is it done?

There are many ways to build a single network. Adding charts to model different authors, you probably met many of the division of the square with a different number of equal parts. Many ways, and each master chooses those he comfortable. Someone who likes to measure the length of the sheet with a ruler, divides toward the required number of sites and get the grid spacing, and someone used an additional building in the square. In various sources, such as «Tanteidan Magazine», you can find many of these separation techniques, and repeat them over think, will give only a few ways in which we own.

First, consider the case when a single grid is formed by dividing the square of the parties on the value of «2k», where «k» - any natural number * .13

Most preferred choice of such a move is due to get the most simple and convenient grid deploy to the area of folding. The whole process of dividing the parties is reduced to alternately reconciliation parallel trunks (ris.1.25). Naturally, for the entire grid to divide the square in the same way across.

1.25 The division of the square to "2 k» equal parts

In the case where you want to divide by the square of an arbitrary number of areas, the situation is somewhat more complicated. For example, to divide the side of the square into three equal parts, already have to use geometrical constructions (ris.1.26).

13 * Natural numbers - numbers that arise naturally in the analysis of objects.

1.26 The division of the square into three equal areas

The division into many sites require more complex constructions. Since this problem is always of particular importance, the general division algorithm invented by an arbitrary number of equal segments. On this subject there is a lot of work, they can be easily found on the Internet. Origamisty many mathematicians from around the world have been developing such methods. Consider one of them. This algorithm can be obtained as one of the properties of the generalized theorem stated origamistom and American scientist Robert Lang «www.langorigami.com» (ris.1.27.1). For more information you can get in magazines «Tanteidan Magazine (55-56)», which he described in some detail his discovery, which are successfully used by the master of the world. So, if you consider the case of "a" = 0, we obtain the equation KN / NB = (xy) / y (ris.1.27.2).

1.27 The algorithm of division of the square to an arbitrary number of equal segments

With this geometric property of the square of the leaf divided into the required number of segments is very simple, using the following algorithm:

- Choose an arbitrary number of "x»> «y», such that the sum would be a «y» it provided the required number of sites. Way division into «x» parts must be known, preferably a power of two (ris.1.25);

- Divide the square on the side KB «x» parts;

-. Reckon on a split of the «y» divisions from point B - we get the point N (ris.1.27.2);

- Carry straight NL and obtain the point M (she shares the diagonal into two segments AM and MB);

- As well as the ratio of the lengths of AM / MB is the ratio of the lengths of the projections on the sides of the square, and the division between the "x" part of our knowledge, is meshed with the required number of sites.

Consider the example of this algorithm grid "23-23" (ris.1.28).

1) Select the «x» (power of two)> «y». Since 23 = 16 +7, the «x» = 16, «y» = 7;

2) Divide the square on the side of the "x" = 16 parts;

3) Fall back "u" = 7 points from the right side;

4) Bend NL - we get the point M;

5) With regard to the point M is meshed.

1.28 Getting Nets 23-23

Of course, this algorithm does not always use literally, especially for networks with a large number of divisions. First, let's deal with the type of number. Typically, the process of obtaining a grid can be simplified. For example, to type numbers «r2k», where «r» and «k» - arbitrary integers. In this case, the first side of the square is divided by a small «r» parts and then «k» time in half (ris.1.25) each of the «r» sites. Just the construction of grids is sometimes convenient to use scissors, especially for

more than 70-70 square cm is appropriate in cases where the algorithm requires many steps. Thus, having some simple division of the type «2n» or «3h2n", you can just cut off the edges along those lines that surround the desired grid. On the worksheet will be the next extra constructions, and the error grid is minimal.

For example, to build a grid of "27x27" for the algorithms, additional construction, as in Figure 1.28. However, if we cut off the part of the grid, "32x32" at a distance of five paces from the edge of the unit, the grid "27x27" will no geometry, and on the sheet will not bend formed by additional construction (Figure 1.29).

1.29 Obtaining a single mesh 27-27

Naturally, the maneuver is not always rational, and sometimes lost too much stuff, but for such networks as "31h31", "63h63" and so on, it may be quite acceptable. After additional constructions can create a lot of problems when cutting the strip thickness of one cell from the grid, "32x32" and "64x64" - a snap.

CREATING PATTERN BP-MODEL

In this article we summarize the results of the study «Box Pleating» and show some examples of the process of creating a pattern for the base model selected tree leaves. To do this, first select the object, the form of which we want. An illustrative example is the shape of the tree. In nature there are no two identical trees - and our model we can arbitrarily complicate and diversify technical nuances. Suppose we have chosen the following tree leaf (Figure 1.30). The main components are: the root, consisting of 3-composite wings, the trunk length «2r»; system branches.

1.30 The tree leaf model "Tree"

The process of creating a pattern model will consist of the following basic steps:

- The choice of the BP-network and method of coupling elements;

- Building blocks of the final model;

- Docking main blocks;

- Optimization of the structure of the model and the manual for the Wed

The choice of the BP-network and method of the compatibility of elements

Selection step is a unit mesh with the thickness of the wings, we want to see the finished result. This model assumes a fairly thin wing. However, the excessive reduction in the thickness will lead to problems in the assembly, as will require either more subtle or more to the size of the sheet.

In any case, if we analyze the tree leaf, we see that the minimum length of the wings, in its composition - «0,5 r». If we take this value as the minimum size of the grid, the leaf length «r», will have the aspect ratio (1:2). Visually, it can be estimated that such a width and leaf structure is not very convenient to fold a tree branch and it is desirable to reduce it. Suitable leaf length «r», with the ratio of (1:4). This means that the minimum period of «0,5 r» need 2 grid cell.

To dock the best way to use the block. As mentioned earlier, this is the most appropriate for the symmetric BP model. And do not be fooled by the asymmetry of the top schemes "tree" - the two "asymmetric" valve can be well placed, one by one, and then the general structure of the model will be symmetrical.

BUILDING BLOCKS OUTCOME BP-MODEL

Structural pattern - a pattern made up of distributed according to a tree leaf fields and rivers, no connecting lines. The final pattern - Wed, consisting of all the lines, wrinkles.

To begin to decompose the wood sash components: valve "C" and «D» - side branches, "B" - the tip of the tree, "A" - the trunk and the root (Fig. 1.31). They will meet blocks «A», «B», «C» and «D».

1.31 Block diagram of the model

Next, proceed to obtain the structural pattern of each leaflet. 1) Fold the "A"

1.32 Flap 'A'

Wooden 1.32 shows that the door "A" {0, 1} consists of three wings of complex {1; a}, {1; b} and {1; c}, separated shoulder «2r» from the rest of the model.

Leaf {1; a} and {1; b} are identical in structure, each consisting of two single-leaf width «1,5 r» and shoulder «0,5 r». This means that their units are made up of individual fields on the width «1,5 r», surrounded by the river width «0,5 r» (Figure 1.33, right).

1.33 Structural patterns left wings - {1, p}, right - {1, a} and {1; b}

Similarly, the block {1, p} consists of fields relating to the width «r», surrounded by the river width «r» (Figure 1.33 left). Now you need to join them. Given the fact that from the point of "1" turns out all three doors, blocks come into contact with each other at any point along the borders (Figure 1.34a). No matter what wing joints - simple or complex - the "rule of connections" should always work!

1.34 Different types of coupling fields {1; a}, {1; b} and {1; c}

The width of these complex fields is the same: r + 2r + r = 0,5 r + 3r + 0,5 r = 4r, which means that if we arrange them as shown in Figure 1.34.3, the result is a rectangular area. Why is this important?

When docking fields «Box Pleating» recommended laying blocks in rectangular design, to avoid difficulties with the liquidation of the marshes.Therefore preferred docking as in Figure 1.34.3.More important to note that the same orientation with respect to wing plane of the sheet, as the center of all prime fields lie on the same line. This nuance is often used in the design models. With a field like this, it is possible to significantly reduce the size of a single grid. For small networks this is not important, but to simplify the grid "128 x 128" to "32 x 32", you see, is quite appropriate. The very thick wings will be regulated after the folding of the base width divided in two wings.

Next, proceed to obtain the structural part of the shoulder, "0-1." As we can see from a tree leaf, the point "1" remote from the point of "0" distance «2r». So, for the final formation of the block "A" must be prepared to surround the fan {1; a}, {1; b} and {1; c} river width «2r» (Figure 1.35 top).

1.35 Structural and final leaf patterns "A"

In Figure 1.35 (bottom) presents the final leaf pattern "A", which was obtained as a result of the application of all the connecting lines with a single grid.

Later, when they made up the patterns of leaf, docking units will be performed exactly with the final Wed It is necessary to control the correct orientation of trunks in the transition from block to block. 2) Fold "B"

1.36 Valve "B"

Block "B" consists of four fields: three simple and one complex {0; a}. Similarly, "A" block, using lengths of wood shutters (ris.1.36), we determine all the fields that are included in the block "B" (ris.1.37).

1.37 Paul Block "B"

As well as the "A" block, block "V" formed by the joining of all fields. An algorithm for constructing the same, the main thing - to ensure the continuity of the connecting lines. Please note that this block is surrounded by the river is not necessary, as all the doors out of the point of "0." The result is a structural and final leaf patterns "B" (Fig. 1.38).

1.38 Structural and final leaf patterns "B" 3) The valves "C" and «D»

1.39 Leaf «C»

Sidelight («C» and «D») are identical in composition and consist of two simple folds and two complex, and are fixed to the point of "0" means the long arm «2r». They are symmetric about the vertical line passing through the point "0", so it is enough to get the block "C", and the unit «D» is his reflection.

How to build this unit you already know: the corresponding tree leaf fields are joined at "1", surrounded by the river width «2r» shoulder for "0-1", etc. Results are as follows (Figure 1.40).

1.40 Structural and final leaf patterns "C"

BASIC DOCKING BP-BLOCKS

As a result of previous actions we have received and the results of structural patterns of four blocks that form the core of the model. We want to join them together. In general, the docking blocks should be performed the same conditions as for the conventional fields. That is, for Consolidation enough that they touch each other's external borders. In this case, they should be placed so that between them as small as possible wetlands. Indeed, despite the fact that the docking simplified and made along the lines of a single network, to preserve the continuity of the trunk of each of these voids still need to get rid of.

1.41 The structural pattern of the model

Optimization of BP structure and obtain the final Wed

Optimization - the process of moving elements of the pattern relative to each other in order to simplify the structure of the model and the choice of folding. Streamline pattern in «Box Pleating» is much easier than other methods. In this book, the optimization of its own chapter. At this stage, we note the following. Sometimes, especially if the result of joining the main blocks form a set of wetlands, the process of getting rid of them can take a long time (see the "swamp"). In our example, just have to find the optimal size of the square, which will cover an area of their fields, all centers of the structural pattern. Note that the square (the most used and the traditional form of origami) still Conditional: can be covered and a hexagon, and a circle, etc. By and large, the shape of the original sheet of folding can be any. Identify areas of folding for our tree leaf shows that if we interchange the two upper and lower margins of block "B" (ris.1.41.1), the rectangle describing the extreme cents field is a square, and the unit (as well as the base model), its characteristics do not change (Figure 1.42.2). This will do.

1.42 Optimization of pattern

Consequently, swap them, we finally determined the area of folding. This means that you can "cut off" all that lies beyond. Since all the elements that form the base will have been placed inside the square.

Now calculate the number of elementary sections of length «0,5 r» in any of the parties to determine the parameters of a single grid, which we will use the folding model. At the beginning of the design, we have determined that the minimal amount of time «0,5 r» we need two cells of the grid. It follows that if the length of the bottom side is «16r», the number of elementary sections will be twice more - 16:0,5 = 32, and the mere number of divisions by 32x2 = 64. Thus, the grid for our chosen proportions has parameters "64x64". This separation is acceptable to the sheets of 30-40 g/m2 and a size of about 50x50cm. Orientation should first transfer line, and grid lines themselves later become trunks. This completes the process of designing the model of "The Tree" * 14zavershen (ris.1.43).

14 * The assembly of this model can be found in the practical part of the book.

1.43 The final pattern model

HEX PLEATING

This technique was first used several years ago by the American origamistom Robert Lang (www.langorigami.com). Recently, it has become quite popular among the masters of origami through a variety of technical elements and relatively low complexity of this image is in the region of the folding pattern. Like BP, the structure of the "Nex pleating» (HP) is formed by the use of fields and rivers, abutting each other. Similarly, through the trunk, some elements are attached to the other is governed by the thickness of the valves, and more. Setting aside the external differences, and in the use of the fields, the similarity of both methods will be quite obvious. If you compare the material in this chapter with the basics of BP, described earlier, will be able to see this.

«Hex Pleating» - a very exciting technique. For the design in HP enough to have a pencil, ruler and patterns of individual networks (this will be discussed in detail below), or skill in computer vector editor. Of course, design for HP's slightly more complicated than in BP, but a more rational use of

folding (of course, with proper selection of the fields) makes up for this moment. In addition, if desired method may well be used together, which will help expand the technical arsenal fans standard BP.

2.1 Model, designed to «Hex Pleating»

In this chapter, the basics of design at HP, for example, the rules of docking, HP-moving elements relative to each other, the use of single grids, management fields, docking units, as well as much more. But to begin, consider the "basic components» HP.

RIVERS AND FIELD «HEX PLEATING»

The main component of the HP (its elementary particles) are the rivers, which, occupying a fixed position on the pattern to form the structure. Studying the river in BP, we examined the strip (the river), which changed its direction, making a turn only 90 degrees as it moves. When they folded along the trunk we get the same size elements, which are then used in the design. In HP there are no fundamental differences, we find the same elements, but the angles of the rivers will have multiples of 60 degrees (Fig. 2.2).

2.2 Set open river of the same width

All linear methods use the same terminology, introduced at the beginning of the first chapter. We recall the basic concepts for the HP (Fig. 2.2). Black and gray line (border river or coast) when folded gather in white and gray point, respectively, as a tree leaf above. The distance between the two sides is called the width of the river. She maintained throughout its path and is an element of the pattern dividing, located on opposite sides of its borders. If the HP-river closes on itself, that river is called closed, if not, then open. As in BP, HP-open river are themselves part of closed rivers that are within the area of folding, it does not affect the length of the generated wings. At first glance it may seem that the river in HP performs a rotation on some other rules: Orientation harder to define the line, and turning themselves look different. But it is necessary to get used to manipulating the grid on the unit used in HP, as the design is hardly difficult BP. However, this is very important to understand how some turns HP-basins (Figure 2.3), so we consider this question in detail.

2.3 Turning the HP-river

Suppose at some point we need to change the direction of the river, according to the Orientation constraints imposed itself technique «Hex Pleating». Possible angles for 1 Step - 60 ° (Figure 2.3.1) and 120 ° (ris.2.3.2a) clockwise or counterclockwise. In this case, the line Orientation will pass through the point of intersection of the coast, mirroring the adjacent portions of the river. To make a turn at an angle of 180 degrees requires a minimum of two steps, and they will be around a single point (Figure 2.3.2b - gray).

At a time when the river is closed on itself, it isolates its wide inner region of the outer, thus forming a box or block, the outer boundary of which coincides with the outer boundary of the river. Moreover, if the inner region consists of a simple field, the result is a single leaf (ris.2.4.1) if the internal field - complex, it will be an integral flap (Figure 2.4.2). When inside a closed river is nothing, the flap length is equal to the width of the river.

2.4 Simple and complex HP-field

Unlike BP, «Hex Pleating» replete base * 15polyami. Because of this, significantly increases the set of fields that are useful in the design of (Fig.2.5).

15 * The fields in which the inner coast - point, and external - described convex geometric figure. Used to simplify the final processing model.

2.5 Some of the basic HP-fields of the same width

Of various fundamental fields smallest area has a regular hexagon, the greatest - the equilateral triangle. If the flaps that come out of their assembly, will have the same parameters, the first field of education required is 1.5 times less paper than on the second. That is, to save paper material and facilitate the final processing of the valves, the most appropriate to use the HP-form field with a correct description of the hexagon.

Note that the HP and BP are often combined, it allows simultaneous use of advantages of both techniques. From BP - uncomplicated docking, from HP - a wide range of techniques and saves paper.

In the course of such a combination of methods a number of new basic fields. In addition to standard angles at the vertices of the HP-60 ° and 120 ° field, adds another angle to 90 degrees. Construct such a field is easy. The fact is that in the basic fields, based on the features of their structure, it is possible to inscribe a circle with a radius equal to the width of the river. So, if we drawtangent to the circle, perpendicular to the other parties, HP-field, we can get mixed, "HP-BP" element (Fig.2.6).

2.6 Fields of mixed type

This manipulation of the shape is convenient to carry for the optimization work, so moving the HP-field is much more complicated than the BP field. However, it is understood that the side of the square and the side of the hexagon can not be simultaneously divided by an integer number of equal parts, as their attitude - an irrational number. Therefore, docking of these elements and replace the HP-fields to mixed to be done after careful analysis of their relative position.

LINE HP-FOLDS

As already mentioned, the standard linear methods use only two types of lines, wrinkles: Test and Orientation.Their functions and features remain, regardless of the choice of algorithm design. But because of the fact that the form fields in its various techniques, the relative position Orientation lines may be different. So, if BP Orientation lines intersect only at right angles, the HP options intersection set. External differences should not prevent you find similarities between the lines of the folds in the BP and HP, as the principle of their construction is the same (Figure 2.7).

2.7 Orientation and connectors, HP-field

In Figure 2.7.1, marked with black lines Orientation. They also determine the trajectory of the river to form the elements of the model. In this case, Orientation lines pass through the opposite corners of the hexagon. This is due to the fact that the river carries rotation relative to the inner bank (center field), keeping the width. As a consequence - for any base field outside straight river sections relate

to a circle whose center is the same as the center of the field, and the bisector drawn from the angles become Orientation lines.

With regards to the trunk, they (as in BP) is used for mounting the elements to each other and are always perpendicular to the banks of the river on the way from one line to another backsight (ris.2.7.2). And, in the moment of crossing the line Orientation trunks reflected mirror, according to the rules of Kawasaki.

In the process of folding of HP-fields on the sectors there is the familiar "calling card" of linear methods - "accordion" of the layers (ris.2.8.4), which is formed due to the opposite orientation of the connectors. Although the presence of a number of layers increases the thickness of the valves, with proper selection of the fields in the HP is not as important as in the BP and the thickness is not significant, and it takes less material (ris.2.8).

2.8 Assembling the basic HP-field

Please note that if BP ratio side of the field «b» to length sash «a» is 2, then here «b / a» is about 1.15 and if it is not taken into account, you may have difficulty in choosing the right proportions in the base form .

Add up all the valves in the «Hex Pleating» uniformly, but the shape of the top of the same gate length varies. For thin wings it does not play a special role (especially in cases when, after folding the base have their thinning: legs insects, crustaceans, horns, etc.), but if the doors will be using to maintain their appearance (body parts of animals), then consider this relationship still stands.

LENGTH HP-VALVES

2.9 Location of HP-fields with respect to the drawing frame

Adjusting the length of the valves can be accomplished using sheet line folding. This is already in the final stages of design to change the properties, and the lengths of the valves, the fields are located on the outer areas of the page (Figure 2.9). The figure shows the HP-fields of various shapes that form the folding doors of the same length.

Fields that are located entirely within the sheet (1,2,3) form a leaf out of all paper material. This is the standard situation for the valves located in the center. Once inside the leaf is only part of the field (4-10), the gate length depends on what part of it. Thus, the basic fields (5.6) lose a certain area, but their centers are located within a sheet. In this case, the formation of saving paper material, and doors have a maximum value. Without losing the length is possible until such time as the center of the field reaches the boundary of sheet (4.7) * .16

Due to the angular parts of the opportunity to reduce the amount of material on a particular leaf, but because, as noted in Chapter One (BP) in the corners is recommended to have the longest leaf. If the center of the fields outside the plane of the sheet (8.9), then the gate length will decrease its distance from the center of the field boundaries (is less than the width of the river, located in the fold). In our case - maximum perpendiculars from the points of restraint Orientation lines and boundaries of the sheet on the sides of fields (p.8, p.9 - gray dotted lines).

Stretched field (3.10) are added in the same rectangular fields «Box Pleating» (ris.1.9) - first central trunks, and then everything else. As for their length, one needs to look for the most "favorable" conditions for all points of the field. That is, if one center is located inside the leaf, and the other does not, the door is fully formed, the entire length.

It should be noted that if the intersection of the boundary of the sheet formed accordion, its appearance may be different (ris.1.22). So it is possible to give different properties flaps, choosing the correct form fields and placing them on the border of the sheet to the desired angle.

NO SINGLE-SCREEN

To design and carry items on the list in the "NexRleating" used triangular mesh. The angles between adjacent grid lines are guides to 60 degrees. This makes it easier to put the fields themselves and rivers, as well as facilitating their dock on the perimeter. There are many ways to build such networks, a look at some of them.

16 * The location field "7" in Figure 2.9 and most preferably at a low and waste paper we obtain the same gate length, but without the backsight line, in contrast to other situations.

Easiest triangular grid can be coated on the surface of the right of an equilateral hexagon, the image of which can be obtained from the paper-form with a compass and a ruler (ris.2.10).

10.02 Getting a regular hexagon

Equivalent to how we received the standard BP-rectangular grid, connecting opposite sides, can also be obtained on the surface of the triangular mesh hexagon size «2n-2n-2n» (ris.2.11).

2.11 Getting triangular mesh on the hexagon

Such a grid on hexagons are often used when folding paper mosaics. Cutting off the extra edge on the similarity (Figure 1.29), you can get any size grid. NO need for this arises if a hexagon is selected as the area of folding, although out of the finished grid can also cut the sheet in any form.

Could be limited as described above, but more often it is for HP models used triangular mesh directly on the square, and the construction of the grid becomes more complicated. The fact is that after the design grid can be obtained by complex division or orientation relative to the boundary of the square. Therefore, the design of appropriate target because of the square, and the elements of the model itself, that one part of the grid lines parallel to the sides of the square. So it will be more convenient for the design, and to transfer the image to the assembly area. To build on a square grid that satisfies this condition, you must first divide the side of the square to «n» of equal parts, and then restore the rest of the grid lines (Figure 2.12).

2.12 Getting triangular mesh on the square

It now remains to transfer Orientation line-fold project to the grid and can be folded. Only now, in order to deal with how it is done, you need to consider the structure of the grid itself a little closer (Figure 2.13).

2.13 Triangular grid unit

Triangular grid consists of three groups of parallel lines located at 60 degrees to each other (Figure 2.13 left). The choice of such a network, in which the distance between adjacent connecting lines remains constant, allows not only the purely join field between themselves, but also to make the connecting lines between them will be the same distance. The boundaries of the HP-fields will always be placed on the rails (Figure 2.13 right).

By analogy with the BP-nets in triangular meshes using a parameter such as - grid spacing "a" * .17 By choosing the initial step of the grid is regulated by the length and thickness of the flap. For instance, in Figure 2.13 (right) after the assembly fields formed leaf length «r» = «2a '. Note that when there is an opportunity to have well fields and the river to the build model evolved in strict accordance with the tree leaves.

2.14 HP Docking elements on a triangular grid

In Figure 2.14 (left), presents a set of elements that satisfies a specified wood shutters, all lie on the margins of the grid lines. Length wings {a; 1}, {a; 2} and {b; 5} are two steps grid, {b; 3}, {b; 4} and {a; b} - one step. All connectors are perpendicular to the borders of fields, and therefore on the grid, they will be as follows (Figure 2.14 right).

Next, pay attention - a very important point! After finishing the design of the model (that is, after the Orientation lines), but before the "cut" of all the unnecessary parts of the boundaries of the area of folding, turn the unit on a grid of 30 or 90 degrees, with respect to some of the sites, while reducing step to the value of distance between the trunks. In other words, if we had a grid with step "a" (ris.2.15.1), after turning it a step would «b», where «b» = 0,577 «a» (ris.2.15.2). Next, a new grid is used as a reference system for the transfer lines to the sheet. ** 18

Step 17 * HP-grid - the minimum distance between the parallel lines on the unit grid.

(Ris.2.21.3), which is for beginners and will at all daunting. Do not be afraid of a little bit of patience and after assembling a pair of identical elements all will fall into place.

2.21 Patterns for one tree leaf

HP-BOG

In general, the docking complex blocks inevitable appearance of the marshes. This problem is solved by the same means as in "Vox Pleating», as follows:

- Move fields to each other;

- Change the trajectory of the rivers. 18 ** Source single grid along which get position Orientation lines, called Orientation, deployed single grid along which the construction of the trunk - connection. More this point will be discussed in the next chapter, in the "diamond-shaped grid."

2.15 Rotating the unit mesh

Why do I need to turn maneuver backsight grid?

- Orientation grid is perfect for most of the design process: it can easily be traced beyond the borders of the rivers, which are involved in the build process, consistently butted elements together. In addition to the backsight grid can be removed from the wetlands and get the final image Orientation lines.

- Connection Mesh is optimized for subsequent assembly model due to the fact that, after turning all trunks are located exclusively on its rails. This means that after you apply "turn around" on top of the structural grid pattern that will only pick up the location of folding. * 19

Of course, many will say that you need to immediately design a model to "turn around" the connecting grid. What - I will not argue, it is an individual matter. I write in the book, only the methods that use the self and in ways that are comfortable to me. I note only that no optimization of the river sometimes take a convoluted shape, hardly at all of the nuances possible to trace the novice designer. Especially, the above rotation is not too difficult, especially if you are building a computer pattern vector editor such as «Inkscape» or «CorelDRAW». If you design using available tools, it is enough to just once a template to make two different grids with single step ("a" and «b» = 0,577 «a» (Figure 2.15)) on an opaque material, and use them always. After that, very easy to implement the design on tracing paper placed on top of the grid pattern (photo 2.16).

19 * Centers fields will coincide with the nodes connecting the grid

2.16 Application of triangular mesh * 20

20 * The first step is taken mesh step "a", it is based on the structure of the fields and the river (photo 2, photo 3). Further net change (step «b» = 0,577 «a»), rotated by an angle of 30 or 90 degrees (photo 4). Then restore the connection lines (Fig. 5), and the resulting pattern is ready (photo 6). Will designate landmarks and select a form sheet folding, of course, relative to the grid connection, and the design part is completed.

So, decide for yourself which method to apply in practice, and what is more convenient for you. Later, during the docking elements, any arrangement will be carried out by individual nets, but the process of the rotation will not be described, so the test will have to do yourself.

HP DOCKING-ELEMENTS

As in BP, docking, HP-elements can be performed consistently and block, according to the basic rule of docking (section - "docking BP-elements"). We demonstrate this with a concrete example, which we saw in the previous chapter (ris.1.10).

SERIAL NO DOCKING-ELEMENTS

Sequential docking is alternating combination of elements to each other, since at some point in the tree leaf to the last, from field to field, given the structure of the model. Of course, is mainly used in the HP modular docking, because getting rid of the wetlands in this methodology - objectives can be

met. But for simple models and models of medium complexity to break the model into blocks does not make sense, and suitable join sequence data.

Using the previous chapter the sequential algorithm, field by field, first left sostykuem fan flaps, 0-1 on his shoulder and right fan (ris.2.17.1).

2.17 Docking HP-HP-fields and rivers

Similar to the "VoxRleating" side of the folding wings are formed of three HP-fields related to each other on the perimeter. Just average connection part is done by the river, which divides and HP fan. Only now it will look differently * .It should be noted that at the junction of the angular fields should always be based on connecting lines, it will provide the ability to build a pattern. That is, if you do not involve the use of a single mesh with arbitrary arrangement of the fields (as in our case), the folding base is enough. Although, of course, the orientation of the valves will be uncertain. For the control, you can enter the intermediate connectors (ris.2.17.3) near the center of the fields. Thanks to them, the leaves will change the direction of the plane of the sheet without disturbing the overall structure of the tree leaves. In this case, the assembly 2.17.3 pattern would look like this (Figure 2.18).

2.18 Assembling the base form

Despite the fact that the process takes more time initially excluded all possible errors in the transition from one element to another, allowing guaranteed to solve the problem of wetlands. By the way, the process of serial connections also applies when creating blocks for block docking model elements. As you may have noticed in the figures 2.17-2.18 turned out not "pure HP representative," because as the distance between adjacent connecting lines are constantly changing. The main purpose of this example - to show all the links necessary for folding base. Of course, the rational use of the very few, and it is inconvenient for practical use as well as the transfer of each site will be based on the coordinates of which are still to be determined. But now, using a single triangular mesh (described earlier), this problem will be solved

21 * Do not confuse the form of folding - now we do not consider the use of specific forms of the sheet on that later in the practical part, so just leave that part of the fields and rivers, which are directly involved in the formation of the model. automatically, since the position of the main units pattern will be easy to remove from the grid connection.

BLOCK HP DOCKING-ELEMENTS

As has been mentioned many times in the previous chapter, the layout of the blocks follows the same rules as the layout of simple fields, as for a clean build rule docking elements should always work. This is based on the structure of all the techniques and not just linear. Other methods may be another form of fields and rivers, may not be connecting lines, but in any case the doors "go" from

one point, the river, they are made on common surfaces. So, we split our tree leaf, as before, the two components of valves "A" and "B" (ris.1.15). Then you can begin to write the block "A" of the HP-elements. In this case, three fields, surrounded by the river (ris.2.19).

2.19 Building Block "A"

Since docking fields within the block is made consistently, starting with the fact that one by one, left the field butted fan leaves. All three valves connate, and hence on the overall pattern of the field related to the surface. To do this, choose the three basic fields and have their centers on a common trunk (ris.2.19.1). Further, according to a tree leaf, box fans surround the river {0, 1}. Thus, we have "A" block in the structural form (ris.2.19.2). Now for the final pattern of the block you only spend trunks according to the selected leaf width (ris.2.19.3).

Getting the block "B". Since the composition of the right of the fan corresponds to the left, the same way butted three identical to the width of the field so that you can dock the blocks without the formation of wetlands. For this perfect mirror image of the left field of the fan (ris.2.19.1). Thus, we can easily put together the two blocks along the left edge of the block "A" (ris.2.20.1).

2.20 The final docking blocks

In this case, a set of three core fields will be folded into one set of wings, and the field on the outside of the river - in the other. The river will develop along the perimeter of the trunk (like the "VoxRleating"), forming a link between the two groups of lateral leaves. The final form of the pattern will look like Figure 2.20.2.

Notice how to choose the location of block "B": the centers of fields were directed against each other, ensuring the same orientation with respect to the plane of the leaf sheet. Moreover, the distance between the connecting lines more step backsight grid, «b» = 4x0, 577, «a» = 2,3 «a», since the distance between the connecting lines we have chosen four times more than in the case described above (Figure . 2.15).

Of course, HP and BP are very similar to each other and studying «Box Pleating», HP optionally can quite make out and explore on their own. However, HP has a very useful feature, which in its pure form is not found in the BP - turns the rivers in the trajectory angles. Subsequently, the study «Mix Pleating», you will appreciate the experience of HP-design. Although the manipulation of rivers in all procedures carried out by the same rules, at first hard to understand that the formation of the same tree leaf, a set of VR-river, shown in Figure 2.21.1, its structure is no different from the set of HP-rivers in Figure 2.21.2. Not to mention the final HP pattern

When the voids should first review the original location of the fields and rivers - sometimes that's enough. If a permutation does not work, try to change the trajectory of neighboring rivers or some part. This maneuver is performed by manipulation with Orientation lines. In this case, from the river

certain fields begin to go beyond its normal movement in order to give the necessary forms needed to eliminate the bog (ris.2.22).

2.22 Two simple HP-field forming the flap of equal length

For example, consider the basic HP-field (ris.2.22.1). As already known, the river forms the flap equal to the width of the river, and thus consists of an infinite number of elementary rivers. Their composition can be arbitrary, in Figure 2.22 is selected composition «a1», «a2 ', ...,' a (n-1)», «an». The nearby river is very easy to combine into groups, getting rid of wetlands without additional fields forming the new flaps. Note (ris.2.22.2) that the inflection in all the rivers on the outside of convertible River, will also change its trajectory, and all the internal rivers remain unchanged. Under these transformations, after a change of motion, the river back again to normal.

Give an example of a pattern constructed wood shutters (ris.2.23) and consider getting rid of detail swamps.

2.23 The tree leaf

We have before us three nodes in the tree, "1", "2", "3" and two arms "1-2", "2-3". On the basis of this structure, the two fields emanating from a point "1" is limited by the node "2" river "1-2", and from 3 fields node "3" total river "1-3". Denote the leaf pattern {2, 1} for the first block patterns wings «d», «a» and shoulder "2-3" for the second, and the pattern of leaf {2, 3} for the third. Suppose the docking we get the following result (ris.2.24.1). For clarity, the figure will leave only the necessary folding model line, without the mesh.

Marshes at 2.24 at the interface of the blocks

With this arrangement, the fields at the boundaries of the 2nd and 3rd unit formed two marshes triangular (marked - "?" Ris.2.24.1). For a simple fill these voids trunks (ris.2.24.2), we obtain a pattern with two unplanned flaps «x» and «y». If the folding is possible using the resulting flaps, you can leave everything as it is. However, if you get a clean base form, it will have to get rid of the bog. And we will implement this by changing the path of rivers some of the elements of the pattern (ris.2.25).

2.25 Disposal of wetlands without disturbing the tree leaf

You can do the following (ris.2.25.1). Select fields wings "c" and "e" (2.24) to fill the marshes for its rivers. The "c" - fill left the swamp, "e" - the right respectively. Denote the transformed field as "A" and "B" (ris.2.25.1).

Please note that the "X"-swamp (ris.2.24.2) has the shape of an equilateral triangle, this condition can direct the entire river entirely within the swamp. Thus, we not only ensure the integrity of the structure, but also get a new base field "A". As for getting the field "B", here are a few more complicated, because the whole river to send does not work, and only have to transform some part of it. In our example, the converted portion of the river in Figure 2.25.1 indicated by black dotted

lines. Remains to be missing connectors (ris.2.25.2) and preparatory work is completed. Without a single grid similar constructs is difficult, but for HP, where the design is on triangular meshes, problems are rare. The main thing - to monitor the preservation of the width of the river, as it moves to a new trajectory and closely monitor turn himself when passing through the backsight line.

CREATING PATTERN NO MODELS

In this section, we summarize the results in the study of "Nex Pleating» and show some examples of the process of creating a pattern for the base model of the selected tree leaves. Especially take a sufficiently complex object ("Deer" - ris.2.26) so that you can try out all the details and the difficulties in the HP-design.

2.26 The tree leaf model "Deer"

As already mentioned in the case of the "VoxRleating" to begin to deal with the thick flaps that will be used to form the elements of the model, and then define the connection step grid. For this study the most delicate part of the model - "horns", and consider the fields that are involved in their formation. Then choose the number of trunks, which we no longer fit (ris.2.27).

2.27 Fields single valves involved in the formation of horns

Suppose we have chosen the following forms of single leaf (ris.2.27). The ratio of their lengths is accordingly 2 ¸ 3 ¸ 4, that is, is the ratio of the number of divisions into which we have divided by hexagonal fields. The shape of folded wings unfolded highlighted the darker color, but after folding pattern in the flat base will be only half. Thus, we choose the step grid connection. Orientation grid will be a step equal to the length of a single leaf - «r». Next, we split our tree leaf on the components and begin to get the block each (ris.2.28).

2.28 Block diagram of the model

Leaf "B" and "B", "symmetrical about the center line, and so their power is more convenient to choose a mirror image of each other. The dashed lines are connected shared the points at which the blocks are linked.

Now consider successively all doors and form their structural patterns and outcomes for future connections. 1) Fold the "A"

2.29 Flap 'A'

Note (ris.2.29), at the point "A" at a distance «3r» from the top (or «r» from the center of the block) originate from two leaf length «r». It follows that their fields should touch each other along the common border (ris.2.30.1). As the fields are selected hexagon and two right triangle, the ratio of the lengths of the valves which will be 3:1.

2.30 Block {0; a} on the grid backsight

Since the entire system is separated from the base of the valves to "0" at a distance of a shoulder "0-a» = «r», then the rest of the fields of the general block separates the river width «r» (ris.2.30.2). Having received this system remains on the perimeter sense to regard it with leaf length «4r» and with two doors length 2r (ris.2.31).

It is possible that the initial version of the field distribution is subsequently changed (during docking units or optimization). At this stage, most importantly, to keep the tree leaf and the symmetry axis, as this unit is located in the center of the fold.

2.31 Block "A" on the backsight and connecting grids

For convenience, all the doors of the assembly model should be directed to one side of the plane of the sheet, the more so as to change the color of individual elements of the model is not necessary. This means that must pass through the center of the connecting lines of the same orientation as in Figure 2.31 (right). 2) Fold "B"

2.32 Valve "B"

Fields should be docked from the end to the beginning, as the shoulders «ab», «bc», «de», «e-0" (ris.2.32) is more convenient to build the pattern sequence, surrounding the combined elements of the new rivers. This means that the bank "0" river "0-e", we define the last.

Let's start with the composite wing {a; b}, in her point "a" is at the junction of the two wings of length «2r». Therefore, the pattern arrange shore "a" at the border

two related fields of width «2r». Then, according to a tree leaf, define bank «b», located from point "A" at a distance «2r». For this pave the river width «2r» on leaf pattern around the group issuing from "a" (ris.2.33).

2.33 Structural and final leaf patterns {b; a}

Again appeal to the tree leaves. At the point of «b» is mounted another long sash «4r». That is, the resultant field {b; a} (ris.2.33) should apply to the field width 4r, along the shore of «b» (2.34.1). Further, since the point of «b» is separated from point "a" shoulder 3r - paving the river {c; b} (ris.2.34.2).

2.34 to structural pattern sash {c; b}

Notice how the width of a single river «cb» split into two components. This transformation is due to the fact that after covering the complex field (ris.2.34.1) river width «2r» topography changes, but because the rest of the river «cb» will follow a new path (ris.2.34.2).

In the same way consistently ranks left field, moving from node to node. First «d», then «e» and, in the end, "0". One of the possible use of such a distribution of fields for further design (ris.2.35).

2.35 Final leaf pattern {0; e}

In view of the same composition valves "B" and "B '" relative to the center line, the structure of the block "B'" in a similar manner. And, as mentioned earlier, for the convenience of the assembly will block "B '" mirror image block "B". This will provide a symmetrical pattern about the center vertical line, provided that the other parts will be symmetrical. Of course, the very pattern of the second horn may not reflect the pattern of the first and used in pure form. On the result of the assembly is not affected, but the process of the transfer lines to the area of folding can complicate. Since the coordinates of all nodes will be different.

So, at this stage of the project, we have three sets: «A», «B» and «B '», which must be connected, and as a result of folding to form the head and antlers. In "NexRleating" because of the more complex than in the process of joining BP fields and join blocks of optimizations should be at all intermediate stages of the finished pattern, and in the process get rid of educated wetlands (by changing the shape of fields or paths of rivers). This case is no exception, and therefore combine all three blocks in one head, not forgetting the fact that the laws of connecting blocks are the same as for conventional docking fields.

Since the pattern of the model we have chosen to fold, symmetric with respect to the axis, and the lines joining the blocks "AB" and "AB" "will be symmetrical about the axis of symmetry of the block" A ". So, enough to connect any of the block with the block head horns, and then do the same operation on the other side of the mirror. For example, select the docking blocks «A» and «B '» and consider the boundary of the compound (ris.2.36).

2.36 Docking Blocks "A" and «B '»

In Figure 2.36.1 shows the initial position of blocks 'A' and 'B'. " If you shift the "1" "A" block, freeing up space field "2" block "B '", the blocks' A' and 'B' "dock so that the tops of all the fields of both blocks will have the same orientation with respect to the flaps plane of the sheet. Such an arrangement is suitable for our case, since the problem is to change the color of individual valves we should not. In this case, the displacement field of "1" is on the perimeter of the block "A", and the structure of the block «B '» not change.

After selecting the position shown in Figure 2.36.2, we got two swamps, one internal (inside the unit) and one external (outside the unit). These wetlands are within the selected areas, the low and high respectively. Before proceeding further docking - get rid of them. To eliminate wetlands remember those described previously. In this case, we use the change of direction of neighboring rivers (ris.2.37).

2.37 Elimination of internal swamp

Swamp ABCD - parallelogram (ris.2.37.2) with vertex angles 120 and 60 degrees, and the aspect ratio - AB ¸ BC = 1 ¸ 2. Not difficult to show that the point of the "E" (midpoint «AD») at the intersection of the bisectors and ÐABC   ÐBCD, which means that the distance from the "E" to the «AB», «BC» and «CD» equally. In other words, on the point of the "E" can pass the river, covering its surface the swamp, reflected in the bisectors ÐABC and ÐBCD. Paragraphs "3-4" shows a possible variant of this river and connecting lines within it. As a result of the abovementioned actions we got a field with the same length of the flap. A similar method is used quite successfully in the "NexRleating." With it, not only to get rid of the inner marshes, but also from outside. What we actually do with the upper (ris.2.36.2) Wetlands (ris.2.38).

2.38 Elimination of external swamp

In the case of this swamp change the trajectory of the River "A" block is even simpler than in the previous case (ris.2.38.2). It can easily be shown that the distance of «A», «B», «C» and «D» to the sides of the serpentine channel same and equal to the width of the initially selected for the transformation of the river "A" block. It remains to apply the connecting lines, as shown in Section 3, 4, and the resulting pattern of stacked units will be ready. 3) Fold the "C"

2.39 Fold 'C'

Lots of block "C", in charge of the front legs, symmetric with respect to "1", which means that the images of the lateral field pattern plots make for easy assembly of mirror images of each other.

To start form the pattern for {1; a} (ris.2.40) the same way as were leaf pattern {b; a} block "B" (ris.2.33).

2.40 Final leaf pattern {1; a}

In theory, the next step is to attach to the side of the leaf {1; a} the same, but mirrored sash - {1; b}, and then surround the resulting fan river width «8r». But if we look at the tree leaf, we see that {1 sash; a} and {1; b} separated from the head of this most shoulder "0-1", that is, blocks of these wings separated river «8r». Of course, if you act with the described algorithm, it should be included in the head-shoulder sash originally. But, then we had to join the larger blocks, using a lot of extra material to fold. Do otherwise - between the head unit and the fan leaf {1; a}, {1; b} is open pave the river «8r» (ris.2.41) - deliberately cutting off the excess part of the river "0-1" imaginary domain sheet folding. Divide the river itself with 8 elementary constituents width «r», and that's why.

2.41 Branch head unit open river "0-1"

Note that the upper surface of the side fields of block "C" - a straight line, and the lower boundary of the head unit is often changes direction. Consequently, without a transformation of the rivers during the docking unit is necessary.

The first layer of the river width «r» cover its surface two sharp-angled niches (ris.2.41). It makes no sense to change the trajectory of the rivers in the blocks "A" and "B '" in order to give the desired relief of its surface (easier to fill the void outside the river than to change the shape of the fields in the structure of the blocks). And so, with our river width «8r», transform the lower surface of the head unit in a straight line (Fig. 2.42 - 2.43). For convenience, we consider the transformation of the rivers in two separate areas (shown in Fig. 2.41).

2.42 Transformation of the head unit boundaries in a straight line (area "1" in Fig. 2.41)

Consider the domain of "1." Please note that after covering the width of the borders of the river «r», the subsequent increase in the rivers layer covering the surface of this part, will give us the desired effect - a straight line. In any stratification will always "step", as shown in Figure 2.42.1, a height equal to the value of the «r». To get rid of the steps we resort to some tricks 2.42.2 or 2.42.3. In the first case, the input we have the thickness of the river «2r», the output - «3r». * 22Na Figure 2.42.3 shows an example of the transformation of the system of the three rivers, through which the stream width «3r» input, becomes «4r» output.

22 * Such manipulations are often used in «Box Rleating", with the difference that there is change of direction of the rivers are produced at an angle of 90 degrees.

Variants of this transformation are many, and a sufficient number of "spare" their rivers limited only by your imagination. The remaining four rivers will be parallel layers expand the boundaries of the main unit, the lower boundary is a straight line, which is what we wanted.

Further analyze the region "2" (Fig. 2.43).

2.43 Transformation of the head unit boundaries in a straight line (the area "2" in Fig. 2.41)

We cover the surface of rivers sequentially, as shown in step 1-4, all niches are filled with sharp-angled, obtuse and all parallel to increase their value to layer thickness on the rivers. After coating the river in thickness «r» rid of angled niches (2.43.1), the rest of the boundary of the "2" parallel shift by an amount «r». We have in store with 6 single river width «r», and should be enough to transform the lower boundary of the main unit in a straight line. Obviously, a simple layering can not do, therefore, have to transform parts of the rivers. Give the option of such a transformation. To reduce the number of external start marshes due to the fact that the axis of symmetry, curves niches will mirror images of each other. This means that for a certain number of layers of rivers covering the bends, a moment will come when the side Orientation lines intersect themselves expelled swamp without changing the shape of rivers. In our example (ris.2.43.2), with rivers «4r» and «r» we get rid of the first two niches.

As a result, we have in store only one single river width «r», and we have to fill it rather massive blunt swamp depth «2r». To transform this river, as shown in Figure 2.43.3. Having started the river this way, we are left with a small acute-angled hole (dark sector ris.2.43.4). This hole can cover the entire width of a river «r», which is quite acceptable, as in the subsequent docking blocks at our disposal will be as much as «11r» - more than enough for this manipulation. Continuing docking blocks 'B' "," A "and" C ", you must consider the fact that a small acute-angled niche must be available to fill the river. In our case, this may contribute to the shape of the field allocated for the front legs. Blocks can now join freely and without additional conversions. 4) Fold «D»

2.44 Leaf «D»

According wood shutters, for a pattern we should dock the three fields, two complex (back legs), bottom (tail) and surround it with the river «11r» (trunk). However, as is the case with the block "C", it is better to cut off part of the river, is not involved in the design, separating blocks wide open river «11r». This will help not only to separate the parts of the base form, but also to fill the gaps in the previous block "C". It is this river we expected to fill a small sharp-bog at the bottom center of the boundary (ris.2.43.4).

Please note that the proportions of the front (the block "C") and rear (block «D») feet of the same, that is, the composition and sequence of fields and rivers, forming these doors, you can choose the same. We did just that, having carried out docking unit "AV'S" and fan leaf Block «D» with open river «11r» (ris.2.45).

2.45 Docking units "C" and «D»

Take one layer «r» of «11r» our river to cover the surface of a small swamp an acute unit "C" (ris.2.43.4). The remaining «10r» can be directed, as shown in Figure 2.45.1 (dark area) to the lower boundary was a straight line (suitable for docking) (ris.2.45.2).

Next sostykuem remaining area of the tree valves (rear legs and tail). The lower boundary of the river «11r» - a straight line, so, too, Abutting the border should be straight. Arrange field hind legs straight under the front - this will help keep the orientation of the connectors. In this case, the center bottom of the swamp formed (ris.2.46.1). We get rid of him, when we define the boundary of the folding put it square on the entire project area (black dashed line), keeping the length of the valves (ris.2.9).

2.46 The choice of folding and cutting off the 'excess' pattern

As a result of applying the least square area on the abutting blocks, we are left with one empty niche. From it have to do long tail «2r». We could, as before, let the width of the river «2r», it fills the outer marsh, or use the nearby rivers. But the simpler way.

If we cover the inside of the niche width of the river «1r», is a triangular field of width «4r» (ris.2.46.2), which can turn our door after the usual bisection. This will not cause problems, as she lies on the border leaf sheet. As a result, the final pattern, after excluding extra lines * 23vyglyadit well (Figure 2.47).

2.47 The final pattern model

Lines can be excluded in order to increase the width of some of the flaps. In this case, the legs, the body and the muzzle.

MIX PLEATING

With the deepening of the study of BP and HP techniques, the designer, along with the accumulation of experience, new, bold ideas. There comes a time when resources limited specificity of these techniques, it is not enough to implement their plans. Then the inevitable question: "Is it possible to generalize the linear method in a single integrated system, in which there will be a strict dependence on the design of the trajectory of the rivers?". Imagine how you can extend the range of techniques in the construction of the structure of the pattern, if it was not a "conditional" limiting the angles of rotation of the rivers, as in HP and BP. Choosing arbitrary trajectory river, you can get absolutely any form of basic fields. This capability opens up enormous prospects to create flaps model, pre-defined shape. The task of the rational use of paper material central to linear techniques can be solved very efficiently. Indeed, look at Figure 3.1.

3.1 Dependence of the area right on the length of the base field selected leaf

Figure 3.1 shows examples of both wings of the same length «r», you can use less paper material, increasing the number of sides («n») correctly described the figure. Here «Sn» - an area described by n-gon. At the same gate length field is the largest area of a triangular shape, then a square, and so on. By the way, this is another confirmation of the fact that with all the convenience «Box Pleating» - one of the most wasteful methods, but we have already talked about earlier. These are the prerequisites for a method "MIX Pleating». MR algorithm design is different from other linear algorithms, because the "framework" that serve as starting points for BP and HP in this methodology no. So, the solution is joining fields requires a different approach. Those constructs that are used automatically, based on the terms of orientation of the rivers, now will be the result of some checks.

"MIX Pleating» - a new and still evolving methodology. However, some elements of MR are quite common on the patterns of modern origami masters. Similarly origamisty used element known as Elias Stretch, before the formation of BP. In this area, a lot of origami "white spots" and opportunities for research, so MR can provide "food" for thought innovators and discoverers of new horizons.

The name "MIX Pleating» is not accidental. The combination of these two words, conveys the essence of techniques, like «Box» or «Hex» «Rleating." «Mix» indicates that the pattern is projectedthrough the use of arbitrary elements. Their choice will depend on your creative ideas. «Pleating» - says that the method is linear, that is, the design is carried out using the entire set of trunks required to form the structure of the model, which form when putting some analog "bunching". Having considered the principles of design in an MC, we finish the study of linear methods. In the following chapters, we will explore techniques and simplified decorations. In part, they may be developed without knowledge of the underlying MR, but many important issues will be available only after the development of the information provided in this part. It may seem a little complicated, because of some deeper into the mathematical aspects of the transformation of the plane. Do not give up, you can do it! One thing for sure: good sorting out the MP, you can design if not "all", then - "almost all", with pre-planned structure (Photo 3.2 shows two MR model).

3.2 MP model

Certainly, «Mix Pleating» will be useful to writers who avoid "wasting time" in design. Not necessarily the same to change the whole structure of the pattern, sometimes enough to transform the border of the fields, which would make the valves model the desired form. But, you still need to know how to do it. Having mastered the basics, even the most hard-line fans BP can find many useful MP - receptions. Indeed, sometimes it is simply necessary to unload the structure of some leaf, or even entire blocks. Of course, this is not a simple model, but the gain would be quite noticeable when working with complex tree leaf, for example, like the figure of a deer in the previous chapter. If you do not hold a competent optimization when building such models can cause serious problems. In such cases, knowledge «Mix Pleating» in experienced hands will make a long and tedious work in a pleasant pastime. Let's start with the familiar «Mix Pleating» and, by analogy with the previous chapter on BP and HP, consider the basic concepts and techniques of their properties.

RIVERS AND FIELD «MIX PLEATING»

Elementary component in «Mix Pleating», as in other linear algorithms, a common river, only the free movement trajectory. Rivers in MP are no different from the rivers in the other methods. They serve to form the valves, eliminating wetlands and separating elements pattern of each other. The practical nature of MR river does not change at all, what we have learned about the properties of the rivers before other linear techniques that apply now. Similarly, the MP-river are some freely convertible paper strips. If you cut a strip out of the area of folding and fold along the trunk, then the result will also be a paper accordion height equal to the width of the river - the distance between the parallel side edges (Fig. 3.3).

MR 3.3 Broken River the same width

These edges are called the banks of the river and then they are going to fold in two points. Figure 3.3 black lines merge into the white dot, the gray line - in the gray point. MR river can be closed and open. Located within the closed area of folding-open the border. When the inside of the field takes only one river or no, it has a field called simple when Several rivers - the compound (complex). Turns are made according to the image of the surface of the docked. As in HP and BP, the rotation by 180 degrees is at least two stages (Fig. 3.4), the maximum number of steps is unlimited.

3.4 Turning the MR River at 180 degrees

The figure shows a 180 ° turn in two consecutive steps: first to ĐAO (ris.3.4.1), then at ĐVO (ris.3.4.2a), that is, ĐA ĐV + = 180 degrees. Please note that the angle between two adjacent lines Orientation equals 90 ° (ris.3.4.2b). This aspect is often helpful in the design. For example, when you want to start up the river "snake" to fill in gaps or change the shape of the field. Moreover, thanks to this orientation of lines, it is possible to use the "diamond-shaped grid" in MP, but more on that later. In general, when you turn the river into two parts by an angle = ĐSO ĐAO ĐVO +, the angle between the lines is equal Orientation ĐSO / 2 (Figure 3.5) * .24

3.5 Turning the MR River

* BP is often used in between turn 90 °, ie the angle between the lines ĐSo Orientation is always 45 °.

If a field has an internal bank just a point, and external - a convex shape, then these fields, as well as in all linear technique called base (Figure 3.6).

3.6 Basic MR field

The base of the field appears arbitrary figure, which you can inscribe a circle of all parties. The flap will have a length equal to the radius of the inscribed circle, the vertex door will coincide with its center. As in the methods BP and HP:

   - Connecting lines are directed perpendicular to the sides of the field and are recorded, the line passing through the Orientation;

   - Rivers, within the structure of the field, can alter its trajectory.

However, the MP transformation movement of the rivers can be anything you like, and compared to other linear methods, gives you much more freedom to manipulate. Figure 3.7 shows an example of two identical (in length formed wings) fields, only in the first case, all the layers move parallel to the river, and the second is constantly changing direction. Thus, in the area abutting MP lead to the desired form. It should be noted that the design is better to use a correct description of figures - this will facilitate the transfer of Orientation lines in the area of folding.

3.7 Two simple MR field, forming the flap of equal length

LINE MR-FOLDS

In «Mix Pleating» used Orientation (ris.3.8.1) and connectors (ris.3.8.2). The first type of line is used to change the shape of the fields by changing the trajectory of the rivers. With the second line type

adjustable thickness flaps and pattern elements are docked together. That is, the lines of the folds in the MC have the same functions as in the BP and HP, but that's to build themselves trunks more complicated. In particular, due to the fact that, in general, for there is no fixed MRI unit grid, except for special cases.

3.8 Orientation and trunks MR field

Despite the arbitrary choice of the form of the field-polygon outer coast will gather along the bottom of the doors, leaving the inside of the structure of an accordion trunks. Obviously, this provision is valid only if the entire field is within the fold.

MP-going field, along the trunk so (ris.3.9).

3.9 Assembling the base-field MR

Unfortunately, the distance between adjacent connecting lines in the IR may not always be constant. It is often necessary or "sacrifice" precision proportions, or to make additional payments. It all depends on the type of the selected fields and ways of joining. Therefore, the creation of the assembly diagrams «Mix Pleating» models very problematic (only exception is based on some individual grids: the diamond-shaped and combined), but the patterns are added as standard and simple. Process significantly easier if shifting the center field in the coordinates, even when it comes to non-uniform fields (simple field consisting of several rivers). The assembly of these fields is similar (ris.3.10). Please note, as an inhomogeneous field, consisting of a base field and the river formed a flap length L = R + r, that is, increase the length of the river wing «r» the value of «R». Similarly, in the previous sections of the river changed in HP and BP fields, with the difference that the change in direction of the river were made at fixed angles.

3.10 Orientation and trunks MR field

In the same way going and complex field: first-line curves are outlined in each simple field separately, and then, depending on the orientation of the lines themselves are created and leaf blocks. Add elements of the base should be from the center to the border, it will consistently create centers of fields, fixing them in the intermediate stages, which will undoubtedly affect the cleanliness of the valves. That is, you must first establish some central-fold zipper to refer to all nodes, and then use them to build and other sections pattern. Otherwise, you can get in a very disadvantageous position when necessary to control the assembly once all the valves at the same time, which often leads to the collapse of the building and damaged paper. Moreover, it is not necessary to train yourself to bad, even if the model is not very complicated. Subsequently, when a sequence of actions will be executed automatically, even the assembly neberuschihsya patterns become commonplace.

LENGTH MR VALVES

Besides the standard way to transform the structures within the scope of the assembly (ris.3.7), the length of MR valves are often adjusted by changing the position of the fieldsconcerning the boundaries of the sheet. So you can not only change the length of the leaf, and give it the desired properties, while minimizing the amount of paper material.

Figure 3.11 shows the eight fields that form the leaf of the same length (except for the "2" and "5"), as the total width of the river for each figure is the same (ris.3.11).

3.11 Location MR fields relative to the sheet border

Despite the fact that all the pieces must be in the same leaf, in some cases, the border of the sheet reduced their length. It depends on where the center of the field - a point coincident with the top flaps after folding. In the case where the center of the field is in the range of leaf area (item 1, 3,4,6,7,8) - gate length is preserved. If the center of the field is located outside of the sheet (item 2 and item 5), the length of the resulting flap is the greatest width of the river within the area of folding, that is, the distance "a" and "b" respectively. It should be noted that some of the fields (item 1, 2,5,6,8) is outside the fold. In such cases, part of the field, which is located on the border of the square will change its appearance, but not affect the overall length valves. It occurs in all linear algorithm design as well as the connecting lines that cross the side of the field, parallel to each other. That is, on the border with the plane of the sheet surface of the valves change its visual appearance. Examples of these changes are described in the first chapter (ris.1.22). Such transformations field borders can be used to create models with frequent change of color on the surface of the body (tigers, zebras, coral fish, etc.).

DOCKING MP-CELL

Rules are the same for all docking techniques, and MR is no exception. Should also continue the direction and orientation of the trunk, as well field valves, located on the same level of the valves, a common touch surfaces or each other on the perimeter, etc. However, in contrast to other techniques, MRI is primarily used by serial docking elements, though of course it all depends on the situation. Basically, this is due to common problems that occur with the elimination of internal wetlands, especially for complex models. On the one hand, it allows you to choose any shape in the design field, but on the other - is increasing the time spent on the creation of the Wed Let us "consistent" and "block" means joining more.

MR DOCKING SERIAL CELL

As an example, we study already known to us from the first chapters of wood shutters (ris.1.10).

Thus, the two wings of the fan separated shoulder «r», and so on pattern side blocks will separate the river, having a width «r» and stores it on the whole trajectory. Based on the parameters specified in the tree leaf, you need to determine the form fields, and their arrangement. Of course, the docking of the field can be placed arbitrarily, but you should always remember the rule: in center field and at the interface of backsight lines are connecting lines. This will ensure their continuity and provide an opportunity to lay down the final pattern on a flat base.

Here is an example of an arbitrary arrangement of fields for our wood shutters without the structure of the trunk is not closed by the river. Of course, the concept of a closed and closed MR rivers exist solely for the conditions on the plane of the sheet. But do not forget, what about the boundaries which form of the fold-open MR River also retain their properties, but already have a slightly different form. In general, here is one possible a pattern for that tree leaf, where the fields selected in an arbitrary figure described (ris.3.12).

3.12 Docking MP-fields and MR River

Planning session by the standard model elements. The fields are joined to one another in turn, in accordance with the tree leaves. Pay attention to the non-convex shape of the field - in their structure, they are nothing new. Their structure is not uniform, but keep the width of the resulting river throughout its trajectory and equal «r». This maneuver is often used in MRI to make items easy to dock species. Running a little ahead, we note that the formation of MP units in two stages. First, create a board, as in the BP and HP, and then begin to transform the field in such a way that limits the joint had a minimal number of bends or better were not at all. In this case, as a result of this manipulation of the river "0-1" to gather in knots "0" and "1" in the basic form (ris.3.12.2). The figure shows the connection option fields, in which all the vertices will have the same orientation with respect to the plane of the sheet (ris.3.12.3). This means that if, for folding the two-color paper is used, all the doors will be painted in a single color. Folding is standard, given the fact that the neighboring connectors have a different orientation bending (ris.3.13).

3.13 Assembling the base form

During folding, we have a base form that satisfies the selected tree leaves. Before us was not the task of controlling the thickness of the leaf, so the distance between the neighboring trunks arbitrary, only taking into account Orientation guides in the selected fields. Of course, most of the lines can be excluded from the image of the pattern. Moreover, it is recommended to do so by leaving a minimum trunk during docking fields. But in this case, in addition to creating the same orientation with respect to the plane of the leaf sheet, shown as an arbitrary distribution of fields, you can use a different spacing between the connecting lines in different so-called Orientation sectors. Orientation sector - this part of the field bounded by the perpendicular from the center to the adjacent side and the edge of the field, they conclude (ris.3.14.1). Orientation notion sector plays a very important role in the design, so should be explained separately. The fact that the thickness of some of the valves should not decrease, but rather do more.For example, the figure of a deer, discussed in the previous chapter: the horns of one thickness, legs another, etc. For this it is necessary in certain areas to change the distance between the adjacent connecting lines. So, in order to realize these objectives, will help the knowledge of Orientation sectors.

The main parameter Orientation sector is its width, it is equal to the distance from the base of the perpendicular from the center to the corner of the field. According to the structure, Orientation sector symmetric about backsight line, that is within the sector, the distance between the input trunks equal to the distance to the exit (Fig. 3.14).

3.14 Orientation sector

Please note that if the joined fields Orientation sector form a closed system (white areas ris.3.14.2), the distance between the connecting lines within it can be chosen arbitrarily, or you can delete the line altogether. Note that the closed sector Orientation form the basis for the design of such techniques as «circle-packing» and «sectoral 22.5". Since this book is devoted to the study of linear methods, we will focus only on the basic principles of using Orientation sectors in MP. Sector technique is quite detailed in his book American master origami Robert Lang «Origami Design Secret».

Consider the construction of a pattern on wood shutters (ris.3.15).

3.15 Sector MR units

Adding the sector unit - a system of sectors (ris.3.15.1), consisting of the 4 sectors, and open the river, we obtain the tree leaves. If consistently surround his layers (ris.3.15.2) to the width of «L», then the lengths of all the wings of the tree will increase the value of «L», and the width of the river open will remain unchanged. Thus, adjusting the power sector under the original system and connective Orientation lines, we can obtain the necessary configuration of fields and rivers. Sector blocks also can be placed side by side, without any intermediate layers. In this case, the river will seamlessly into each other (Figure 3.16), and outside again to join or form a new field.

3.16 Docking sector units

May initially have some problems to shift from sector-blocks on the fields and the river because the design has to look at all the other. But with experience, because develop skills, you can easily combine techniques and unload items pattern. Considering the properties of sector units, it is worth mentioning the altitude valve. The fact that the addition of a sector unit when it is not divided into layers, will rise above the general plane of the base. In case (ris.3.17), its maximum height is equal to the maximum radius of the circle inscribed in the sector block, and the outer loop will be determined by leaf backsight lines. So, for example, sector block, shown above, after the assembly will look like.

3.17 Assembling the altitude valve

With such high-rise wings, easy to convert some parts of the model. For example, combining two sector boundary blocks in a linear structure, you can then deploy them along the dock, getting from one side - the figure of the desired shape, and with another - pleating-marketing connection. Similarly, you can get any, pre-planned surface of the base form, dividing the model into adjacent high-rise wing. Returning to the dock MR elements, let's deal with the manner in which the distance between the controlled trunks. For BP and HP, everything was very simple, it was enough to keep the design with respect to one or two isolated grids, respectively, and all the elements themselves to fall into place. In LL more complicated than that, because the form fields are not pre-specified, but because there is no universal single grids, except for special cases of simple diamond-shaped and more complex combined grids. Of course, you can not even use the grid on the similarity (ris.3.12), but it is too inconvenient in practical terms - when folded. How can that be? In this formulation, the question is necessary to find something in common that brings together all types of fields, regardless of their form. Fortunately, the answer is very simple - it is itself selected thickness of the valves.

Explain in more detail. If the design process to apply a variable grid, constantly changes its orientation during the docking of new fields, the need for stationary grid partially disappear. That is, if we build a new field or a complex unit, with respect only to continue the previous trunk, the entire region forms Abutting proper linear structure, in which the distance between the connecting lines all the same. For example, we carry out docking randomly selected fields (ris.3.18) and consider the position of their centers during docking. It all starts with the fact that the first field «R1» arbitrarily applied in any part of the design (ris.3.18.1).

3.18 Docking MR fields

To dock the next MR-center field «R2» and preserve the distance between adjacent connecting lines, you need to center the new field was on one of them (ris.3.18.1.) * Next, hold the tangents through the points of intersection of the connecting lines and the boundaries of the field on the circle. As a result, restoring perpendiculars, we get the field itself «R2» (ris.3.18.2). To get the center «R3» can select arbitrary locations on the continuation of the trunk or at their intersection (ris.3.18.2). It should be noted that this can not adjust the length of the valves, unless you use way to expand the MR field at a fixed point. This technique will be described in detail in the practical part of the chapter, and let's leave it at that. As a result, we performed transactions resulting pattern (ris.3.18.3). The obvious question is: "How can dock MR fields using improvised?" (Photo 3.19)

* First, select the line "grid" on which we want to place the center of the circle and put off the value of «R2», the result is a center connectivity field.

3.19 The use of a variable grid template for joining MP-fields

To start, you need to select the thickness of a single leaf and make a pattern of parallel and perpendicular to the strips they base (3.19.1). The distance between the lines should be equal to the thickness of the selected leaf. For further constructions need: compass, ruler, pencil, tracing paper

 - Choose the width of the initial field (3.19.2), its form (3.19.3) and spend all trunks with shablona26 (3.19.1);

 - Puts a template for drawing so that the side of the figure coincides with the perpendicular line pattern, and one of the connecting lines passed through the center of the field;

* The initial MRI field can act described arbitrary figure, in the case of 3.19 - a pentagon;

 - With a stock draw out the connecting lines with a pencil;

- We perform the same operation on all sides (3.19.4), we get the final pattern of the original field;

- Butted another field *, 27

 - Draw a circle with a radius equal to the length of the leaf (3.19.5);

 - Restoring trunks - first for one side and then to the whole connectivity field (3.19.6). Docking fields completed.

When docking the following fields or even entire blocks of manipulation in the same manner. Given the fact that every single unit to get better on its own layer of tracing paper with the individual networks.

MR DOCKING BLOCK ELEMENTS

Modular docking MR elements in pure form (any form fields, eliminating wetlands) is quite rare. The exception is the docking configurations, based on different individual meshes. The main reason is the complexity of the elimination of wetlands that occur during MR design. So when it comes to modular docking elements directly before connecting blocks is required to bring them to the easy coast to

mate mind. Consider block MR-docking by the example of the tree valves (ris.1.10), dividing it into blocks (ris.1.15). For this part of the bloc "A" proportions and choose the thickness of the valves (ris.3.20).

3.20 Building Block "A"

To start connect three basic MR-field along the boundaries (ris.3.20.1) * 28I will send the river width «r» around the resulting field in accordance with the tree leaves. In its pure form, the block will look like Figure 3.20.2.

27 * If the form field is fixed, the pattern can be done on a template-tracing and dock with the original, focusing on the continuity of the connecting lines. If the form fields are not defined, and is known only to the length of the doors, the first thing you need to select a connector, located on the center of her field of connectivity and delay gate length.

Now it is necessary to transform the boundary part of the river to expand the boundaries of the surface for subsequent joining. Will join the block "B" from the top, because we want to change the top of the outer bank of the "0-1" (Figure 3.20.3). * 29

Let us continue to block «B». The fan consists of three identical wings, so join three fields width «r» and present it to the lower boundary of the rectilinear form (to facilitate the docking unit) (Fig. 3.21).

3.21 Docking MR units

Field unit "B" prepared by the same grid as the fields of block "A". Consequently, both the field of complex join with the integrity of the trunk enough to combine them along the borders (ris.3.21.1). Thus, by the combination of elements, the pattern will have the form shown in Figure 3.21.2.

It is easy to see that such compounds MR elements are not necessarily used throughout the design process. Those who prefer to BP or HP may use such forms fields and dock them only on the boundary of the sheet on the continuation of the connecting lines. In this case, you can save some of the paper to build and to use as a reference unit mesh BP or HP. For example, in the previous chapter, we saw the way you get overlays *** v30NR and BP (ris.2.21). So, using the MR field, you can get quite a similar configuration, adapted both for BP (ris.3.22.1), and any other structure (ris.3.22.2).

* It is necessary to get the fans on the edge of the leaf block "A".

** Place, the distance between the connecting lines may be different if the point of intersection of lines Orientation they do not own. Such areas should be given special attention, trying to reduce their number to a minimum.

*** definition, see "Flat mosaic."

3.22 Getting overlaps with MR elements

Later, when studying the mosaics and share them with linear techniques, you can enjoy the benefits of such configurations. Here I want to mention such advantages as material savings to build and use a variety of forms. Of course, during the docking field MRI may be other problems that we have not described earlier. However, to describe the ways to overcome them we will have to consider much

more complex MR elements, but a little later - in the practical part of the chapter, on the model of "Butterfly."

Rhomboid UNIQUE MR NETS

As mentioned earlier, the MR is sometimes possible to use single rhomboid mesh nets than HP and BP. They are as follows (ris.3.23).

3.23 MR rhomboid grid

Figure 3.23 shows a diamond-shaped MR-grid, made up of the same diamond-shaped cells. Just as in the other methods (BP and HP), there is a need for the introduction of a parameter against which to place the choice of individual fields. In this case, this parameter is the angle of orientation of the grid «a» (ris.3.23.1) - lower corner of the cell. Thus, based on the properties of the diamond, the diagonals will always cross at right angles: AOB = SUN = 90 ° (ris.3.23.2).

What gives us the possibility of such a grid? Obviously, we can build on it selected configuration fields and rivers, depending on pre-selected tree leaf, similar to the unit mesh BP. Indeed, look at the diamond-shaped field MR ABCD in Figure 3.23.2. If we look at the structure, then we see a kind of a closed river, carrying out the total 360 ° rotation about the center of «O». All the individual rotations are carried out in a single operation, passing through the diagonal of the diamond, which are also the bisectors of angles. If we complicate the configuration of the river by directing more complex trajectories, basically nothing changes. In any case, the river will make turns, passing through the adjacent Orientation perpendicular line - as shown in Figure 3.4.

At first glance, the design with diamond-shaped mesh is incredibly simple - the junction elements, as in BP, "not calluses hands", but adds up. However, doing the rivers and their trajectories, we completely forgot about the trunks, which remain orthogonal to the borders of the rivers. If «a» = 90 ° (BP), then of course, no problem - they coincide with the grid, but in general it is not. In MP angle «a» may be quite different.

In Figure 3.23.2 trunks will coincide with straight "OE" and "º F", passing through the nodes «E» and «F» perpendicular to the grid lines. The angle of orientation (Figure 3.23.1) is not direct, «a» = arccos (1/3). In order to get the connectors, there is a way, as we have used previously in HP - to introduce a separate grid connection.

In general, the orientation angle of «a» is:

a = arccos (a / b) (1)

where «a» <«b» * 31 (lateral displacements) - parameters characterizing the position of the trunk relative to the lines of the original backsight grid (Figure 3.24.1).

31 * For a grid of BP and HP grid orientation angles can be calculated similarly. If a = 0, a = 90 ° - is BP-grid, for HP-grid: a = 1, b = 2, a = 60 °.

3.24 The choice of the orientation angle diamond mesh

In fact, after the distribution of the fields on the diamond mesh design is very similar to HP. In both cases it will be convenient to use the two networks - one for rivers (ris.3.24.2) and one rotated by 90

degrees to the trunk (ris.3.24.3). In both cases, the grid Orientation and connection have a different step, which can be numerically calculated by the formula (2).

$$\sqrt{} \quad (2)$$

Here all the elements except the Y (n) - a step grid connection are set before the project:

- "A" and «b» - lateral displacement of the trunk;

- «X (k)» - selected step backsight grid;

- «K» and «n» - the mesh size reduction factors, backsight and connective respectively.

That is, you choose a value of lateral displacement - calculated orientation angle grid «a». Then, with the selected step "X (k)" built itself Orientation grid. Then choose the coefficients decrease step («k» and «n») concerning a single diamond-shaped field (Fig. 3.25) and the calculated step connecting the grid.

3.25 Choice of mesh size reduction: «k» and «n»

The value of «k» - natural number equal to the number of steps in the length of the grid backsight single leaf. This value is sometimes more convenient to select different from unity - for the convenience of the design, due to some specific features of grids (Figure 3.25.1 «k» = 2).

The value of «n» (also an integer) - a value which characterizes the thickness of the final leaf and is the number of divisions, which we want to share the maximum pitch coupling grid «Y» (Fig. 3.25.2 «n» = 4).

In addition, Figure 3.25 shows another important parameter: «N» - the number of divisions of a single side of the field (on ris.3.25.1 «N» = 5). Calculated «N» follows (3):

(3)

From this equation (3) follow the restrictions imposed on the values of «n», «a», «b» in the design. Namely, «N» - must be an integer, that is, «2bn» must be divisible by «ba» without a trace! Otherwise, the range of rivers in such a grid significantly reduced.

Please note that if «k» = 1 and «n» = 1, the design will be carried out on grids as possible step. So for example:

For the grid-3.24.3: «n» = 1, «k» = 1, «a» = 3, «b» = 2, so Y = 0,447 X;

HP-to-grid: «n» = 1, «k» = 1, "a" = 1, «b» = 2, where Y = 0,577 X, which is what we used in the previous chapter. * 32

As with any technique, the design with diamond mesh has its range of applicability. If we consider the use of the grid for the design of the model completely, in terms of spent material transfer of the grid lines, the time for calculation and subsequent assembly, design for BP sometimes seems more advantageous. However, the use of diamond-mesh as an aid, to get some pie MR elements or even entire MRI units, often just a "vital" and incredibly effective for future connections. That only is one highly sought-after, the "standard" situation where some of the pattern you want to create a

structure of multiple wings, separated by some distance - it could be foot arthropods, leaves on a branch, needles hedgehog etc. On the diamond grid, this object is very elegant, with a minimum of effort (Figure 3.26.1).

 * Note that the HP-grid - a special case of grid MP, with the angle of orientation of the «a» = 60 °, which due to some structural features of the cell has the ability to add another degree of freedom of the field (more on that a bit later.)

Item 3.26, built on a diamond grid

In appearance resulting pattern in Figure 3.26.2 is very similar to a set of VR-sectors, and develops just as easy. However, the build will differ markedly from thatsame block, made in BP on wood shutters, depicted in the upper part (Fig. 3.26). In BP-block all the doors will come out of a single point. Naturally, this element is the sector structure, and in order to give it the edge of the line, will have a little "pokoldovat" over Orientation lines. But the result is worth it, especially since received MRI units can join as ordinary MRI field: even at the edge of the sheet (Figure 3.27.1), though wholly within the design (Figure 3.27.2).

3.27 MP-blocks based on diamond mesh

As you can see, adding the fields completely mediocre structure extensions, we got quite a nifty combination of rivers (Figure 3.27). MR unit on

Figure 3.27.1 in its composition is quite suitable for the formation of, for example, the forelegs mantis. Folding unit 3.27.2, we can get a head on it and refine the hair and facial features.

Using a diamond mesh with MR design mainly involves auxiliary. Would still like to know of these elements can greatly simplify the complex blocks. It is also important to note that the docking MR elements in blocks on a diamond grid is very simple, much like BP, except for the small nuances. Thus, the pattern tree (Figure 1.10) can be made from diamond-MR fields (Fig. 3.28), without much structure transformation (Figure 3.20.3).

Docking 3.28 blocks per diamond grid

Design and docking units on diamond grid is as follows:

- Selects the input parameters {k; n; a; b} (Fig. 3.28: «k» = 2, «n» = 1, "a" = 1 and «b» = 3). These values are substituted into the formula (3) and (1) to obtain a «N» and «a» (Figure 3.28: «N» = 3 and «a» = 70,53 O).

- Orientation grid construction, according to the selected step X (k) and the formation of blocks (ris.3.28.1-3.28.2), in accordance with a tree leaf model * .33

- Calculated step connective grid Y (n) by (2) (Figure 3.28: Y (n) = 1,414 X (k)).

After this, the direct coupling of blocks as ordinary fields, along the lines connecting the grid. Thus, in the figure (Figure 3.28.3) blocks

33 * In this case, we have saved a selected set of wings, similar to that shown in Fig. 1.15.

"A" and "B" are joined in such a way that the top of the final block was a direct line * .34 It will easily connect any combination of arbitrary MR fields, regardless of the internal structure of the block. As a result of docking blocks we get the next pattern (Figure 3.29.1).

3.29 Final patterns for wood shutters 01.10

In fact, in a general way to the design of a diamond grid to add nothing more. What follows, as in the other methods, to limit the result area of folding, and the pattern is ready to use ** .35 It may, however, let's look at a simple example (Figure 3.29.2). Here we see that the docking unit is feasible, if one of the units to reflect vertically. This is possible thanks to the fact that the items were based on a grid with the same pitch. At first glance - nothing special here, especially as we have already seen docking arbitrary MR elements. However, on closer analysis, this particular case presents us with a number of very interesting technical perspectives.

First, it is a reflection of the grid along the borders of the field, you can create symmetrical configuration with respect to the folding area (midline or diagonal of the square). Second, is the ability to use different altogether Orientation grid design. In particular, reflected the grid is very easy to adapt to design insect with many legs, and multiple screens at the same time allows to diversify the range of basic fields.

If reflection backsight grid along the block boundaries, in principle, should not cause trouble - witness the reflection of the design of symmetrical halves in BP or HP (see "1" and

* In practice, Orientation and grid connection are made separately in two patterns, similar to HP, with only pre-selected parameters.

If you limit ** MR design within one diamond mesh, it is recommended to have the cell axes parallel to the axis of symmetry of the sheet

"2"). Is the joint use of different networks, may have questions. So, what will it take? (Figure 3.30)

3.30 Sharing of various individual networks

1) Choose arbitrary Orientation grid with the selected values of lateral displacement («a» and «b»). It can be as diamond mesh, mesh and HP (ris.3.30 - lower).

2) To coordinate grid in the parameter Y (n):

$Y_1 (n_1) = Y_2 (n_2) = ... = Y_h (N_x)$ (4)

This will require the following:

- Select one mesh and calculate its value to Y (n) by the formula (2);

- To do the reverse operation and calculate $X_i (k)$ (equation (2)), for all other nets;

- The templates of all networks (for example, tracing paper - in the same way as described in the second chapter).

3) docked templates (Figure 3.30.1), with the lines connecting grids (Figure 3.30.2).

4) Divide the tree leaf on the blocks, given that each unit has its own wings designed mesh * .36

5) Perform the design and move the line to a separate list (see Figure 3.31)

 * If the dock mirror network, then this is not required, and the river can be reflected along the common border

Note (Figure 3.30.1-top area «W»), that the docking grids can be formed swamps, from which it is necessary to get rid of. For example, you can turn the swamp into the fields, as shown in Figure 3.31.

3.31 Joint design for different grids

Naturally, the design should take into account that, for various lengths of single leaf nets are different, but because the structure of the model should be reviewed in advance. It may be sufficient to use only reflected the net. This effects the elapsed time by eliminating the need for making templates of other nets.

It is important to note that the diamond grid can be obtained not only diamond-shaped field (Figure 3.32.1)

3.32 Changing the shape of a diamond-shaped field

As you probably guessed, the sharp angles of diamond-shaped field distribution of the material most rational. So, this problem can partly be solved by changing the trajectory of the rivers adjacent acute-angled sections. For this must be brought center field along a common axis (ris.3.32.2) to the maximum possible value at which point the "intersection" of the fields coincide with the node connecting the grid (Figure 3.32.3 - gray dot). In this case, for Orientation lines along which the border part of the river changes its direction, just enough to hold the bisector in rotation angles (ris.3.32.3) before crossing. In such a mating elements must be met only requirement - the approach of diamonds to make a point of intersection of the bisectors (Figure 3.32 black point) did not go for the center of the field (Figure 3.32 white dot). Of course, the "intersection" of the diamond-shaped fields and possibly beyond the common axis (Figure 3.33.1). However, in this case, we have to control the coincidence of nodes connecting the grid and at the same time all! points where the line changed direction Orientation (ris.3.33 gray and black).

3.33 Changing the shape of a diamond-shaped field

If you do not, be broken pleating-EW structure of the model element. And because these units should assemble in advance, preferably in a template, so you easily could use it in conjunction with the main grid. In pure form, this transformation is an extension of MR-field at a fixed point, but more on that later.

Before proceeding to the practical part, we consider another area of application of diamond-shaped grids. Specifically, the construction of individual grids for combined linear techniques.

UNIQUE COMBINATION SCREEN

With an amazing, almost a new line of origami, it is possible to arbitrarily increase the degree of freedom used fields. Not to mention it would be wrong, given the

that basic field techniques have combined linear structure of the underlying MR fields, as their species. Although, the very essence combined algorithms goes far beyond the basics covered in this book, we consider some special cases, which can easily be used to create MRI units each.

As you already know, with diamond-shaped grids can build rectangular field, which through adjacent Orientation sector is different integer trunks. It is sufficient to calculate the orientation angle, lateral displacement of the parameters «a» and «b» (Formula 1). So, with a few diamond-shaped grids can be combined so-called grid.

Combined single grid - these are single grid with which to lead the design, using the wrong described basic fields (Figure 3.34).

3.34 Examples of combined grids

The figure shows the combined grid with different degrees of freedom «i». * 37Ih there is an infinite set of various shapes and external characteristics. Analyzing in detail the topic, recently seem complex and innovative HP and BP are starting to look more "a little bit poor." Limitless variety of linear methods built on the combined grid is simply mesmerizing. In addition to the incredible optimization capabilities that are brought before the designer, there is a possibility of arbitrary MR units, any pre-selected structure. Working with combined grids exciting venture for the design of a truly unique models created in linear methods that previously no one has ever used it. Unfortunately, all the charms of the combined networks will enjoy aorigamisty mathematicians, because they work very often requires in-depth knowledge of mathematical analysis. But, nevertheless, some private features and nuances will be useful to all, as

 * The degree of freedom of the grid «i» - the value describing the number of base fields that are used in the design. It is equal to the largest number of base field lines within a single mesh. For HP-grid «i» = 6 for diamond «i» = 4.

their knowledge will receive no extra payment extra degree of freedom of the diamond-shaped grids. Let us consider them in more detail. Combined grid formed by the rotation of several diamond-shaped grids of identical pitch around a common node. In this case, the shape of the future of the unit base field can be seen in the image of the intersection of unit cells (ris.3.35).

3.35 Preparation of single cells combined grids

As you know, in place addressing the various form of lozenges, forms a convex polygon, each of which can inscribe a circle. So, for effective combination grid requires the following important limitations.

Padiusy inscribed circles should be equal.

Which implies a necessary condition for further calculation of parameters of combined networks (5).

x1y1 = x2y2 = ... = xnyn = r2 (5)

where «xn» and «yn» - the width of adjacent sectors «n»-th rhombus (Figure 3.36), which is equal to the distance from the corners to the base of the perpendicular from the center of the inscribed circle («y»> «x»).

3.36 rhomboid base field

Pay attention to the new settings. In size, they are the width of the diamond-shaped sectors Orientation base field. If you choose the value to some integer, then we will be able to pass through the angular sector integer trunks. In this case, it will be possible to determine the orientation angle «a» of the required grid (6) without lateral displacement of the trunk «a» and «b», as we did before

* 38 a = 2arctg √ (6)

These parameters are chosen in advance and provide a framework for all the major elements of the combined fields. They are:

- Orientation angles of rhomboid cells in combined net;

- The width of all sectors of the field combined single grid.

Steps to get the orientation angles are usually not a problem. He made the final stages of creating a grid, just before the layout of individual diamond-shaped grids, and after selecting all the values «xn» and «yn», satisfying the requirements. The rub and mathematical uncertainty generated myriad hybrid linear techniques, lies in getting the width of each sector within a single combo box.

The problem lies in a very inconspicuous at first glance, the nuances of which we so easily avoided by earlier. Specifically, the design of the unit mesh side fields must cross the whole number of parallel strips "bunching". This point is directly connected with the search for integer solutions of various mathematical equations.

The work becomes much more complicated if the formation of the unit cell is carried rhomboid grid with different angles of orientation. In these situations, the simultaneous analysis of the group have put quite a massive mathematical equations, making such tasks more inheritance remained origamistov theorists. To the application of origami these situations have a "ghost" attitude, especially if the calculations are made for combined networks with a high degree of freedom.

In practice, the better to look for a solution, using a similar diamond-shaped configuration. Due to this limitation, greatly simplifies the calculation and analysis of the preparatory work. Although, of course, such private solutions exclude the full range of possible networks, but believe me - their number is already more than enough.

38 * In addition to calculating the value of «a», there is a good alternative for the construction of the diamond-shaped grids. In this case, the algorithm for their preparation is done in the reverse order: the values of «x» and «y», determined step connection, then with the {k; n} (Figure 3.25) is calculated step backsight grid.

Let us consider, in detail, the construction of a combined grid of hexagonal base field with two diamond-shaped grids (ris.3.37).

3.37 Getting hexagonal basic fields

In Figure 3.37.1 shows the case when both are diamond. The intersection - described hexagon symmetrical about the common perpendicular passing through the center of the inscribed circle (ris.3.37.1a).

Dark green represents the sector, the width of which is not known. Before proceeding it is necessary to calculate (7).

$z_1 = (7)$

As you can see, to see to it that would be the width of each sector was an integral value in this case - a piece of cake. Sufficient that the difference (y-x) was even (2,4, ..., 2n) .39 It now remains to calculate the angle of orientation of the diamond-shaped grid, and the preparatory work is completed.

Take, for example y = 5, x = 3:

- Calculate the width of the desired sector, (z_1): z_1 = (5-3) / 2 = 1;

- If z_1 - integer count of grid orientation angle «a» by (6), using the values "x" and "y". In this case the angle of «a» is equal to: a = 2arctg (0,774) = 75 O31 '

It now remains to make templates of two diamond-shaped mesh with the orientation angle «a», and when they overlap obtain the desired mesh (ris.3.38).

 * If the calculation results in a fractional value zn, then the situation is not critical. Just multiply both "x, y, z_1, ...,zn» on the value of the denominator, and the resulting numbers will satisfy the condition. So {x; y; z} = {3, 4, 0.5}, to be doubled - {6, 8, 1}.

3.38 Getting nets methodology HP {1, 3}

As you can see, the design of such a grid is similar to BP and HP. Based on the fact that the steps of both networks are: the river, the switch from one line to another diamond mesh, retain their integrity, like HP built connecting grid, rotated by 90 degrees and so on. There is little difference, except - Orientation Orientation lines (but here, I think there should be no problem: run the bisectors of the angles formed by the centers of the fields, and the rest of the line will make the most of the grid).

Please note that the technique (ris.3.38) on the grid signed HP {1, 3}. What does this mean? If we consider a single field (ris.3.38.2-dark), we can see that the sector boundary crossing or one of the bars, or three - hence the value of a brace (a subclass of the technique). "HP" - points to the class method and the shape of the unit base field («R» - rhombus, «H» - hexagon, «O» - octagon, «D» - decagon, «DD» - dodecagon, ..., «N» - n-gon). In general, a unit field techniques NP {zn; ...; z1} will look like (3.39 A single basic field techniques NP {zn; ...; z1}

If the values of «zi» repeated somewhere, then the brace is written once, and for convenience: z1 <z2 <... z (n-1) <zn.

Next, consider the case (ris.3.37.2). Basically, the situation is similar, with the only difference being that the more difficult to control the value of the integer «z1». This time, it now depends on four parameters {x1; x2; y1; y2} (8).

The problem is slightly more complicated, but it is still perfectly doable. It is enough to fix the values of "x1", "x2», «z1» (in the construction of a single field) and only then choose values «y1», «y2» in integers, so that all the elements satisfy the original equation.

Suppose we have chosen the values {x1; x2; z1} = {1, 2, 2}, then:

- Substitute these values into the formula (8): 2 = (u1u2 - 2) / (y1 + y2 +3);

- Express one unknown through another: y2 = 2 (y1 +4) / (y1 -2);

- We select an arbitrary integer solution: «y1» = 8, "y2" = 4;

- Calculate the angles of orientation grids (6): a1 = 2arctg (0,354) = 38 O56 '

a2 = 2arctg (0,707) = 70 O32 ';

Docking is similar 3.37.1, with two diamond-shaped grid pattern of equal steps (ris.3.40.1).

3.40 Getting nets methodology HP {1, 2}

Design will be produced at the intersection of the two lines along the grid (ris.3.40.2). Further explained this point would be superfluous: the terminology and sequence are the same as in the description of RP. True, the lines are a bit different, but do not worry - the same model will be enough, that would look into all the intricacies of technique.

As a result, turning the grid and change its pitch, to the structural pattern (ris.3.40.2), we obtain the following final pattern (Figure 3.41).

3.41 Preparation of the final pattern of the methodology HP {1, 2}

By the way, this grid (ris.3.40.1) can be obtained only by using two grids of the same type, such as RP {2, 4}. Although, in general, the composition of the grid will not depend on the two parameters, and three (for example, HP is {1, 2, 3}, which is obtained at the intersection of two grids RP {2, 3} ÇRP {3, 7} = {HP 1, 2, 3}).

As for the grid i = 8 (OP), the solution in the general form with only two networks - a task more laborious. Since there is a new option - the angle between the axes of the diamond b ¹ (a1 + a2) / 2, with a1 ¹ a2 (ris.3.42).

3.42 Receiving PR-structures

Despite the fact that this is an extremely interesting and exciting, from the point of view of origamista mathematician, for the practical application is not easy, with few exceptions. Between values that require simultaneous monitoring, there are very difficult addiction. This makes the task of finding integer solutions virtually impossible for origamista, far from the mathematical analysis. So, for example, a simpler version in Figure 3.42.2 («b> (a1 + a2) / 2") requires finding integer solutions of the equation (9), and then a separate calculation of «b»). * 40

The solution to it is not a simple one. Thus, there is a need to reduce the number of unknowns. This can be done by fixing the position of diamonds along kakih-nibud landmarks that define all unknown quantities.

Many of these configurations, depending on the situation and the problem. Consider some of them and see how changing the overall picture when you change some parameters. For this study the location of the three diamond-shaped areas that are at the intersection of the octagonal base field (Figure 3.43).

3.43 Getting octagonal base fields

As you can see, the basis for the initial construction of the octagon selected build configuration, shown in Figure 3.37. In this case, two additional degrees of freedom formed by the third diamond, crossing two source.

40 * «z1», «z2» - the desired width (the sector shows a dark color), «r» is equal to (5), and «ai» is (6) («xi», «yi» - different for the i-th rhombus) Please note that the number of unknowns «zi» is different - it depends on the angle of orientation of the diamond source: up to 60 ° - one unknown «z2» (ris.3.43.2a - y> 3x); over 60o - two: «z1» and «z2 "(ris.3.43.1a - at <3x).

How to determine the «z1», we already know - the formula (7) or (8) (for the general case). As for «z2», there will be a useful general formula for calculating the «zn», for any «N»-base field of NP, arranged in a simular manner (10). * 41

«Zk» - width «k»-th sector, «xm» and "um" - the parameters «m»-th diamond (ris.3.36).

Note that is not necessary to use a different "Hk" and "uk" - it all depends on the shape of the field that you want to see in methodology. Although, in general, this is possible. Integer widths of sectors that make up the basic unit of the field, should be as small as possible, preferably not more than five. Otherwise, the fields with a high number of parties form unreasonably thin flap. That is, the grid OR {8, 9, 15} is almost certain to be very little use.

Using (10) with a concrete example:

- Choose the original mesh to the first intersection: RP {1, 9} ÇRP {1, 9};

- Calculate the width of the first sector of uncertain «z1» (7):

z1 = (9-1) / 2 = 4

- Choose a rational solution to (10), with (5): Let «z1»> «x1», z2 = y2 (4 * 2) / (4 + y2), as x2y2 = h1u1 = 9, then z2 = (4u2-9) / (4 + y2) Þ examining this equation, choose "y2" = 6, «z2» = 3/2 "x2" = 9/u2 = 3/2,

- Give everything to the whole width of the mind: just multiply all values by two, the result is the desired grid options 1 and 2 - RP {2, 18}; grid 3 - RP {3, 12}, «z2» = 3; ** 42

- Calculate the angles of orientation of RP-nets that are part of the required HR-grid (6): a1 = a1 '= 2arctg (0,333) = 36 O52', a2 = 2arctg (0,5) = 53 O8 ';

Follow this procedure is the same, with the only difference being that the RP-nets that form OP-grid is not two, but three. Otherwise, no change:

- Build templates of all RP-nets, designed to advance a transparent material (eg, tracing paper);

- Butted all mesh together in the pre-selected position, in accordance with which all the calculations to find the widths of undetermined sectors;

- Fix the position and form of the final OR-pattern grid.

 * Used when creating networks with a high degree of freedom (RR, DP, DDP, ...).

42 ** Do not pay attention to the high «z1», «y1" and "y2" - these values will not participate in the formation of the identity of the base field and as a result we get the OP {2, 3}

Naturally, if you are designing a model using computer editors («Inkscape», «CorelDRAW», etc.) that work on the PR-mesh is simplified to the limit, since the spin and build a diamond-shaped grid can be a couple of clicks of computer mouse. Not to mention the fact that origamisty keen on programming, it can make the whole "generators combined nets" in accordance with a specified algorithm. But this is, as they say - "Who's that went to college!"

Returning to our OR-grid, provide docking three components RP-nets, according to estimates from (ris.3.44).

3.44 Obtaining the grid for one of the methods OR {2, 3}

Further constructions are performed along the lines of the grid, with nodes at the points of intersection. Unfortunately, the number of nodes that are suitable to select the center of the field, in various different OR-techniques. In advance of their accuracy on the surface, without additional constructions not determine why sometimes uncomfortable for some grids have to create a separate template basic fields. Such patterns can help to identify sites suitable for the center of the field. The rest, of course, need to understand separately with each particular case. Range of techniques and their nets so vast, that is to describe the nuances likely will not work, so, in general, it really necessary in this. If you do everything correctly calculated, and subsequently get accurate templates RP-nets, it is enough to stick to the widths of incoming rivers and selected as a center field units with a maximum number of grid lines.

Of course, even if «i»> 6, there are universal grid, in which the design will be as easy as in the BP and RP (one of which we will introduce later.) But for the most part of the grid are so complicated shape, which move all the lines on the sheet is simply impossible, and therefore should eliminate some of the lines, fitting the general pattern for the standard HP-BP or landmarks. For example, in this case BP-grid use is very simple, thanks to the fact that four of the eight degrees of freedom perpendicular. At the intersection of these lines form a standard unit square grid - it will greatly facilitate the transfer of a pattern of lines on the final image of folding (ris.3.45.1).

Structural OR 3.45 {2, 3} pattern

This aspect, of course, makes the design in the OP {2, 3} is not only a theoretical fun "inquisitive" origamista theorist, but also quite effective method that can use any practices. Note the single underlying field (ris.3.45.2), all of our design parameters accurately seated. In this case, it can be seen as half of a unit cell of a square grid has three connectors. It follows that, in this method the turn connecting the grid do not need, simply divide the distance between the trunks of six in all directions (ris.3.46).

3.46 The final pattern of the ER {2, 3}

Naturally, the entire grid is better not to apply, and build the most efficient locally in areas where necessary. This is especially important in areas that do not use a single line at all (ris.3.46.1 - dark areas). These lines will be restored even in the assembly process. Going back to the location of diamonds (ris.3.43), we note that in (ris.3.43.1a - ai> 60o) all performed similarly, but slightly more complicated, because of the unknown quantities for two - «z1» and «z2» (10). By the way, in general, the method of distribution of RP-nets (ris.3.43.2a - y> 3x) is the most rational: in any case, will have to control only a single value for both DP, DDP, and for other MP-techniques. As for the OP-grid formed by diamonds, as shown in Figure 3.43.3. As you can see, the unknown quantities will also be two: «z1» and «z1 '», as in the case of (ris.3.43.1a - ai> 60o). With the value «z1» - all clear (8), but «z1 '» will be calculated differently. In fact, nothing special happened, just a few changes the numerator of (8), that is, z1 '= (y1h2-h1u2) / (x1 + x2 + y1 + y2). This was a consequence of changes in the orientation in which the initial value (Fig. 3.47).

3.47 The relative position of diamonds

In case (ris.3.47.2) outside the area of intersection was an obtuse angle, which would entail the replacement of the "x2" to "v2" in the formula (8), everything else remains the same. For easy understanding, remember this: the numerator is the difference of the product of the widths of sectors, with the centers and outside, respectively, in the region of intersection. Sometimes it is convenient to use a different formula, given A = (y1, y2), B = (x2-x1) (ris.3.47.3), in this case the «z» is equal to (11). You can use either option, both easy to use and easy to analyze.

z = (11)

All of the following steps: to build networks, their connections, and finally, the design did not change, is similar (ris.3.44-3.46). We shall not - move on.

Speaking about the PR, not to mention an amazing one of a broad class of methods - OR {2, 3}, which is very clearly stands out as

BP-net against the variety of diamond-shaped grids. Due to its versatility and ease of use in practice, this method has a separate name - OR * (with an asterisk), distinguishing it in such a way as octagonal centering technique.

What is unique about the PR *? Features a lot, look at some:

- RR *-net can be easily constructed on a normal BP-grid;

- Very high node density, suitable for selecting the centers of the field;

- All part of a single base field are equal;

- The angle between adjacent diagonals single field - 45 °;

- No need to build a grid connection, etc.

Grid OR * as follows (ris.3.48).

3.48 A single grid method OR *

As you can see, the centers of the fields can be placed in almost every node BP-nets (ris.3.48.1). With that, regardless of the location of the field - it will be the same shape, symmetric with respect to any of the diagonals. The width of the sector, only two and three, and they alternate one after the other (ris.3.48.2). Cell of such a grid is constructed as shown in Figure 3.49.

RR 3.49 for the cell *

To increase the size of the mesh is fairly consistent share similar folds to the same, pre-selected number.

The most beautiful thing in the design in OP * You do not have to make additional payments, to build templates grid, limited only by the area of intersection. All problems can be solved by ordinary graph paper, using a pencil and ruler (ris.3.50).

3.50 Design in OP *

Please note that virtually all of the nodes located at the sites techniques (ris.3.50.1). They are defined by the coordinates of BP-grid selected for design (ris.3.51).

RR 3.51 * - design on the grid BP

Connecting lines are built on the sectors is very simple. To do this, you need to determine the direction and divide the distance between the grid lines into six equal parts, as shown in Figure 3.50.2. Moreover, all the lines should not be built, all done in plots immediately prior to assembly. The rest of the design in this method produce similar HP and BP, with minimal time and paper on the formation of the valves.

With this we end up with you to consider the combined grid and return directly to the MP. Of course, we should consider this question in more detail, especially as there were many interesting things in the same DP and DDP (ris.3.52). But would not want to treat the surface are very important questions, the description of which can be devoted to more than one volume, but because the

subject in more depth, we consider in the next book. I will only note that these techniques are also formed at the intersection of a number of rhombic meshes, after the calculation of (8) and (10). However, in addition, you can see a number of new details that require a separate, detailed consideration.

3.52 Structural patterns in DP {3, 5} and DDP {4, 7} PATTERN CREATING MR MODELS

As mentioned earlier, the design of a serial MR preferred mating elements. Look at how this is done on a suitable and sufficiently complex example to cover all the details of the design. To do this, select the tree leaf model (Figure 3.53).

Description of the design process will be slightly different from what we did in the head of BP and HP. Now docked each new item will be considered in detail. It is necessary for a better understanding of MR techniques, and without many details that will be analyzed, the overall picture bases MR is not as complete.

3.53 Wood sash model - "Butterfly"

In our example, a tree leaf in its composition corresponds to the butterfly, which can then be accessed by folding. Please note that the length of the leaf on the tree are not actually - you know the reasons for this later. Sequential mating begins with the selection of the original field, or a unit that is easy to get, to Him we shall successively, one to another, join the rest of the field. For that tree as a starting wing should select the lower part, responsible for the insect's abdomen (ris.3.54). We need to establish the structure and lead to a convenient form for further manipulation. Decision is motivated by the fact that at the initial stage of its formation will not cause problems, which is not the joining of similar configuration to the final design.

3.54 The original sash

In accordance with the above, perform docking fields and rivers in this way for our wood shutters, using the angle between the side surface and the base equal to 70O32 '(ris.3.56).

3.56 The process of leaf pattern {0; d}

Wood shutters, which have chosen - symmetrically, so the center of the field of "0-e" should be placed on the axis of symmetry, that it passes through the center of a trapeze .43 * The width of the middle of the field (ris.3.57.2) we can zoom in and out on will, from zero to infinity, with no effect on the original wood doors. In other words, we can "adjust" the width of the central part of the parameters of the form field, abutting the top (ris.3.57.3).

43 * It is this geometric figure we got to the block {0; d} (ris.3.55).

3.57 Adjustment of the middle part of the original block

Gate length in the MC - the value is not as fundamental as in BP or HP. * 44Bezuslovno all fields and their shape can be done strictly according to the specified proportion and calculate all just like to obtain the system overlays (ris.3.55). However, sometimes in the MC calculation is often so complex that it is very difficult for her to talk, even to professionals with engineering background. I think that such nuances are not interested in amateur artistic approach to design. Therefore, we vary the

length of the valves in some acceptable range, to obtain the most efficient docking elements without overwhelming the process of creating mathematics pattern. Do not worry, you will not feel the difference in the length of the wing «r» or 1,2 «r», ** 45zato you will have a practical skill randomly select the form fields, in contrast to HP and BP.

Thus, we choose the shape of the field of "0-th", focusing on the approximate length of the leaf, so that when it all lines to form a closed system (ris.3.58).

3.58 Docking field "0-e" and the block {0; d}

For simplicity, further design, we chose a square field, thereby setting the orientation of all the connecting lines through the center of the model.

* Except for the design within a single RP, or NP-nets.

 ** By the way, for this reason, the length of the valves on the MR-tree, 3.22 is not applied.

Remember, choosing the form of the field, we have also chosen the orientation of the trunk - because we want to simplify the item for further connections. Fields with a large number of parties and will save us at least part of the paper material, but at the initial design stage can greatly complicate the dock items. In addition, the field itself is not as great as say the block {0; d}, and hence the difference in the cost of paper for a wing to be relatively small. You ask, "Why not a triangular field - and for the docking easier and simpler form?" But imagine the field folded. This site is located on the axis of symmetry, and after folding accordion door is up. This means that the ghost doors to threaded view require additional manipulation (if they help). Incidentally, the same fate awaits any symmetric field with an odd number of sides. The habit of this analysis and make informed decisions come with experience. Please note that the center of a square field is applied to the extension connector (ris.3.58.2). This was the result of the coincidence of two conditions. First, the orientation of the red line provides orientation square wing "0-f", and secondly, in this arrangement, the center of a square field, the length of leaf is formed by about two times the length of corrugations «a, b, c, d» - that is suitable for a given tree leaves. After selecting the shape of the field and the position of its center, we have also corrected an average width of the block {0; d} (ris.3.58.3). Thus, the formation of the original block is completed (ris.3.58.4). Further docking done so (ris.3.59). This we can plan in advance.

3.59 The order further joining elements

In this diagram, numbered different parts of the basic form:

"0" - the original door (abdomen);

"1" "1 '" - the wings;

"2", "2 '" - legs;

"3" - a main door.

First, we attach the wings, legs, and then at the end of the head. Priority docking wings in every part - in alphabetical order. Please note that part of the "1", "1", "as well as" 2 "and" 2 "," symmetrical to each other. Therefore, as for most symmetric models, make a pattern for the final half and flip it

mirrored. Wings and legs out from the same point as the original sash, so the pattern of the field will address along the borders. Head look a little later. So, first we start with the first part (the wings). Evidently, the original leaf at "0" both wings attached. Denote their vertices as "a" and «b» and consider them consistently mount, according to the existing structure of the fields and rivers. If other methods we would first get the structure of the block level, the MP will connect them in series, and continuity checking dock connectors. We begin with a "0-a" (ris.3.60).

3.60 Docking field "0-a", is responsible for the wing

In this case, it is advisable to place center of the field, as shown in Figure 3.29.1. First, do not interrupt the connecting lines, and secondly, gate length will be within the permissible limits for the design and thirdly, the orientation of the "0-a" coincides with the orientation of the moving elements of the original sash. To obtain the lower boundary of the field leaf "a" (ris.3.60.2), choose the point where the line touches the border Orientation original block. Obviously, one needs to choose a point on the surface, to avoid forming new trunks. In other words, it has to be based on a trunk - we chose the point "0". " It now remains to draw a tangent to a circle with a radius equal to the length sash and "mirror your" trunks along the line «a-0 '."

Such a connection block with sash fully rational and convenient - for folding and for further design. We will focus on this configuration, but slightly deviate from the topic and consider the case when the length of the required valves will be more than what we can get in a particular setting. In this case, the MR is very convenient to use the following geometric property (ris.3.61).

3.61 Geometric constructions

If the line "a" cross the line angle "A" at two points "B" and "C", the bisector drawn from the corners "A", "B" and "C" will intersect at one point (ris.3.61.1). * 46

What is useful for origami results from this simple geometric properties? Consider Figure 3.61.2. Suppose we had a field with vertex 'a' (the border of the field included the rays of angles "x" and "y"). At some point, we decided to increase the length of the wing, it does not want to change the position of the reference point "a" ** .47 According to the properties, we can not simply defer to the desired length necessary for us next trunk "a" and, after a common external tangents, get a field form the desired shutter. By the way, similarly constructed two configurations considered in the "diamond-shaped grid" (Figure 3.32, 3.33).

Demonstrate clearly how it works with our example (ris.3.62).

 * proved very simple: it is enough to note that the bisectors of the angles of "B" and "C", crossing at «D», will be equidistant from the line "a" and the sides of the angle "A", which implies that the point «D "also belongs to the bisector of the angle A.

 ** Possibly because of previous calculations or for the convenience of docking.

This element is often used in folding insects, to give the characteristic corrugations on the body. The book contains a number of ways such separation in different chapters. Choose one of the options that have already been mentioned in this chapter (ris.3.55).

3.55 MR system of rivers, forming the flap of the required form

The meaning of this separation is that the centers would be all the fields are on the same line perpendicular to the base unit. It follows that all the folding wing will consist of a single layer on the outer surface. This distribution method overlays a more "efficient" in terms of the use of material other than described in the chapter about HP (ris.2.21), as each new leaf of additional layers of paper will not cover.

Depending on the options selected rivers and fields in the system of the unit will be oriented differently. Let us dwell on our tree leaf, where the width of the river is the width of the field (ris.3.55 right). Here, for the angular position of the borders to the grounds by calculation, we consider the triangle "ABC." He's right, as the Orientation lines are the bisectors of the angles formed in the ground to change the direction of the rivers, that is, the angle of the "B" is equal to half of the straight angle.

Let 'B' "- The intersection« AC »and the outer bank of the river. Based on the conditions: ĐBB'C = 90 °, AB '= 2B'C (Fig. 3.55 right), should (B'B) 2 = 2 (V'C) 2 and, respectively: (ctg (CBB')) 2 = (B'B / B'C) 2 = 2. Now we can get the value of the angle between the base unit and the outer side of the river bank, it is Đy = 2 (CBB ') = 2arcctg (1,4142) = 70O32'.

Likewise, the angle is determined for other relationships (width of the river) ¸ (width of the field): for "2 ¸ 1" - 60 °, for the ratio of "1 ¸ 2" - 78.46 A.

In general, for these configurations, if you select the width of the river - «m» and the width of the field - «n», then the angle between the base unit, trapeze and side shore «y» is equal to (12).

y = 2arctg √ (12)

With that, thanks to this formula, you can perform the inverse operation - search ratio of the width of the river to the width of the field. This situation can occur if the border you want to add this type of complex flap, and the relief surface except changing the angle of inclination. In this case, the feasibility of such a change can be verified (13).

= (Tg (y) tg (y / 2)) (13)

3.62 Expansion of the field at a fixed point

If we want to increase the length of the MR valve, inappropriate tree model, you can use the following algorithm:

- Postpone the neighboring trunk a distance equal to the required - get the point "a '";

- Draw a circle of radius of the new;

- Reflect the relative length of the connecting line "aa";

- A tangent at the point of intersection of the circle and reflected at the point "a '" trunk (ris.3.62.1);

- At the intersection of the tangent and the vertical border of the original block obtain the point "y" ";

- Connect the dots "y" and the point "a", we get a new line Orientation field gate length of which will have a certain value.

After that, leaving only the line folds, get the final pattern of angular sectors of the extended field (ris.3.62.2) * .48

Returning to our configuration, we recall that the model that we add - this butterfly wings which should be wider than the thickness of the chosen leaf. To increase the width to stretch the field more efficiently to the desired value ** .49 In this case, this manipulation will look like (ris.3.63).

48 * This method of increasing the length of the leaf in the design is called the extension of the field at a fixed point.

49 ** This question I briefly mentioned in previous chapters, when describing the rectangular field and various transformations of closed rivers.

3.63 Stretching MR field

Since the radius is preserved, respectively, then the line connection points "a" and "a '" is perpendicular to the trunk. You can stretch the field more, but in this case there is no need, because the thickness of the expanded leaf is enough for the formation of a butterfly's wings. The next step, tangent to a circle centered at the point "a '" from the point of intersection of the connector and the outer bank of the original block - get the lower bound of the field leaf "0-a" (ris.3.63.2) Now some will depart from leaf "0-a" and move on to the "0-b» (ris.3.64). This is needed for the rest of the field, with a fixed distance between the connecting lines.

3.64 Joining the field of "0-b», along the bottom of

Algorithm combining the elements of the same, but in this case, is docked relative to the lines of the field of "0-a." To do this, obtain a lower bound

field of "0-a" build with the same pitch connectors and put off by the length of their wing "0-b», according to a tree leaf (ris.3.64.1). As a result of both fields are restored easily. In Figure 3.34.2 shows the resulting pattern of elements combined to date. In this docking field-wing completed.

Now proceed to the part of the valves responsible for legs (Fig. 3.28. (2)). What do we have? Three approximately equal leaf emanating from a single point. By analogy with the previous phases of the project, on the continuation of the existing trunk choose the place where it is most convenient to arrange the top of the first field. As can be seen from the tree, the length of a flap about (approximately) equal to half of the wing, resulting in the last stage. On the basis of the proportion which perform field-foot dock "0-A" of the unit, obtained previously (ris.3.65).

3.65 Docking fields-feet of "0 s" and "0-b» to get the block

Choosing the position of the centers of fields, as always, will observe three basic conditions docking MR elements:

- The center of the field at the intersection of the trunk;

- The radius of the field is approximately equal to the length of the "branches" of the tree leaf;

-Leaf should have the desired orientation relative to the plane of the sheet (based on the characteristics of the project).

Orientation relative to the plane of the leaf sheet determines its color folded. That is, besides a different attitude, different directions after folding doors will be painted in a different color, if you use double-sided paper. In this example, change the color is specified in the conditions, so the orientation can be saved and in addition add up such doors easier.

As described in previous chapters, in order to match the orientation of the adjacent leaf, requires that the connecting lines entering the centers of fields have the same orientation (the valley, valley, mountain, mountain). In our case (ris.3.65.1) this condition is satisfied, since the center of the field "a" and one of the centers of power are the same.

True, the radius of the field at a dock slightly more than half of the wing, but he was still within the permissible limits. Further, as in the previous step, we restore another leaf (ris.3.65.1), under the terms of docking.

As you probably noticed, the radius of the second field is slightly smaller than the radius of the first, but still remains within the permissible value. In addition, the radius of the first field was a little overweight. I repeat: if you need a mathematical precision, you can always expand the field at a fixed point. The objective of the practical part is not the - most importantly, to learn to join MR field using improvised - template, compass, ruler and graphics editors. A precise manipulation you can learn on its own, for example, studying the patterns, which in large quantities can be found on the Internet. Here are a few ways to change the width of the field that is used in practice itself (ris.3.66).

3.66 Adjusting the width of the field-foot "0-b»

In Figure 3.66.1 field expanded at a fixed point. This method is described in detail earlier in this chapter (ris.3.61) shall not stop. We only note that the thickness of the assembled valve would be a bit more than before the expansion. This, in turn, can add some complexity in the final assembly process, because it will need to shape the wing, consisting of a large number of layers.

In Figure 3.66.2 shows how to adjust the width of the leaf through the introduction of a fictitious field. What is its essence?

Please note that with the introduction of the field in the form of a wedge with an angle at the top of the "x" (ris.3.66.2), our field (using the same radius) to move up, with its orientation relative to the trunk will be different. Thus, by varying the angle of the wedge, we can find the value of "x", in which you receive the desired position of the center of the required field. Usually, the values of these angles are, solving trigonometric equations, depending on the conditions in which the fields are defined in each case. As for the fictitious field, could be resolved in the future, including some of the new field or river, as one of the layers. It is important to note that when you enter a fictitious field there is another new line Orientation (black dot-dashed line) with respect to which will include all connectors.

Returning to our model, we now turn to dock field "0-s." Nothing new has been added, act normal. On the continuation of the trunk, the orientation of which coincides with that of the previously transferred to the pattern field centers and lay off a circle with a radius equal to the length of the "0-c", taken from the tree of the valves (Fig. 3.67).

3.67 Preparation of the final pattern after joining the left-field group tabs

It remains to combine the head flap of the unit, received to date, and the final MR pattern for that tree is complete. Please note, the upper sash fan head (ris.3.59) is from the point of "0" (joint place all parts of the model) at a distance "0-1." This means that the unit will be separated from the rest of the river width of the "0-1" (ris.3.68).

3.68 Construction of the River "0-1"

Width of the river was chosen approximately in line with the top margin of the original block "0" (ris.3.58). In this Orientation lines in this area formed Orientation sector. Further manipulations will be carried out in accordance with the square, whose boundaries we choose for folding model (ris.3.69).

3.69 Selecting the boundaries of folding

Let's start with the central wing of the field "1-c» and place it inside the marshes in the lower middle of the block (ris.3.69.1), bearing in mind that we are not interested in full form fields only part within the sides of the square. As a result, the lower bound (black dotted line) to the center of lift «r» = 0 (ris.3.69.2) and let him through connectors. Obtain a lower bound of folding, go to the final part of the MR design.

As the wooden shutters (ris.3.59) 1e = 1a, 1d = 1b. Therefore, the symmetry, will cover area "?" (Ris.3.69.2) doors «1e» and «1d», and then display the result reversed.

Fields «1e» and «1d» combined area are quite small, and we can safely maximum compression of the sheet to get rid of excess paper material when folded. Thus, in our case, you can determine the final borders of the square. The result: the left boundary will pass through the top of the field, responsible for the "lower" leg (foot field of "0-a»), and the top will complement the shape of a leaf to the square.

Getting to the formation of the field leaf «1d» (ris.3.70).

3.70 Docking fieldsheadunit

Placing the center of the field leaf "1-d» on the right trunks, draw a tangent to the circle at the ground of the river bend (ris.3.70.1). This forms a swamp (area - "?"), Which must be filled. It

You can do this by changing the trajectory of the rivers that make up the field leaf "1-d», but now it's not necessary.

Please note that at the point of "1" starts the head, the shape of which will depend heavily on the image of the final folds. Advance its texture, we can hardly predict, therefore, introduce the field elevation leaf "1-x" (similar to leaf fig. 3.17), as shown in Figure 3.70.2. At the final pattern is symmetrical axis will be another the same field. When we add the base and straightened tall sash along the joint line, we get the color model of a flat surface, without forming flaps.

As for the leaf "1-d», then it is useful as a stretch, as the little leaf "1-e» and without too much space. To do this, we simply extend the "1-d» towards «d-d '» at a fixed point (ris.3.70.2).

Next, attach the wing box "1-e" (ris.3.71) to the final pattern obtained at this time.

3.71 Docking field leaf "1st"

If you attach a standard (ris.3.71.1), all the conditions are met and the tree leaf is formed, but the shape of the rivers "A" and "B" will be a little more complicated assembly. This can be corrected by changing the shape of the top of the field foot valve "0-a" (ris.3.71.2). So we essentially unload dock and make it easy for folding model.

In principle, the design of the final model of the pattern is completed, because the units for "2 '" and "3", "reflect fairly symmetrical blocks" 2 "and" 3 ", about the center. As a result of a butterfly pattern will look like Figure 3.72.

In conclusion, we note that in the practical part of the basic techniques were described docking MR fields. Similarly, you will be able to unite not only the field, but whole blocks of different MR techniques combined (RP, HP, DP, ...). This can be very convenient, especially to the border junction straight on a single grid, a piece of cake (data tricks we have repeatedly were doing). The rest, as they say: "It's art."

3.72 The final pattern MR model

"Fluting"

Shirring

In the previous chapters of this book describes how to design BP, HP and MP. Each of these techniques has its own characteristics that make and patterns, and the resulting models are quite different in appearance. What unites them is that in the process of assembling patterns, folds formed by multiple trunks alternating orientations, which when folded form a kind of accordion. In this chapter, we will consider ways of decorating the valves through the use of these harmonicas, namely to give svorkam corrugated shape.

Such a method of transformation of the plane of the ordinary accordion pleating called - corrugating or ribs. It can equally well be applied to all the above methods.

4.1 models designed on the basis of corrugations

Corrugation very beautiful and astonishingly diverse. Sometimes you just can not believe that the corrugation is made on the basis of conventional harmonica. Creating these forms addictive despite the length and difficulty of assembly. Absolutely everyone can find something in the fluting on the taste. Someone more like normal transformation of the plane, someone will use to create the grooves rotation figures to attract someone to the possibility of free transform plane corrugations that due to their structure is easily various strains. Corrugation can complicate and change, add new elements to the transformation of its form, as in a standard form, and the rotation can be included in the composition of its individual flaps and more. Currently, corrugating, as a genre of origami is quite popular. On the internet almost every day there are new varieties and execution gofrirovok most bizarre forms. In this chapter we outline the use of corrugations in linear methods. Also focus on the individual design of corrugated shapes rotation of rectangular bands. The objective of this book is separate and fully describe all the nuances of corrugation - on this subject can not write a book. Therefore consider only the basics, with which you can easily use the ripple in the design of linear

methods. For those who want more depth to master this type of origami, the information in this chapter may serve as a good "starting point" in the investigation of corrugation.

FLAT Gofre

If you create a ripple remains within the plane of the bellows, and its elongated shape does not change the slope (slope of the tangent), this flute is called a flat. Flat corrugation formed by Orientation lines passing through that (Figure 4.2) harmonica gets the desired form.

4.2 Transformation of the accordion through the line Orientation

In Figure 4.2.1 Orientation dashed line. As you know the rules of Kawasaki, trunks, passing through them, continue their movement, "mirrored" on the back - just like connecting lines between the margins. Naturally, trunks accordion while retaining its orientation relative to the plane sheet. This makes it easy to restore the orientation of all the lines that make up the pattern. As for the assembly, corrugated elements will emerge as well as the line in the Orientation sectors (Figure 4.3).

4.3 Addition of corrugations

Pay attention to the build process. Connection side accordion sections is exactly the same as in the linear methods, respectively, are arranged along the leaf backsight lines. Only if this does not add up bumps themselves completely, and put "on display" internal structure. By the way, is incomplete folding is sometimes used to convert a form of leaflets and making them reefing without additional corrugation. Of course, in Figure 4.3 shows a simple example, but to move on, you must understand how the orientation backsight line will affect the overall structure of the corrugations. If "paint" a corrugated language "fields and rivers," we get a set of open rivers, adjacent to each other (Figure 4.4).

4.4 The internal structure of the corrugations

Notice here that does the same laws that we have described in the methods above. But if the design of the models we have tried to avoid the rivers, which often change direction, there is, on the contrary it is necessary, because these are the basis of the river and corrugation. Please note that the lines of concertina, after passing through the Orientation lines "X" bumps (we call this region the channel), will take its initial direction. This important point should be noted separately. Return to the starting position makes it impossible to reuse the channel (ris.4.4.3) on the continuation of the harmonica. This is a fairly common way of corrugations, moreover, it greatly facilitates the process of assembly and re-application Orientation lines with a simple translation. Naturally, you can change channels repeating: to reflect them, or convert various manipulations. But always, the condition: the line bellows must again return to its original position. It should be noted that the channels can be crimped and irregular shape. Choice of it depends on what type of structure you want. Such manipulations are often used by masters corrugation (Figure 4.5), but their practical application and use goes far beyond the scope of this chapter. We note only that in such cases, designing the structure of the corrugations, you must still comply with the preservation step bunching in the transition from channel to channel, exactly as in the movement within the channels of the rivers.

4.5 Block diagram of movement within the channels of the rivers

We now return to the rectangular channels that are used most often in the context of linear techniques. So, for example, the most popular of them (Fig.4.6) also consist of a system of rectangular channels.

4.6 Block diagram of a corrugated

Note that the river, forming a corrugated Figures 4.6.1, 4.6.1a, parallel to each other, and in Figures 4.6.2-4.6.2a - mirror opposite, and it is possible to change each other, keeping the orientation of the lines accordion. As for the corrugations (Figure 4.6.3-4.6.3a), the whole image of her rectangular channel is a complex river, consisting of three simple. The banks of this river are parallel and perpendicular to the trunk, so there is the possibility of re-docking. In the same way, analyzing the river, make up the channels, designed all kinds of flat ribbed. It may seem that submit the form bellow on the pattern - it is difficult, but it is only at first glance. Filled his hand - you can easily learn how to get the forms you need. A little patience, and this area will be useful origami assistant in the design, including the decoration corrugations conventional valves.

CURVILINE Gofre

As you know, the corrugations are not always strictly flat. You have definitely come to the works, based on applicable scribers curved surfaces. Someone is using the corrugation to create different shapes of rotation, someone to represent curved surfaces, such as water ripples, etc. Such types of corrugations called curvilinear.

To figure out how to convert direct form of conventional longitudinal bunching in a smooth curve, let's see what the curve in terms of how origami and paper tape may repeat the form, getting a corrugated surface. In this context, under the curve refers to a line in which the slope of the tangent is not a constant. In Figure 4.7.1 shows one of them.

4.7 Curve and putting it inside the projected channel

As you can see, the slope of the tangent line throughout the change. For our purposes it is important to note that in some places it is repeated, and sometimes (in the straight sections) retains its value. Omit derivatives strictness analysis, the task of the book is the practical application of various methods of design. Therefore, we consider how, in practice, you can repeat the shape of the curves, using layers accordion. Naturally, to mimic the image of the curve, keeping everything excesses does not, so it is enough to find the channel, beyond which the line to be released (see Figure 4.7.2).

Since the corrugation formed by transformations with pleating-accordion, the bandwidth should be selected as constant and equal to the distance between adjacent connecting lines. Thus "weave" corrugations can without additional manipulation of the fields. In this case, the smaller the step bunching, the better the curve described. First, consider the simplest and easiest way to convert an accordion. It's based on getting the channel, repeating the original curve. Manipulation here will be conducted directly with the accordion. This does not necessarily have to straight sections remained the same accordion. It can freely fill-open rivers, as for flat corrugation (Figure 4.4). In other words, this longitudinal transformation will be used to move from one section of the rectangular channel, which is placed in a curve, in the next section, etc. Inside each of them will use the same rules as in

flat corrugation. To obtain such a transition pattern corrugations, to begin to get the images of lines, wrinkles in the areas of inflection in its individual segment. For this, we will thin paper tape, which is equal to the distance between the connecting lines. The length of the ribbon elements responsible for the straight sections, you can then adjust (depending on which plane corrugations will be added). Example of the process of getting the lines of folds on a single tape is shown in Figure 4.8.

4.8 The process of creating the channel, the envelope curve, using paper tape

How is it done? Explain the order. The figure marked with a 'y (x) "- curve, which should be covered with a strip of paper, the thickness" a ". Naturally, the curve and the strip be portrayed in the same scale as the rest of the tree leaf model to avoid inconsistencies size model with dimensions of corrugations.Approximately at the point where the line will change the trajectory, paving the channel width equal to the width of the strip, in this case - the value of "a". As the figure shows, the channel crosses the image of the strip in four points. If after opposing to the crease after knee bar will match one of the areas with a channel (depending on which opposing points we have chosen). The points that we need, marked in white on the enlarged image area (ris.4.8.1). Next, go to the following important turn line (ris.4.8.2-3).

As a result, action figures 4.8.1-3 we got Orientation line folds on a single tape (ris.4.8.4). Now we need to get the image of the pattern for all segments of the corrugations. It's enough to reflect the inflection lines stripes on its edges in the transition from one layer (Fig.4.9).

4.9 Reflection Orientation lines tapes

Also, you can then make a stretch of straight sections in order to integrate the image of an accordion in open rivers, transforming corrugation. In this condition must be satisfied: the length of the rectangular area must be equal to the total width of all rivers combined. After determining the orientation of the lines CP (sequentially, from bend to bend) - is folding (ris.4.10).

4.10 Addition of corrugations in the image pattern

It is quite possible to get the same image of the curve by one element corrugated, slightly changing its shape. For example, the transformation of the normal longitudinal corrugated fasteners, along the same line of "y (x)" is as follows

way (ris.4.11). However, it is quite time-consuming and not always practical.

4.11 An alternative way to create a curve corrugations

Although, Orientation line pattern (Figure 4.11.2) can be obtained by using the same algorithm as in the previous case. That is:

- Are determined by the line folds on plain paper strip, according to step bunching;

- Symmetrically reflected fold strips, relative to adjacent connectors.

But, unfortunately, these complications often lead to the fact that many Orientation lines are not parallel. With a large number of folds folding is very time consuming, not to mention the fact that the receipt of their location is also not an easy task. Of course, if you set a goal to get this exclusive corrugation, in the end, everything will turn out! Personally, I have a policy with pleating: scribers

should only be used on straight sections. This seriously makes folding, and the appearance of the model is not particularly affected, especially if the accordion many layers.

Convolute, and a figure of revolution

Curved corrugations can be used in many ways, including for creating shapes rotation. Consider an arbitrary body of revolution (ris.4.12).

4.12 The structure of the rotation

The figure of rotation - it is such a volumetric figure, the lateral surface of which is the result of a continuous line around the rotation axis. The "language" origami gofrirovok this means that to get the desired shape just enough to get the structure of the rotation curve and to ensure its continuity - until the connection edges. How to get the rotation curve, we already know. We can only make a long enough corrugation in order to be able to connect it to the edge, stretching the corrugation to the desired size. Align the edges can be different. Of course, you can act with "pure origami", laying one layer after another, but it is likely that the attachment is quite weak and the model falls apart under stress. In this case, you can help yourself with glue. One drop of glue on the edge of the corrugations, in my opinion, does not hurt - especially in cases where the model is used, for example, as a lampshade or as a vase (that is, if it is necessary to ensure its durability when used). If desired, a figure of revolution can be folded out of the foil paper. This paper holds the shape and glue to fix it is not needed. We show how the process of creating figures of revolution with corrugation on the example of model design jug (Fig. 4.13).

4.13 The process of the side surface corrugation rotation

- A sectional model of rotation selected for folding *, 50

- Determine the rotation curve. In our case, the whole length of the perimeter of the point where the axis of rotation and the bottom of the jar to the neck (ris.4.13.2);

- Denote the model form of revolution that we need to get through the transformation of the accordion (ris.4.13.3);

- Transform the tape width in step bunching (ris.4.13.4). **

* It is necessary for determination of the rotation curve used to create the model.

** If your experience allows, you can directly insert the corrugations on the straight sections. Otherwise: first get the kinks Orientation folds, and then, stretching them, weave them into the selected channels corrugation width.

After the folding of the rotation curve (in a modified form for assembly), we obtain the final corrugation pattern, reflecting a pattern of stripes line accordion. In this case, it looks as shown in Figure 4.14.1.

4.14 The process of corrugated body of revolution

Pattern develops sequentially, from one cross the line to the other, thus transforming the plane accordion. The result follows a curved corrugated (ris.4.14.2). Its total width * 51dolzhna be sufficient to align the edges of the normal bellows (Figure 4.14.3). ** 52

The corrugations in the LINEAR TECHNIQUE

As already stated, the corrugations are formed from the pleating-accordions. Naturally, the question arises: "Is it possible to use the corrugated and linear techniques together?" Answer: "Yes, of course!" Moreover, it is incredibly effective methods by which you can decorate even the most ordinary ideas. This is due to the fact that the corrugations on the surface can take almost any form. You can give a textured surface of the wings, relief form water, hair, roughness, etc. The main task is to get the accordion for us in the right area.

 * The distance between the outer folds of an accordion.

 ** Size when folded paper tape speed bumps should be taken over (17-18) Rmax one complete revolution, where the value Rmax - the distance from the most distant point from the axis of the corrugations (ris.4.14.2). This figure is based on experience and is not required for use. Can help to estimate the size of the source worksheet.

If corrugated sheet is located on the border of the design, and will be located within a pattern from end to end, then this is not the location of the corrugated portion and thereby jeopardize the design. In this case, the ripple is on the extreme side, and by extension the trunk perpendicular to them, construct border connections. Knowing the boundaries of the site, starting join fields and rivers.

The problem is solved more complicated if you want to get inside an accordion pattern. In this case, we have to get out of the plane of the harmonica. Consider the case shown in Figure 4.15.

4.15 Obtaining an accordion in the central area of the sheet

Length accordion will then be equal to the distance «L», from the fold layers and to the places of the plane of the accordion (Figure 4.15). Importantly, the most central part of corrugation prevents us to use extreme sites to obtain the required number of flaps. Thus, denoting the resulting central corrugation for a river, we are free to continue designing. Thus it is necessary to comply with the rules of joining the MP as the connecting lines will be fixed, and the Select fields must be conducted in accordance with their location in the structure of the model. However, folding corrugated in this case is much more complicated, because it does not have to do one layer of paper, and of the two.

Please note that the direction of the central accordion can be arbitrary - it depends on the goal. Possible ways to get a lot of accordions, each of which has a choice to taste and preference, from my own experience. In Figure 4.15 presents a special case - the accordion is perpendicular to, and connecting lines when passing through an accordion change their orientation with respect to the plane of the sheet.

The following is another example (Figure 4.16), in which the accordion is obtained in another way - the orientation of the lines after the passage through the accordion does not change, and she bellows tilted at a sharp angle to the original.

4.16 Getting inclined accordion in the central area of the sheet

The angle of the resulting accordion is (14) (ris.4.16.2).

$y = 2 \, \text{arctg} \, (s / a)$ (14)

where «s» - step bunching, "a" - width of "turning the curve" * .53 length accordion equals «L» (Figure 4.16). In this form it is used for the formation of wrinkles. As for the future of design in the areas outside the area of transformation, here are doing the same as in the first example. That is, we denote the transformation of the entire region beyond the River, and butted along the borders, in accordance with the orientation of the connectors. The use of corrugated together with linear methods is very often based on the selection of areas to the accordion from the edge to the other. This is due to the convenience in assembly. First, in these areas are dotted sash, and then joined the rest of the elements along the borders. If the composition of the model consists of several such "open" convolute the harmonica, the first designed the most complex of them, then, successively joined all the other elements. The boundaries of the resulting building blocks carefully configured so that you can easily attach the remaining wrinkles.In cases where it is necessary to make corrugated, which folded the whole area should be "closed" to the structure and is located within the sheet, can not do without the stretched "not core" fields. An example of such a field is shown in Figure 1.9.

As a good example, recall Wed model "butterfly", designed in the previous chapter. Areas that are responsible for the wings were designed with the expectation that the inner accordion will unfold when folding. This is clearly seen in the photo of the finished model (photo left 3.2). Similarly, detailed flap can be folded in an accordion, which can then be used to emboss. Consider BP - case (ris.4.17).

 * Width of the "vector line". See "cross-wing" Chapter 5

4.17 Preparation for corrugated bellows of "stretch" of the field

The figure shows that the addition of "non-basic" field (ris.4.17.2) may serve as an accordion for wrinkles. Also, it can be easily used in conjunction with a nearby flat structure, as she will defend the harmonica on some selected distance.

Of course, a pleated sash put in finished form will not be easy - double layer thickness. However, the number and location of corrugated forms can optionally be adjusted in accordance with the selected tree leaf * .54

CREATING MODEL PATTERN ribbed

For example, consider the following tree leaf (ris.4.18).

4.18 The tree leaf model "bee"

 * For example, a bunch of grapes from a single sheet, with each berry is made of corrugated single rotation.

The selected tree leaf in its composition is similar to insect: something like a wasp or bee. Corrugated element model will abdomen insect indicated in the figure of the curve arc. After folding, it will take the form of figures of revolution - is spectacular, adorned element. The remaining doors are

common, standard form. In the process of their design will be guided by the rules, which were described in previous chapters.

Note that if we want to include in the model corrugated element, then it must be extracted beforehand. It was with him should begin planning to avoid difficulties in the future docking. Therefore, first we split our tree leaf on the main unit (Figure 4.19).

4.19 Separation of model structure into its component parts

Will design a bottom-up, respectively, denote our blocks - «A», «B», «B '», «C». Given the above, we first need to get the corrugation, responsible for the abdomen (block "A") .55

Please note that in the corrugated box, we added not only curved section, but also the river through which the block "A" will match the other units of the model. This arm will be considered as part of the corrugations. First define its position and options, and then proceed to the transformation of a paper strip, giving it the shape of a given curve (Figure 4.20). *

 * The process of corrugated forms described earlier in this chapter, makes similar manipulations with single tape, adding different elements on the straight sections to decorate the outer surface corrugation.

4.20 Production of corrugated pattern element model

Again, the choice of the outer surface corrugation can be completely arbitrary, fulfill your creative vision. It can be as usual harmonica, and an arbitrary set of open rivers, providing the desired pattern. But do not forget that the final shape of the corrugated portion will join with the rest of the fields and rivers of the model. So if you create a pattern should seek to make a straight line joining the border - which we have in our example. Then reflected line folds against the edges of the paper strips. The site of the final pattern for the block "A" is shown in Figure 4.20.3 (lines of different orientation in the picture have a different thickness).

Now you need to determine the approximate number of divisions of the unit mesh, which we need for quality wrinkles. It was noted earlier that the optimal width of the strips of paper to create corrugated rotation is about «17R», where «R» - the maximum distance from the axis of rotation of the surface corrugation.

In our case, the «R» about equal «5s», where «s» - single step tape. Then the width of the sheet is: 17x (5s) = 85s, ie the docking of the remaining sections of the model should be oriented around "85" trunks.

Now produce fields docking blocks "B" and "B '" and "C". The process of joining these blocks has been described in previous chapters, the new features here. We can only give a general description.

Leaf parts of the "B" and "B", "out of a single point, therefore, the field inside the blocks will not touch each other along the border. In our case, we perform docking with Orientation sectors (ris.3.14) - this will help get rid of the intermediate Orientation lines separately and adjust the thickness of the valves, as in the legs, and in the wings. Next butted field of lower valve of "C". Note that it is located on the axis of symmetry of the model and does not belong to the "B" or "B '", but it

also applies to that, and the other block on the perimeter (as "grow" from one point of the tree leaves).

The next step is separate whole block obtained at the moment of the upper sash warhead. To do this, paving the river based on topography docked surface. Internal bank of this river will match the surface of a complex field obtained at the moment. At the end of first butted the first couple of fields that are symmetric about the center, and then the rest of the field a treetop leaves.

This process we have previously considered, so there is not going to go into details. After docking of all fields is to choose a form of folding and cutting off all unnecessary for assembly.

If we want to limit all the elements form a square, then we can obtain the following final pattern model (ris.4.21) (dark areas tucked or cut prior to assembly).

4.21 The final pattern model

Rather, for the assembly of this model will require large-format sheet - this is due to wide corrugations needed to fold the bottom, but the look is much more attractive than the usual and ordinary leaf. By the way, do not forget that when you create a corrugation of rotation, making a full circle is not necessary - you can do well in, say, half. Although the lower part of the model will be hollow, the form of its visible part is not affected.

At first glance it may seem that the pattern looks very complicated - do not panic: corrugated sections are usually formed similar and monotonous. You can check it out, putting to practice simple wrinkles. Not necessarily go directly to curved corrugation advise to start "get hand" on the flat. Though of course, this is an individual matter. Some like to take just a super complex work, and someone - on the contrary, to hone skills on simple models, gradually moving to the complex. But in any case, the most important thing - it's a go! I'm sure with each new attempt your work will be better and better! Also, if you have already mastered the previous three chapters, crimping should not cause any difficulty.

The "paper mosaics"

In the previous chapter we have examined a way to transform the appearance of the flaps as embossing. I recall that when corrugation pattern adorning the surface of the valves in a set of rivers that cross the face of the bellows on the trunk rather complicated trajectory. This is a great technique by which a host of famous models such as the "Hedgehog" Eric Zhuazelya "fugu" SiphoMabon, "Aquarius" Hojo Takashi and more. But there is another, no less important area of origami, which occupies a very special role in the design of linear methods. This area is called origami tessellation, or the technique of origami paper mosaics.

Paper Mosaic - a relatively young field of ancient art, but in recent years it has become increasingly in demand among origamistov. The appearance of these origami masterpieces as "Fish Koi» Robert Lang, or «RuyZin 3.5» Satoshi Camille, it must use techniques origami tessellation. Most paper mosaic exists as a genre, but thanks to it, you can learn how to meet the models and their parts incredible designs, giving the surface a truly amazing, spectacular and colorful appearance.

The following are some of the models, the creation of which I have used techniques jewelry leaf with mosaics (Photo 5.1).

5.1 Models, decorated paper mosaics

As you know, the classic tile - this decorative arts, whose works are formed by the linking and consolidation on the surface of colored pieces of glass, or ceramic, and

The "paper mosaics"

origami - the art of folding shapes from a single sheet of paper without scissors and glue. Overall, this is a completely different style of art - on the techniques used, the materials and so on. How could they be combined?

The fact that the role of multi-colored paper mosaic modules perform so-called cells, which are joined to each plane of the sheet so as to form a solid frame. If, however, illuminate the finished mosaic on one side or the other, we will see a colorful image, pattern, which results from the fact that different parts of the surface covered by a different number of layers. In other words, transformed plane obtained through origami manipulation, passing light, forms a mosaic ornament, painted many shades of one color. Folding the paper mosaics - a very exciting activity that requires especially careful when assembling the basic elements. Mosaics can be folded from almost any paper material - from tracings and to cardboard. In this case, the genre is incredibly rich in a variety of combinations of various forms. Following the specifics of this book, we will consider only the basics of flat paper mosaics. However, this will be enough to begin development of the more complex aspects «origami tessellation». For example, in recent years have become very popular three-dimensional puzzle, in which the elements of a flat folding used with three-dimensional transformations of the plane. So you can get wonderful, three-dimensional shape, coated stranded patterns. As an example, it is worth noting the famous collection of bulk masks made American Joel Cooper, to the whole world the beauty of origami, built on the symbiosis of sculpture and mathematics. Looking at his work, you know that the world is limitless paper mosaics, and learn it really worth it!

Mosaics can be divided into two basic types: those made using the single grid, the other without. In this chapter, we will consider only the first, because the more we are interested not so much the Mosaic as their combined use with linear methods. As for the mosaic, designed with no single mesh, then joining them in the structure of the model is possible, but often unnecessarily complicated.

So, the basic building block of the mosaics are the so-called cell. Cells repeatedly repeat the folding and consist of an element or group of elements abutting each other. The cells are different, but they are most often formed by four standard elements: a triangle, parallelogram, trapezoid, and hexagon. Sometimes the master mosaic paper used and more complex shapes * 56odnako thus, include a mosaic pattern in the structure can only be extending the frontiers of the page (more on this later).

 * pentagons, octagons, irregular shapes described etc.

The "paper mosaics"

Generally, in practice, in a paper mosaic used only rectangular (in BP) and triangular (in HP) unit mesh. They are used for the convenience of drawing lines folds and simplify assembly. In addition, for the formation of the cells themselves use only two types of transformations of the plane: the imposition and rotation.

OVERLAP

The essence of the overlay is to increase the thickness of the ordinary by successive folds (Fig. 5.2). The number of layers, their width and orientation depend on what properties we require land mosaics. In its pure form overlay - no more than the usual fold-zip. However, since the transformation of the cells are different, then thedirection of the bend sheet, and the number of parallel folds, may also be different.

5.2 Overlay

Overlays * serve as a "foundation" on which subsequently formed all wells and built itself a mosaic. Typically, they are a set of parallel lines, differently oriented to each other. This structure defines the mutual orientation of the planned pattern, and to obtain it requires specific, individual lines of folds. Masters of the genre of origami tessellation, has developed a set of all possible systems of overlays, which can be combined with each other. It should be noted that the imposition of which are used to form one cell will be completely unsuitable for others. Therefore, the design, the mutual compatibility of the different overlays must be checked separately in each case. When placing the tiles, overlay, they are made, sometimes peresekayutsya.57V these cases come in different ways. For example, on a rectangular grid, so you can dock the overlay (Figure 5.3).

 * cash in paper mosaic represents not only the action - fold-lightning, and the area to the pattern, which is bounded by parallel lines adjacent folds.

The "paper mosaics"

5.3 Crossing overlays on rectangular grids

In the triangular mosaics, overlay, an equivalent - a combination of parallel layers, with the only difference being that the main directions of the folds, which are made using a single grid lines are not two, but three. Thanks to all sorts of manipulation with layers inside the cells is much greater than in mosaics on rectangular grids.

If the surrounding differences, the process of obtaining the cells in the rectangular and triangular mosaics completely identical: selected basic guide lines, and after folding is the formation cross section in accordance with the rules of Kawasaki. As a rule, they are: 60 and 120-degree intersection (Figure 5.4).

5.4 Crossing overlays on triangular grids

In addition, there is already a large arsenal of options for connections overlays on a triangular grid, there is always ample room for your experiments. It is quite possible to find many other ways to connect

The "paper mosaics"

components of cells. For example, in the case of (ris.5.4.2) little corner, marked with a black arrow you can not fill in, and get out, without changing the structure of the incoming overlays.

ROTATION

Adding different models, you are probably faced with such a popular item, as the rotation. For example, the rotation is often used when putting the flowers. The best known of such models is the "Rose" Japanese Origami Toshikazu Kawasaki. Personally, I doubt that there is origamisty who never tried to lay down that I am not afraid of the word "masterpieces" of the world of origami. The excellent combination of simple design and incredible realism of the results is "Kawasaki Rose" a favorite for many origamistov. It became a kind of standard of beauty, which, willy-nilly, compare each new origami rose, or other origami flower. During its history, "Rose Kawasaki" has undergone many changes, and its various modifications are innumerable, coming up to her feet with needles, leaves, etc. But the basic element of the underlying structure of the model remains - is the rotation in the central square. Kawasaki's Rose - this is a great example of that rotation does not belong only paper mosaic, but that the mosaics found its place as a practical element is required.

Rotation - this way connections overlap, at which the rotation of the figure, at the site of the joint, relative to its center. You can rotate almost any convex geometric figure. With this manipulation, it is easy to implement docking need to pick a set of overlapping overlays.

Within the unit used more frequently rotated grids: a triangle, parallelogram, trapezoid, and hexagon. In this case, a rectangular, rotate mainly parallelogram (square and rectangle), and the triangular - all four. Consider the rotation of the square on the BP-grid (Figure 5.5).

5.5 Rotation of the square on a rectangular grid

As seen in Figure 5.5, the top of the square located at the nodes so that the resulting lateral displacement occurred simultaneously imposing values "a" (ris.5.5.1) from all sides of the square. This value is called the width of overlap and 5.5 it is two steps of the grid.

Please note that the back of the plane developed a region in the center (ris.5.5.4). The size of this area can easily be changed by varying the size of the rotated shape. Patterns containing such elements backs look as if the model is made of several interlocking sheets (this nuance is very important for practical use and without it, as a rule, does not do any one mosaic).

Sometimes the design of the mosaics at the output of the rotation required to get blending widths. On rectangular grids this can be done by rotating the rectangle (Figure 5.6).

5.6 Preparation of different lateral movement by rotating the rectangle

Similarly, by rotation and on triangular grids (Figure 5.7). Now, in addition to the rotation of the parallelogram to dock overlays, you can rotate the triangle, hexagon, trapezoid. In this case, changing the size of the rotated figure on the reverse side can be closed or open to varying degrees, the "back". Below are a few patterns that describe similar rotation.

5.7 Samples of spins on a triangular grid

After folding along the upper patterns, shown in Figure 5.7, the reverse side will closed, and on the bottom - open.   As for the folding domains of revolution, it is for the same type of any figures. For example, Figure 5.8 shows the process of rotation of the diamond with the closed and open "back" (upper and lower images, respectively). Please note that the lateral displacement of the rotation angles of the figures are the unit interval "a" in the grid itself.

5.8 Rotation of the diamond on a triangular grid

As for rectangular grids, lateral displacements may be different if there is a need for different elements join neighboring cells. This requires a change shape of the figure rotation (ris.5.9).

5.9 Rotation of pieces from different angles of lateral displacement

It should be noted that for plane mosaics have to follow the rules of getting a flat folds, described at the beginning of the book. Dock must be designed so that the continuity and orientation of all lines between the cells was not affected. Failure to do so may mosaics for bulk and in some cases, the "vital", but getting flat mosaics such derogation is not allowed.

If you want to make the rotation of figures, other than those that we have discussed above, it is necessary to know the following simple rule (ris.5.10).

10.5 Rotation of arbitrary convex shapes

All the angles of orientation overlays * rotation should be ravny58

With reference to Figure 5.10.1, in the exercise of imposing the following equality (15). It provides a very "flat" rotation, in accordance with the rules of Kawasaki (see Introduction).

d1 = d2 = d3 = ... = dn (15)

Local deviations from that of (15) are the basis for the bulk of paper mosaic. These are:

- Projected flat part of the puzzle, according to (15);

- Selects the nodes where you want to create volume from;

- Replaced the corners flat folds selected nodes.

This, of course, equation (15) is violated, but the parallel folds of the overlay when moving to surround the site allows you to join the new cells.

By this, (15) can be adapted to various combined grid (ris.5.10.2, RR *-net). It's a complex task, requiring additional geometric constructions, but it is doable.

Of course, in theory, the angles «di» may not be equal (ris.5.10.3), but at the same time, the very imposition cease to be an overlay in the "linear" understanding. Overlapping lines are no longer parallel, which is incredibly harder to obtain cells and docking them together.

DOCKING CELLS

We now turn to the process of joining the projected mosaic of cells (Figure 5.11).

5.11 Docking cell mosaic

 * d - the smaller the angle between the fold of the overlay and the adjacent side of the figure rotation.

Suppose there are two arbitrary cells (ris.5.11.1). To combine them, you need to maintain continuity and orientation of overlapping beyond the cells. This can be done as usual imposition or rotation, and with the help of connecting cells. On Figure 5.11 shows the options for docking with the rotation of the diamond, triangle and hexagon. Choice of figures of revolution in each case depends on many factors: the parameters of the docked cell orientation trunks, side offset angles rotation figures, etc. In cases (ris.5.11.2a and 5.11.2v) domain rotation during assembly will be closed from the back side, and in the case of (ris.5.11.2b) will remain closed central triangular area.

Since cells can produce any possible manipulation, the main thing to keep the continuity of the overlays. It is possible to change the distance «S» between cells (Figure 5.11.2b) (extending overlay will continue to satisfy the conditions of the assembly).

By and large, the connection of cells is the same as combining the elements within the cells. In all cases, docking is the same rules, and, learning to join together basic components, you are pretty easy to learn how to combine and cells.

MOSAIC DESIGN

At the beginning of the design, based on the ornament you want to get selected basic building block - the cell. Repeated many times and butted together, the cells form a mosaic frame. *

Here is an example of designing a flat mosaic on a triangular grid. The main structural element, select the cell (Figure 5.12).

5.12 cells selected for folding

As shown in Figure 5.12, the cell consists of three diamonds and hexagons, and these elements are oriented opposite to the plane

 * Designing Mosaics its different characteristics, and start learning the process is using cells taken from the patterns of ready mosaics. It is easier to gain experience in understanding the fundamentals and nuances docking.

sheet. When folded, they form a structure, which rotate 60 degrees clockwise rotation for all figures. Note that the main structural cells should be selected so that the mating elements were in different directions of the unit mesh. This will help to avoid adding additional transitional stage between overlays. In this case, the layout of the cells, the diamonds of one cell joined with overlays another, without violating the rotations themselves diamonds (Figure 5.13.1).

5.13 Joining of three identical cells

So is pre-docking all the major cells that we have chosen to fold (the joints - the dark diamonds (Figure 5.13.1)). Note that if the dock cell in the other directions, the "dark" color to paint all the diamonds. However, there remain a number of areas in which the connectors can not dock on their own, without any additional manipulation. They need to eliminate either having carried intersection overlays, or putting a figure of revolution. In Figure 5.13.1, these sites are located within the area marked by a circle. This design phase takes the most time, especially during the docking complex cells.Sometimes you have to re-plan model, to change certain elements, etc. But, more often, especially for simple cells - the exit is. In our case, it's simple. Just add a triangle, as shown in Figure 5.13.2, and "black holes" in the structure does not remain - all imposing on the joints are closed and will provide a normal mutual rotation of elements when folded. The triangle will then be rotated counter-clockwise, ie in the opposite direction of the hexagon and diamonds. To get the final mosaic pattern, fairly distribute the resulting structure of the entire area of folding, and you are ready to assemble (photo 5.14).

5.14 Assembling the selected mosaic

Assembly is carried out sequentially: element by element. First - the hexagon (photos 5.14.2-5.14.3), then all adjacent elements around it (photo 5.14.4-5.14.5) and by analogy all the remaining parts (photo 5.14.6).

It should be noted that the design of the same tiles can be chosen completely different cells. In our case, for the structural cell can take a combination of triangles and diamonds (see Figure 5.15).

5.15 cells selected for folding

Now passing link between cells is a hexagon, which in the previous case, was the center of the cell, and is oriented in the opposite direction from the plane of the sheet.

Mosaics for the decoration MODELS

Origami is quite often used when putting the puzzle of their models, and this is not surprising. Integrated use of techniques often leads to quite dramatic results. There is an opportunity to add fish scales, hat - interwoven texture of straw, and so on. To obtain this effect are masters in two main ways: in the first - the mosaic structure is not attached to the structure of the model, in the second - Mosaic is one of the structural elements of the pattern, being "woven" into the rivers in different ways.

In the first case, first, is a pre-designed mosaic area of the sheet, then, develops a model (not paying attention to the mosaic). That is, the design is so light that the area on a piece of tile will cover the right side of the model after assembly. Thus, the light appeared fish «Koi» Robert Lang, "Alligator" by Michael La Fosse and many other models. In such projects, mosaics - the result of preparation of the surface area to the assembly, where they are not a structural element.

In the second case, a mosaic is part of the structure of the model. In the design process, it is woven into the structure parallel to the interface of the main elements (fields and rivers). Now just delete the mosaic pattern of the pattern model will not work, because the marshes are formed in the

system trunks. Examples of models made in such a way, can be called the "Dragon Ryu (version 2-3.5)" Satoshi Camille, "Latimer" Chad Kilina and others. The assembly of such work does not necessarily begin with mosaics - it all depends on the complexity of the mosaic and the location of its final pattern within the area of folding.

Both methods have their advantages and disadvantages, but, despite the relative complexity and the complexity of the assembly, the result is worth all the effort spent on it. Let's take a closer look.

Mosaic additions by expanding sheet line

Suppose, after we decided to decorate the design of the model is a mosaic, but it does not want to complicate Wed complex transitions between trunks. In this case it is advisable to resort to expand the boundaries of the sheet with the addition of the paper material. This technique can provide us with an ample supply of paper required for transformation of the plane in a mosaic pattern.

The reasons for choosing (this manner of mosaic model) can be different: perhaps it will be easier to fold, or you want to use a mosaic pattern, weave through which you all know how it is not possible. In any case, familiarity with this technique would be equally useful.

It is important to note that this method may serve not only to add mosaics, but also to enable cross-wings - (photo 5.16) (more on this later), as well as ribbed or geometric designs. Algorithm for all these actions will be the same.

5.16 Models with cross wings "Submarine" and "sawfish."

How is it done?

First of all, you need to design a model to any previously described procedure .60 * Then you need to determine the area or nearby areas on the pattern of which subsequently formed the "branches" of the tree leaves. Such as «a», «b», «c» in Figure 5.17.

 * you can use any method, either: sectoral or angular. In general, sufficient to have just a final pattern, even if it is created on a whim (no methods at all), or borrowed from other authors.

5.17 Replacing the sheet area on mosaic patterns

Next, determine the amount of paper required for the appropriate replacement. You can find out by defining how the expanded dimensions of the mosaic more dimensions when assembled. * Of course, for that part of the test, a mosaic, which we want to see the finished piece (Figure 5.18).

5.18 Transformation of the mosaic structure in the plane

It is obvious that, in general, will change not only the area mosaic, but also the shape of the source sheet from which the shape model. Of what is likely to change the proportion of convertible uneven areas (ris.5.18 right). Therefore, for a new form of the sheet folding, increase the size obtained after the deployment of a mosaic on a certain amount. Schematically, this increase is shown in Figure 5.19 (where "A" - the area mosaic assembled, "B" - the area mosaic loose) .61

 * Folds overlays can intersect at different angles, which is why predict straightened form mosaics almost impossible requires practical work required field.

5.19 Changing of folding

Of course, the above scheme is quite approximate. Because in each case the replacement tile overlays can very significantly change the «a», «b», «c» and «d», as well as the shape of these regions. In general, a '= a + e, where "e" - the amount by which to change the area "a" if you deploy all overlays, its member. Parameters «b '», «c'» and «d '» are defined similarly. If the angular region intersects a different number of overlays, the initial parameters are selected maximum value * .62

Do not forget that this type of replacement flat spots in the mosaic, as a rule, there is the need to tuck the excess at the edges, giving them a straight form. It is for this reason, often use mosaic, built on the VR-grid. Then, in most cases, such surplus is left and the follow model assembly is greatly simplified.

If you need to cover the pattern is not a single area, and a few (ris.5.17), replacements are done similarly. But this should be consistent from site to site. Changing the dimensions of the sheet folding will be calculated taking into account the value of the total surplus generated by decompressing all the mosaics in the plane. Except in those cases where the mosaics are located on the same overlay.

The advantage

uschestvami of ways to add patterns are: first, the universality of the type and quantity used mosaics, and secondly, the ability to add them after the receipt of the final pattern. You can easily choose a completely arbitrary structure of weaving, of all shapes and configurations without having to worry about the details of further assembly and structural nuances.

* If the form is folded and unfolded mosaics - a square (the mosaic on the BP-grid), and the initial model is designed for the square, then the pattern will also be converted to a square shape. In this case, the parties will change the source sheet for the same amount.

However, adding mosaic by expanding the boundaries sheet becomes very complicated assembly process in the application sites. The problem is that multiple overlay, obtained by folding the mosaic will go beyond the limits of folding. As a consequence, increase the thickness of the sheet everywhere, which is why there are problems with the final treatment. Not to mention the fact that the basic shape of the folded sheet of double-triple thickness will be much more difficult. But all the same, thanks to extreme simplicity of design and effective results, this method is often used origamistami, orienting creativity of its technical rigor structure, and the visual appeal of the model.

Interwoven into the structures of MOSAIC PATTERN

Way of decorating the models through the interweaving of mosaics in the structure of the pattern is fundamentally different from that described previously. Now, in addition to select the area to integrate the mosaics, as in the previous case, it is necessary to determine in advance the folds along which all overlay go into trunks (rules docking fields and rivers, and with them the process of design, will remain). A very important role is played by the location of the mosaic: the border of the sheet or inside it. This is due to the fact that many of the mosaics (mostly patterns, based on triangular grids) are extremely difficult to weave into the structure of the pattern on all sides simultaneously. Moreover, this can be done is not always. Therefore, designing the model, most VR-woven mosaic (especially useful if the structure is created by the repetitive single overlap (Figure 5.20)).

5.20 Examples interweaves mosaics based on a rectangular grid

There are many types of these transformations. When folded, they form a variety of patterns, from which it is possible to find a suitable image for any particular situation.

If the area is chosen for the mosaic at the border, and even better - goes from edge to edge of the paper, the design can feel much more comfortable. Volume of the mosaics is immeasurably greater. Now you are free to add to the structure of the tiles on arbitrary meshes, limiting overlays members from only one side. In Figure 5.21 is an example of how one system included overlays (lower pattern), you can get different types of mosaics, not thinking about the dock with the other three sides. * 63

5.21 Weaving mosaics on the edge of the sheet

On the border of the sheet feels quite "at ease" even the structure of the HP-mosaics on a triangular grid when it docked at the location inside the folding would require considerable effort and expenditure of time. The next step, after the choice of the structure and location of the mosaic search begins passing links. What is it? Challenge link - is a set of fields that are connected in a special way by which the transition from one structure to the other overlays. ** Challenge link - the element needed for docking with the mosaic structure of the trunk pattern. Without passing the links connecting lines when folding and remain in a superposition of multiple harmonica. In Figure 5.22 shows examples of passing units for different types of overlays. Some of them you already know from the previous chapters of the book, just before we consider them from the point of view of the appearance of a certain image layers, like an insect abdomen. Now, their functions become more pervasive - namely passing units form the basis for a future puzzle.

 * They are located outside the area of folding.

** Accordion trunk also is a kind of "fan" overlay (overlay all originate at one point).

Rollovers 5.22 units for different types of overlays

Configuration formed by overlapping (they are shown in the figures of the patterns) are chosen depending on the type of mosaics. So, for example, for the mosaics "1", "2" (ris.5.20), you can take passing link "2" (ris.5.22) for mosaic "3" (ris.5.20), as well as all the mosaics in the picture 5.21 - passing element "3" (ris.5.22). That is: the rolling substitution level on the one hand bellows provide the desired output of the system overlays the other.

Sometimes there is a need to increase the number of cells in a certain section, but without changing the settings of the unit mesh. In this case, resort to manipulation. For each type of mosaic can totally different combinations of lines that form a transition. However, with all the wealth of options, versatile way to convert these elements simply do not, as a rule, for each situation has to find the right set of lines by experience. These transitions are called elements increase the frequency overlap.

For passing sections 5.22, increasing the frequency of overlapping elements may appear as shown in Figure 5.23.

5.23 Elements of increasing the frequency of overlapping

Of course, this particular cases, it is possible that you will find more rational configuration, designing their own models, but on the "first", they can be useful.

Obviously, the most difficult is the interweaving of the mosaic structure of the fields in the areas that are within the area of folding. Therefore, for

comfortable design should try to choose options such mosaics to form their imposition on the opposite side were a continuation of each other - both on the location and the orientation of the plane of the sheet lines. An example of such a longitudinal weaving mosaic is shown in Figure 5.24. * 65

5.24 Mosaic, woven into the structure of the pattern

In Figure 5.24.1 show the items studied previously. In areas "A" and "E" are going over the links, sites «D» and «B» with the elements increasing the frequency overlap, and the section "C" is itself a mosaic. As you can see (ris.5.24.2), with a structure designed overlays, it is not necessary to know the composition of the mountains and valleys in the mosaic to its weave. Is enough to design the fields and the river in the rolling link and stretch them so that you can, if necessary, to include an element of increasing overlap and, of course, the very mosaic.

 * Mosaic is very easy to "break" in the fields and rivers, stretched in the rolling parts, and further design done already formed along the borders.

As for the other groups overlap, leaving a mosaic, there are several options for converting their structures outside of the mosaic.

The first - the simplest: it is possible to overlay these bring to the border of the sheet, without any kind of transformation. Looking ahead a bit, this transformation can be seen in one of the drawings of the practical part of this chapter (ris.5.45, dotted vertical lines).

The second way is much more interesting, but also more complicated. It is used when there is a need to transfer overlays to the accordion with full inclusion of the mosaics in the structure of the pattern. An example of such a transformation can be seen in Figure 5.33 (a section on cross-flaps, which will be detailed later). At first glance, this problem should not cause any problems: like, you can add the same passing links (for mosaic 5.24 would fit link 5.22.4), only this time at right angles. However, not so fast!

You need to understand in more detail. If you take a close look carefully, you will find that the new fields, a longitudinal overlap, will be perpendicular to the transverse, and thus forming them into the river will cross-over links that goes against everything that has been described in this book!

Ironically, the answer to the questions "What to do?" And "Is it possible?" - Yes, "Yes, probably!" However, to fully understand this, you have to "get" the scope of this book, in the area of so-called cross-wings.

CROSS FOLD

As we know, the folding doors in any linear method (in the classical sense), requires only two types of lines: Test and Orientation. Connecting lines in the fields when folded concertina form, located along the plane of the paper, which was subsequently attached to all doors of the base form. Orientation also adjust the shape of the field lines. Well, there is one in origami style wings - cross, which is made by an accordion, located across the plane of folding. This spatial orientation of the base form is made possible by the introduction of a new type of lines that are called vector. Vector line is the plane reorientation accordion folding. In fact, in the "pure" linear methods are also there - the lines are straight and coincide with the borders of the rivers. In a classic case of the vector lines do not affect the structure of the model - they can not make the plane a new leaf for the plane of the sheet, and therefore are not counted separately.

Consider the structure of the simplest transverse leaf (Fig. 5.25).

5.25 Pattern transverse leaf

Note the dotted line surrounding the margin of «L» (Figure 5.25.1). This is the vector line. All connectors that are suitable to the borders of the field, after the introduction of the vector lines are reversed plane accordion (in this case - at 90 degrees). Gate length is not changed, but its direction, if not all the lines of a flat folding pattern (ris.5.25.2) will be perpendicular to the plane of the sheet and doors, built on the continuation of the harmonica. Since folding "not flat", in practice, some parts of the vector lines are likely to not be subjected to bending, and in these places the field will have a classical form. But anyway - the structure of the new field will be a different. For example, the field (Figure 5.25) can be released from the lateral parts of the vector lines, as shown in Figure 5.25.3. Thus as a result of folding, we obtain the same transverse leaf, but already having a flat appearance (Figure 5.26).

5.26 Assembling the transverse leaf

Adding fields of this type gives us a lot of technical outlook, which previously we have not thought of. Surrounding the complex field vector lines and blocks, it is possible to do a lot of objects on a plane and made of a single sheet. For example, it may be a group of people - Figure 5.27.1, or a few trees - Figure 5.27.2, and so on.

5.27 Trees models created on the wings of the transverse

Of course, for each of these objects need a separate unit and a separate vector line. Design algorithm is the same, except for the small detail - all fields cross the block should be packed into a convex shape (that is, all the angles unit must be less than 180 degrees). Only in this way can create a continuous vector line. For example, this condition implies that the cross-BP blocks must be rectangular.

How is this achieved? Need to do as well as in getting rid of wetlands - by the rivers that make up the fields selected for the design. For example, consider the image of the human figure, standing on a certain plane (Figure 5.28).

5.28 Adjustment of the cross-shaped block

Finished the regular design "man" on a tree leaf, we have a block in which one interior angle is 270 degrees (that is, a figure which is packaged unit is not convex).

Notice the dark area at the bottom left (Figure 5.28.1), which borders the troubled corner. To comply with the requirements for obtaining a cross block, we need to fill the gap closed by rivers. To do this, proceed as follows. First reduced vector line (solid polygon in Figure 5.28) and define the boundaries of the cross-block. Then select convenient to transform the river and fill the niche, as usual bog (ris.5.28.2). Then restore the connection lines, and the pattern element is ready. It is not difficult to imagine how a variety of projects can be built with transverse leaf. Respectively, may be completely different levelof the internal components. Some of them may well wear the sector structure, but close to the border of the block to make the transition back to a linear structure. Moreover, if all the angles of cross border blocks are equal, then the vector in each straight line segment will not change the angle of sloping (ris.5.29.1). Otherwise, the change will be on sectors (ris.5.29.2) Orientation parallel lines at the corners of the block. This is very important in the design and transverse blocks it requires special attention.

5.29 Transverse blocks of regular and irregular

At this point a theoretical study of the structure of transverse fields we have finished. The information provided to us will be enough to move to mainstreaming a paper mosaics in the linear structure of the pattern.

Of course, as you can see, this area has a very large origami prospects of and describe all the details can be long, but it is, as they say, "another story." In order to evaluate only a fraction of the transverse leaf features, take a look at Figure 5.30. You are free to continue the study of vector lines oblique transverse folds (ris.5.30.1), or manipulation of the plane-base, such as in Figure 5.30.2, here represented the "man on horseback", where "the people" - a single transverse leaf, "horse" - the result of transformation of the ground plane. Having a basic knowledge, practicing and fantasizing, you can make real masterpieces of modern origami, using its arsenal a tool such as the transverse leaf.

5.30 The use of transverse leaf

So, back to the mosaics and in fact, the main question of this section of the chapter. How by transverse fields, we can write in a linear structure crossing pattern overlay to build on their continuation of tiles?

The answer is in the form of transverse fields, which if necessary can be "stretched" without changing the length of the leaf, if stretched side of the field parallel (ris.5.31) (occasionally, you can stretch the field and at a fixed point).

5.31 Extension of the transverse field

In other words - to form a mosaic, we can use an unlimited number of parallel trunks, formed after stretching (ris.5.31.2). In this group of folds on each side of the field will be independent for further transformations necessary to obtain the desired set of overlays.

How we passing links and increasing the frequency of overlapping elements, we already know (see the beginning of this chapter.) Now let's see how they can be incorporated in the transverse fields (Figure 5.32).

5.32 Education overlap in a transverse field

Pay attention to the central part of the transverse field. As you can see, it is crossed by imposing 'XX' "and« YY '». The nature of such transformations is described by transverse sectors.

Cross-sector - an area within the field bounded by one of the sides of the field, the adjacent Orientation lines and passing between them.

Let me explain with an example. In Figure 5.32 you can see two dark gray areas. The first is limited to one side of the field - «fe», Orientation lines «fg», «eh» and transient element of «g» to «h», passing through the point, «g», «x '», «y'», «h». Accordingly, the second area - party «ad» Orientation lines «ab», «cd» and transient element of «b» to «c», passing through the point of «b», «x», «y», «c». Both areas are closed and form the structure of transverse fields in these areas. This is a cross-sector, which we denote [fe] and [ad] respectively.

To form one of the inscribed overlay requires two opposing top passing units. Thus, each «X», inscribed in the structure should be allocated to «X '» - opposing the cross-sector and general neighboring trunk (Fig. 5.32). The same thing - to impose «YY '». It follows that for the convenience of design wise to choose a mosaic to form their opposite

passing links were mirror images of each other (Fig. 5.33). That is, the work must be predominantly correct (ris.5.33.2) or stretched (Figure 5.33.1) geometric shapes with an even number of sides.

Of course, if you prefer, you can experiment with arbitrary shapes of fields and their cross sectors. But I would not recommend to complicate the already complex element, which then has to be transferred to the area of folding by the control points and, of course, add up.

5.33 Adding a mosaic structure in a transverse field

As shown in Figure 5.33, for the mosaics "X" Two sets of mirror opposite sectors - [AB; CD] and [AD; BC]. In the mosaic «Y» is involved 3 groups: [AB; DE], [BC; EF] and [CD; AF]. By the way, similar to 5.33.1 was obtained back part of the model "Gargoyle" (photo 5.34) - distributed under paws transverse leaf. Surely you have noticed that the vector lines are marked by a wavy line. Already mentioned by some unpredictable situation vector lines when folded, and in this case, the exact form we will likely not get it.

5.34 Model "Gargoyle"

When assembling, the strips accordion gathered into a bun at the base and are at different angles, which are then distributed evenly (it all depends on the location of the connector relative to the boundary of the field). That's OK, because the "non-linear" region is hidden from the eyes of the plane mosaic. This is clearly seen in Figure 5.35 for an example of an assembly of the transverse field with a mosaic 5.33.2. As a result, the assembly, the base we have a strict NO-linear structure as in the standard HP-margin: Orientation to the lines at the corners and with the connection at the base.

5.35 Assembling the transverse field with a mosaic

The assembly of the transverse field in the following order:

- Add overlay forming a mosaic and, in fact, the very mosaic (Fig. 5.35.1-5.35.2);

- Reorient (if required) folds cross sectors so that the base they had characteristic linear techniques harmonica (Figure 5.35.3 - 5.35.5);

- Add up all the angular region between the lateral sectors (Figure 5.35.6);

- To bring together the base of the transverse field (Figure 5.35.7);

- Forming a pleated-base (black dotted line), to distribute portions of the cross sectors evenly under the plane mosaic (Figure 5.35.8) (see to that at the base of the transverse field trunks took "their" space inside the accordion *) 66

- To make the mosaic flat shape (Figure 5.35.9).

If the structure of the model included several such valves, the stack should be consistently "from the complex to the simple," in accordance with an algorithm. With that, the same way you can enter not only flat, but the bulk mosaic (Figure 5.36).

5.36 Three-dimensional tiles in transverse fields

Similarly, the selected mosaic, which remove border blending options ** 67 (ris.5.36.1).In accordance with these values, selected cross-over units of sectors. After that, the pattern of mosaic (ris.5.36.2) is included in the overall structure of the new field (ris.5.36.3).

In most practical cases it is necessary to weave a mosaic with a sufficiently large number of cells in the area of the transverse field, which contains a relatively small number of trunks accordion-base. To solve this problem, we can proceed in two ways.

1) The easiest way, which we have already discussed in this chapter - the entanglement of the required number of cells by increasing the frequency of the elements overlap. In Figure 5.37 are highlighted in dark gray area on the border with mosaics. Manipulation is performed in all-over links.

 * As in a regular MRI field for further connections to the elements of the model.

 ** This type of mosaics, often need to move away from the mirror symmetric structure opposing passing links, especially when the very volume form on the surface does not have symmetry axes.

5.37 Increasing the frequency overlap

One gets the "complex" field as well as the cross-sectional area with a mosaic (Fig. 5.35), but not to start assembly with rolling management, and increasing the frequency of the element with the overlays.

A notable feature of this method is the possibility of repetition. That is, you can add not one, but a whole system of elements increase the frequency overlap for any increase in the number of cells on the surface of the mosaic flap.

2) The second method is more complicated: the desired number of cells is achieved by branching overlays (partly self maneuver seen earlier in this chapter). It lies in the fact that a means of internal transformation within the overlay, turn it so that one get two (Figure 5.38.1) and more (see Figure 5.38.2).

5.38 Branching overlays

With this method it is possible to get the output different widths overlap (ris.5.38.3). This applies in cases where the required write a mosaic based on the rotation of "non-standard" geometric figures (Figure 5.9). Moreover, if you want to reduce the value («b» <«a», «c» <«a»), the angle of the «x» <90 °.

Using the branch to increase the number of overlays on the surface of the transverse field, it must be ensured that all the side overlap to form a closed structure (Figure 5.20.1), and the original guide, as always, with their cross-docked sectors.

The final image of a mosaic is likely to change its orientation relative to the surface of the transverse field. This can be seen in the arms of the model "Gargoyle" (photo 5.34). This feature should be considered in advance before the start of design. It is advisable to practice in the assembly of these fairly complex pieces on separate pages, where you can adjust the project if necessary.

Both methods may well be used together. You do not have to overload the pattern with additional elements to increase the frequency of overlap, and the number of cells increase significantly (Figure 5.39).

5.39 Sharing elements increase the frequency overlap

Pattern in Figure 5.39.2 consists of all the key elements that we considered in this chapter. Mosaic itself, which is the main "target" of the transverse field (Figure 5.39.2) is formed by overlapping obtained after branching at the exit of the element to increase the frequency. These elements are highlighted in dark gray (ris.5.39.1) border tile.

The most difficult areas for the assembly in the rotated by 45 degrees mosaic are 12 cells with the rotation, so start the assembly of the cross-field follows from them. Otherwise, no change: The assembly is carried out in the sequence described above (Figure 5.35).

5.40 In the photo is a detailed cross-field assembly 5.39.2. Vector line "not stable," but because the very door at the nodes {A; B; C; D} will shape not "flat" or "almost flat" (photo 5.40.5). If the edge Mosaic seem too large, they can just bend inward, with the final processing of the mosaic, it is possible to do away from the other side of the tree leaves. For example, the mosaic can be folded a basket, and the harmonica "hang" some ribbing rotation - get a basket of apples, etc.

5.40 Assembling the transverse field with woven mosaic

It remains to add that fits into the mosaic structure of the valves can not only in linear methods. True, different methods have their own characteristics, and each will be slightly different approach will be manipulated by the Orientation sectors closing trunks on himself, tall shutters, etc. However, this topic is for another publication and requires a separate study and deeper into the foundation sector and angle techniques.

CREATING MODELS MOSAIC PATTERN

Design models with mosaic elements by "expanding the boundaries of the sheet," except for the calculation of the parameters of the variable region, is no different from the design of conventional models. Since this information has already been described in previous chapters, proceed directly to the creation of a mosaic-like patterns formed by interweaving pattern in the structure of the pattern. To do this, consider the tree leaf (Fig. 5.41).

5.41 The selected design model "Pangolin"

The tree leaf (Fig. 5.41 top left) fit many models, be they dinosaurs, crocodiles, etc. Dwell on the folding model pangolin, whose body is known, is covered with horny scales rhombic located tiled over each other. This model is ideal for the design with interwoven mosaics. Moreover, due to the fact that the model scales on the legs are smaller than on the back, to decorate the body shape, can be used to increase the frequency of overlapping elements (ris.5.41sprava - the final result).

Please note that the entanglement of the mosaics should immediately focus on the real image, so you know exactly where and when to add different types of patterns. This is important, because the image of the surface is critical to the success of the appearance of the model, and depending on the type of tile will produce a different set of overlays. In other cases

design, as described in previous chapters, it was enough just to identify a tree leaf (there was no need to pick apart the pattern of body surface). In this regard, the creation of models with a more complex mosaic surface design in specific techniques. This is due to the fact that is necessary to consider a number of limitations that arise with the introduction of various rotations and overlaps in the structure.

Despite the fact that wood shutters look so easy. Interwoven at the mosaics is not important. It is possible that for the simpler configurations pattern will look horrific. The complexity of the project will depend on the type of mosaics, patterns, which in and of themselves do not look easy. If we consider that we add passing links, increasing the frequency of overlapping elements, transverse and conventional fields, the picture may well shock even the most experienced origamistov.

In such cases, the main thing is not to panic and not to abandon the build up to a detailed analysis of the pattern. Personally, I have often found himself in such a situation. At first refused to fold model due to the abundance of technical nuances, afraid of the picture. But after analyzing the main components, passing links and other intricate places, you realize that it's pretty trivial.

To design a model with woven mosaic sequence, from one item to another, just like adding corrugations (Chapter 4). The exceptions are those AREAS mosaics, all of which blend converted by passing parts of the accordion. In this case, the pattern can be freely join as the fields, or combined into blocks. You must first select a mosaic depending on the pattern on the surface of the real model. In our case fits mosaic 5.42.

5.42 Scales selected for folding model

It's pretty spectacular mosaic simulating scales. It's perfect for our model looks very attractive and very simple sum, which is important for models with woven mosaics (due

the complexity of the final pattern). Now you need to choose a passing links, forming imposing this kind, and we can begin to design.

Allowed to use the standard BP-passing links, such as in Figure 5.43.

Rollovers 5.43 BP-units for the selected tile

By selecting these links passing, formed elements of the complex, which can be connected to each other, like any normal field, in accordance with all the rules of joining. There should not be any difficulties, questions docking has repeatedly discussed in the book. Now we need to determine the best way to create a basic set of overlays, because our model is completely covered with scales. That is, you need to get the long-longest mosaic, woven into the structure of the pattern. If mosaic miniature, so to speak, is part of a light decoration form, passing the problem of the links do not represent themselves. The case changes dramatically when you need to get not 5-6 overlays, and say 30-40. In these cases, the result will be formed by the superposition of inflection huge number of folds, zippers and likely will put before the master impossible technical challenge.

Back a bit and remember butterfly design in the third chapter. In the design of the abdomen butterflies you and I have calculated the angle MR field at which formed overlay that meet certain conditions (ris.3.55). There is a formula of obtaining the angle between the side surface and the base of the field, depending on the width of the river and the width of the field. Now, substituting the values we need, we find that for our conditions (see Fig. 5.42.1), the angle «y» is 60 degrees. That is, the design can be easily implemented in a "pure" HP. It certainly simplifies our assembly and transfer lines on the sheet-folds after the end of the design.

So, to bring the mosaic to a suitable form for joining, we write the complex field of HP-on components (Figure 5.44.1).

5.44 Using Overlays to integrate the mosaics

In Figure 5.44 shows only the upper part of the composite field. By introducing such a restriction, we will automatically enter a system of reference in which the original item will make the edge of the tail. In this case it would be appropriate, since the maximum length of this model lies just behind, so there is no need to add the surplus, not involved in the formation of the outer form. With regard to expanding the site overlay (Figure 5.44.1), everything here depends only on the number of cells that we want to use across the flap. Taking the image of the pangolin, and based on its proportions, we can determine - the three central range of scales in the center and a half on each side (we'll add

them to the final design stage). Thus, focusing on a selected set of scales, and expand the boundaries of the Overlay to the desired value (Figure 5.44.2). Next, go to dock Rib, where, based on the proportions of a model, we have to expand the area overlaps, forming the back.

Folding model to match our wood shutters, it is necessary that the border of the rivers that form the back in contact with the boundaries of fields, the hind legs and the base of the tail. As a result of this arrangement can be used freely vertical overlap between mosaics (ris.5.45), simplifying the design process by eliminating the corresponding cross-sector.

5.45 Docking dorsal and caudal parts of the model

However, with this arrangement, because of the difference in the width of the mosaic pieces, there is a need to skip the side vertical overlap in the area of the dorsal caudal fold fields (they are marked on ris.5.45 vertical dashed line). In this case, all the connecting lines running through them, will be recognized as a backsight line. Also, there are two external swamp "?" On the sides of the place docking. As the wooden shutters, these areas will continue to be the beginning of the blocks corresponding to the hind legs of the model.

Note the very wide river, which describes the tail unit. Its surface has a mosaic pattern, and, in terms of the structure of the model is of no value. However, if you look at the backsight line, then everything will fall into place. Due to this river, expanding the trunk overlay, as well as the very middle of the mosaic. The resulting excess can be subsequently removed when folding, tucking into the model, but at the moment this river should be left alone so as not to complicate the design.

Now consider the structure of the front and rear paws. In contrast to the previous puzzle, now we need to introduce elements of increasing the frequency of overlap to reduce the size scales. For this type of assembly is fine mosaics discussed earlier (ris.5.23.3). The very same side of the unit in charge of the legs, will then be as follows (ris.5.46).

5.46 Adding increased frequency overlap

The front legs are designed and folded the same way. Now you only have to dock all the missing fields and limit the resulting configuration of the square of folding.

In fact, for this model, everyone can pick up the proportions of the tail, trunk and limbs, which are more familiar. It suffices to repeat the algorithm and enter your reference points.

The final model looks like a pattern as shown in Figure 5.47. Maybe your results will be different places: more or less the tail, or not to be used to increase the frequency of overlapping elements, etc. But, if you repeat the process of design, the overall design of your pattern pangolin will be about the same.

5.47 The final pattern model "Pangolin"

EASIER PATTERNS

Learn the basics of designing a linear techniques, we moved steadily from simple to complex, the images you have in mind models gradually acquired the shape and structure. And in each chapter - be it a simple basis BP, or the intricacies of mosaic patterns - we have always referred to this chapter. Simplification patterns - the final stage of the transformation of your idea into a complete, concise structure, to have a model not only external but also the structural beauty. Unfortunately, the joy of receipt of the final pattern model, made in the linear method is often overshadowed by serious problems arising when folded. Designing is not easy, and if more and assembly "do not go", the hands are simply "down", and not only for beginners, but also for professionals who are well versed in all the subtleties SR.68 Suppose the master ran into some pattern, which add up to known methods is impossible. After several unsuccessful attempts, as a rule, try to solve the problem by taking a piece of paper large size (can it be that, contrary to expectations, the more difficult to fold *). The result can be dramatic - the feeling that time is wasted and lost the desire to fold model. On the one hand, a sense that the assembly on the forces, and to abandon the pattern in the final stages of folding tantamount to leave the marathon distance of 100 meters to go. On the other hand - to begin to re-folding, with the feeling that something is missing - the same as to get to the start again immediately after a grueling race. How then do in such cases?

I think a lot of those moments origamisty experiencing some dissatisfaction with the result - and the design, and the folding patterns of other authors. Usually, the search begins more elegant way to transform certain elements redesign, and so on. This indicates that the experience gained can already make some quality to building and, most importantly, the design of models that have a much more complex structure and a set of flaps in the patterns, but something is missing. For further growth will have to master the theory of simplicity patterns.

I have no doubt that when you buy the experience, you will discover a lot of new possibilities "unloading" Wed The need for and effectiveness of simplicity patterns will be evident as soon as you feel, how much more convenient and faster model develops. And, of course,

 * The more paper, the greater the consequences of inaccuracies creases, and folds to make difficult - if only because of the fact that the lines themselves are getting longer ...

without understanding the basics of simplifications are very difficult to create a high-quality chart to models that could easily be perceived not only by professionals but also for beginners. And so, gradually, step by step, making it easier to certain elements of the "heaviness" pattern, it is easy to achieve a more "readable" form of their project. Knowledge of the basic principles of simplicity patterns is most relevant for the linear design techniques that are the focus of the book. Indeed, a characteristic feature of pleat-models is the huge number of lines formed in the process. Currently, there are a wide range of methods and supporting software tools that allow you to design a model with a very complex and multifaceted structure. Therefore simplification patterns - one of the most pressing issues for modern design. Basically, on a professional level origamista can be judged by how well done simplifying the pattern and structure modeli.69 Unfortunately, the scope of this book does not allow to consider simplifying the extent that this issue deserves. The chapter presents only the basic principles. But, nevertheless, simplification - this is an area of origami, the knowledge of which is enriched mainly on personal experience in practice, specific examples, while creating a pattern with the given parameters. * The purpose of this chapter - to give beginners an idea " where to go,

"and" what to look for? "for further professional growth. Else, willy-nilly, you have to master yourself. So, simplifying patterns is divided into two main stages: Optimization (relative position and shape of the trajectories of the rivers) and replacement (Orientation sectors, blocks and other elements). In fact, these steps intently follow each other. If optimization is done poorly, then the replacement is usually not much help - no exceptions in the bill. If the design is made with the expectation of future replacement, and optimization will be part of itself. When we are dealing with complex mating fields, for example, the design in the HP and MP, the discharge pattern can be made for the individual blocks, followed by docking changed items. In the design of a simplified BP produced mainly after receipt of the final pattern. First, we consider in detail what the change and how they are performed directly in practice, using the available tools.

* Personally, I regularly reviewing patterns of their old projects, I find new perspective of simplicity, which had not noticed before. Some models have undergone optimization updates to 10-15 (I think this is not the end.) In the end, we all learn, we learn something new and useful.

REPLACEMENT ELEMENT PATTERN

Replacement - is the process of simplifying the pattern due to the transformation of one element into another, with a more convenient form for use. When replacing the main base settings are saved - the length of the valves, the proportions of the major elements of the base, etc. For example, consider the patterns (Figure 6.1) for one and the same tree leaves.

6.1 Standard and simplified version of the pattern for that tree leaf

In both patterns of all the elements of the original wood shutters, just the right one is a bit easier to build than the left pattern, made in a linear method. In a simplified version of a number of new "mini-wings" between the major fields and rivers, which can be easily hidden behind folding area (although, if desired, they can be used to decorate the model for final processing.) These are made of the same Wed sheets, and major components have the same coordinates relative to the boundaries. Moreover, patterns can be obtained from one another by simple manipulation of the fields and rivers, but more on that later. While we note that in this case, a simplified version of the pattern was derived from the first just using substitutions. As you know, each pattern is made in a linear method has the characteristic external features: parallel lines that form the structure of the model. However, some elements Wed also belong to a sector techniques. In these areas, you can do without the "bunching"

Trunk *. These elements have their place in the linear structure also using some of the standard procedures. If earlier it was the particular examples, thesimplifying the use of such elements to the forefront and made intentionally. Thus, in Figure 6.1, a simplified baseline pattern used repeatedly by replacing the elements of the method "22.5 O-division." ** It is easy to see that the manipulation to replace that run on similar elements are also made for specific algorithms, which makes it easy to remember the sequence of actions. With a little practice, and over time you will learn how to make change to the eye, without going into specific detali.70 It should be noted that due to the ease upgrading of BP in the "About 22.5", with the appropriate skills, and replacement by competent optimization, it is possible to completely get rid of the "bunching" of trunks, making BP model is the model of "22.5 O". This simple technique is often used by even the greatest masters, because "22.5 O-separation" - one of the oldest and most popular methods. And "22.5 O" is no exception! This is

the beauty of simplification - if you want, you can go from the linear method in any pie, changing pattern as partially or entirely. Preserving wood shutters, you may want to seriously facilitate assembly, while leaving the trunk of an accordion to education, such as tile or corrugated. In general, replacement and mutual transition between the methods in the design - a very promising field of research, especially for fans of the sector metodik.71

BASIC PRINCIPLES SIMPLIFY PATTERNS

Virtually all of the simplification process is not to the fields and rivers, and on the Orientation sectors that form closed during the docking area. The most preferable if the sector angles coincide with the centers of the fields. In cases where the sector angles and centers of fields located at various points, the problem is not much more difficult, and the need for simplification may well be conducted only over a part of the docked Orientation sectors. Let's look at what changes you can make with the pattern immediately, without additional calculations. For simplicity we consider some standard replacement «box pleating» (in other linear methods they operate on the same principles, regardless of the structure of the Orientation of lines).

 * Previously, the study of the foundations of design in BP, HP and MP, mentioned the use of elements of techniques such as Circle-Packing, 30o-division, 22.5 On-sharing, etc.

 ** In those areas where the accordion trunk goes directly to BP, and abutting the sector form closed rectangular border.

The easiest step is to check and exclusion of BP pattern extra trunk without changes and transformations form fields. That is, you should get rid of all the lines that are not directly involved in the formation of the structure of the model. For example, compare patterns of Figure 6.2, satisfying wood shutters, chosen by us at the beginning of the book (see Figure 1.10).

6.2 Simplification of the pattern by reducing the number of trunks In the pattern, shown on the right (Figure 6.2), we have removed all of the lines that are not used in the formation of fields and rivers. As you can see, after "cleaning" pattern, structure and composition of the base flaps survived. It is important to note that this example - the abstract, and in this case, from a practical point of view, such a decrease in the number of lines would only lead to an undesirable increase in the thickness of the valves. But this principle is quite convenient and commonly used in the real design. Especially if you need to change the number of trunks is not the whole pattern of a whole, but at different sites. For example, in the modification of the model through the transformation of the pattern of separate angular sectors. Thus, some river "1" single quadrant sector BP (ris.6.3.1) can be replaced by the next element (ris.6.3.2), consisting of rivers "1", "2" and a triangular field.

6.3 Option convert single quadrant BP - sectors

This element is often used in linear methods for converting Orientation sectors. He performed at the corners of sectors, with an even number of reflected trunks. Please note that you can easily adjust the number of trunks, located on opposite sides of the bisector of the angle and get an even number of different areas, they are separated (Figure 6.3.3). It helps to relieve those areas pattern where the lines are not required (back to Figure 6.1, you can see the use of this element.) In Figure 6.4 shows how the folding of the element of transformation angle BP - sector.

6.4 Procedure for the folding angle VR-sector

Figure 6.5 shows another very effective way to replace the standard, which is produced at the junction of the two quadrants BP - sectors. Where trunks form a U-shaped curve (Figure 6.5.1), it is convenient to perform the modification shown in Figure 6.5.2. In contrast to the conversion of angular sections separately (Fig. 6.3, 6.4), this manipulation is performed for both docked quadrants simultaneously.

6.5 Options for docking of two BP-sectors

With this transformation, as in the case of Figure 6.3, the width will remain "a», «b» entering and leaving the rivers "1", "2", but will be able to adjust the number of trunks, forming an even number of adjacent sections (ris.6.5.3). A small triangular field formed inside, you can optionally hide the frontal area of folding, and it does not affect the tree leaves. Often, this small triangular segment is left for a more full and realistic elements in the final processing of: forming a claw cancer, crab, scorpion, etc. With the segment can be distinguished boundary of the claws, whereas in pure form this site, built in the likeness of the element (see Figure 6.5.1), do not leave the dividing lines, causing claw would like to continue the course, and not a separate joint * .72

We should pay particular attention to one more detail. As you can see, the top formed a sector unit, in the form of an isosceles right triangle large size, which does not contain the connectors. It can be left unchanged as when folded, and add closed trunks thickness adjustment valve. This sector is one block from the main unit cell method "on 22.5." If left unchanged, the pattern (ris.6.5.2) will develop as follows (Figure 6.6).

6.6 Procedure for the folding of two adjacent sectors of VR-REPLACEMENT SECTOR UNITS

We now turn to the rotation of sector units, forming a closed area. Examples of interchangeable sector units can be seen in Figure 6.7.

 * Of course, the land can be converted to standard overlays folds - lightning, but if a lot of layers in the harmonica, then do a similar replacement will be better.

6.7 Interchangeable sector bloki73

All relevant sector units can be substituted for each other, and the tree leaf is preserved (except for small side-fields), and the parameters of all incoming and outgoing rivers in the quadrants will remain unchanged. Figure 6.7 shows a special case of a great number of such changes, and the form is not limited to transposable elements box. But the diversity of these changes will be available to you only after studying the sector and angular methods *.

What changes can be made without payment, to simplify the pattern designed in other linear methods? With the exception of special cases of the above techniques for HP and MP can be used only to reduce the number of trunks (Figure 6.2) and the transformation of a single angular sector (Figure 6.3). In other cases, as a rule, are made easier after a series of mathematical calculations or graphical changes to ensure receipt of the proper configuration of sectors or centers of side fields.

Optimization of BP pattern

The concept of optimization is very often mentioned in previous chapters. In origami for optimization understand the process of moving fields and rivers to each other without changing the structure of the base form in order to simplify the pattern elements.

In this section, we discuss the principles of optimization separately for BP, because only in this technique to simplify the patterns is not required

 * This does not mean that the replacement should try to do everywhere - a lot will depend on the location of the rivers in specific situations. In this case, I prefer replacement, based on the methods of "About 22.5", because the angles formed by dividing a right angle into 4 equal parts.

special calculations. Also move the rectangular fields and rivers along the rectangular grid is immeasurably easier than prodelyvat the same operations in the HP and MP. Of the relative ease of manipulation move fields and rivers that in most cases, the optimization can be done in BP after the receipt of the final neuproschennogo pattern, and not in the process of its creation.

Consider the optimization pattern BP model by example. For that, first bring the final pattern for wood shutters, shown in Figure 6.8.

6.8 The selected tree leaf model "aircraft"

According to the structure of the tree leaf, the base model is similar to the aircraft: a tail for balance, with wings and wheels. Once the project is created pattern, and we begin to optimize and replacements, the model form will not have special significance, because all the work will be carried out over the pattern. How to figure it out, we know (the process of designing a BP described in detail in the first chapter). Go to optimization by considering the final pattern (Figure 6.9.1) and design (Figure 6.9.2) for the selected form sheet.

6.9 Summary and design patterns are obtained for a given tree leaf

On 6.9.2 shows the design pattern inscribed Orientation lines and boundaries of the rivers used in the design.Basically, with his help, and being optimized.

So, first of all, we examine the patterns for items that are capable replacement. To seek any symmetric sector units, or a combination of the familiar elements * .74 In our case, the area suitable for to replace it without having to move the fields to one another, is part of the pattern, marked with a dark color (Fig. 6.10. 1).

6.10 The process of optimizing the structure patterna75

This is quite a large sector of the multicast block, and therefore fix its position. ** As distinct sectors are no more blocks, we start optimizing the structure, which move those areas which will shift to new possible replacements (here, in principle, the quality of work, depending on your fitness).

Note (ris.6.10.1), which displaced the lower field along the dotted lines until the matching nodes highlighted gray and white circle, we get two more regions (ris.6.10.2). Now they are also subject to change to various sectors of the blocks, made in the sector techniques. Thus there is an opportunity to transform a few more fields, stretching them as shown in Figure 6.10.2 (the direction of stretching

is shown by the dashed arrows on the right of the pattern). They are stretched to align the gray and white circles, in order to obtain another closed symmetric field at the top of the pattern (Figure 6.10.3).

In the results of this manipulation we was alone BP - the area shown in white in Figure 6.10.3. This kind of "pie River", in which the connecting lines are parallel to the side boundaries. On other areas of BP - the separation is not required, which means that at this

* In the analysis special attention should be focused on the largest clusters of sectors, as small change that can occur along the way, did not significantly affect the final result.

** There are times when you need to "sacrifice" one block for the formation of other, more voluminous and complex, but the replacement of which you can implement. preparations of the optimization can be completed and begin to replace the selected areas (ris.6.11.1) (in suitable blocks sectors of the method "About 22.5", described earlier). Block of sectors "A" is a special case unit sectors, shown in Figure 6.7.2, except that it is stretched. Replacement in the remaining blocks of sectors "B", "C" and «D» produced in blocks (Figure 6.7) - in our example, they fit the same. As you can see, after the manipulation gives quite a different picture of the location of the connecting lines and forms of the rivers. There is no doubt of the correctness of actions - all connecting lines to be outside the sectoral units, does not affect the line inside them. As for the major rivers, although they will describe all possible trajectories, the main thing - keeping the basic parameters of elements of * (ris.6.11.2) .76

11.6 Substitution of sector units, receipt of the final simplified pattern

In this simplified pattern can be completed, because of significant changes will not do. However, if you want to get clean, "22, 5O," you can still convert the remaining two BP-element (ris.6.11.2 - circles): the "left" - instead of joining two adjacent sectors (Figure 6.5) and "right" - conversion of the angular sector (Figure 6.3). The procedure is described above. As a result of this work we have simplified the resulting pattern of the model, which is shown in Figure 6.11.3.

This way to simplify this pattern is not the only one. Practicing the optimization of such patterns over time, you will be taught a wide range of techniques and be able to produce a variety of replacement, receiving and simpler configuration. The most important thing, in my opinion, but also the most difficult - to learn to "switch" from conventional units (fields and rivers) in the sector blocks. This "vision" of the structure pattern from different sides will come only with experience - try, from simple to complex, and you will succeed.

 * All side doors, which are formed in the process of folding the base, will be hidden behind the front layer of the folding. They do not affect the final set of items and will match a pre-planned structure (tree leaves).

TAPE HP & MP PATTERNS

Subject to simplify procedures HP & MP incredibly capacious. It includes a "reservoir" of mathematical calculations and geometric transformations. The process is complicated by irregularly shaped abutting fields, preventing carry out optimization or replacement, and often requires familiarity with the fundamentals of mathematical analysis. Therefore, the HP and MP optimization is

performed in parallel with the design, consistently transforming and simplifying the shape of the fields that need to be replaced. To understand the nature of the difficulties encountered in the optimization of these techniques, we consider the structure of the conventional crane. As described earlier, you can use it freely interchangeable square sector units in BP (Figure 6.7.3). Similarly, you can replace the square block in the MR sector, which is generally known to form different flaps (ris.6.12).

12.6 Substitution quadrangular sectoral MP - Block

At first glance, the change is implemented in the same way we did for BP laid diagonally marked bisectors, and you're done. But, unfortunately, is not so simple. The problem is that for a given length of flaps formed when folded, can only be the only such replacement. This follows from the fact that there is only one center of the inner circle of collateral, and with the point of intersection of the diagonals and bisectors it matches only in special cases - for the correct figures. In general, the result of the following (ris.6.13.1).

6.13 quadrangular sector unit

In the central region (ris.6.13.1) dark color shows the river separating our power sector. They are formed when the docking point for the sector to center of the inscribed circle. If the point of the dock will be the incenter of the "x", relating to all sides (defined by rivers entering a sector unit), the picture changes (Figure 6.13.2). All fields are joined unit clean, and do leaf out of a single point (Figure 6.13.3), which is what we needed. It is these centers the inner circle "x" and have to look ahead with calculations or graphical techniques.

For example, stopping at a certain stage of the design, we decided to place further connections include some sector-MR unit. First, we need to select the numerical value of the total of the rivers that are part of our future, a sector unit (these values are chosen according to your project from the tree leaves). They are designated as {R1, ...Rn} and starts the usual solution of the geometric problem of finding the parameters of the unknown quantities (Figure 6.14).

6.14 Calculation of the sector MRI units

For example, for a sector of the triangular block radii of tangent circles satisfy the equation given in Figure 6.14.1 * .77 Similar equations can be formed for any sector units. If we consider the symmetric configuration with the four circles around a fifth (Figure 6.14.2), will have to solve a cubic equation ** 78, as in the case of 6.14.1 - just a square.

* 77Eto equality at the time brought the Nobel Prize for Chemistry (1921) Englishman Frederick Soddy.

78Pri finding ** «r» for such a set (group of circles around the center), in more complex combinations (arbitrary quadrangular, pentagonal and other sectoral units) to solve the equation is not so simple. For example, if you take a sector unit in the form of an arbitrary quadrilateral described already have to solve an equation of degree 4 type $Ar4 + Br3 + Cr2-D = 0$, where the coefficients are expressed in terms of {R1, R2, R3, R4}.

Thus, substituting the parameters «R1», «R2», ... , «Rn» (river included in the sector unit), you must first solve the equation for «r». Then, the circle of radius «R1 + r», «R2 + r», ..., «Rn + r», respectively, from the center «R1», «R2», ..., «Rn», available on their crossing the circle center «r ". We can only remove the center coordinates or get reference lines needed to migrate to the area of folding.

What do origamistam far from mathematics, which simply needs to be replaced or that sector MRI unit? Here it may come to the aid of the opening graphics solutions computational problems that periodically "float" in the press, or even in the public domain in the internet. Modern techniques of design are rapidly evolving, more complex structure is designed models, respectively, increasing the relevance of the use of "graphic" (not calculated) changes difficult elements for the origami as a whole.

Take, for example, the case of the search for the center of the inner circle of sector unit (ris.6.14.1). This problem may well be solved with a graphical algorithm. This geometric problem is widely known as "the problem of Apollonius," and its exact solution by inversion, and the transition to concentric circles of many known since high school. When designing a triangular sector-MR unit are free to use these building needed to solve this problem (of course, on a separate sheet and with a compass and ruler).

For a symmetric configuration with four circles around the fifth (ris.6.14.2) elegant graphical solution found famous Japanese origamist Toshikazu Kawasaki 79issleduya generalized classical base crane * (Figure 6.15).

6.15 Graphical solution of computational tasks T.Kavasaki 6.14.2

Unfortunately, this graphics solution 6.14.2 fit only for the quadrilateral, symmetric about the diagonal, however, using only these elements can greatly simplify your work. There are common solutions for any described quadrangle, but their production requires more than a complex manipulations, such as the solution (Fig. 6.16) * .80

* Source - Tanteidan magazine № 110 T.Kavasaki article, the case R2 = R4

6.16 Graphical solution of computational tasks R.Lenga 6.13.

In Figure 6.16.3 shows the construction of the structure of a possible replacement for any quadrangular block of sector «ABCD» (Figure 6.16.1), through the transformation of the top "0" unit in the two fields with the centers of "1" and "2." These points are located at the intersection of the tangent to the corner circles {R1; R2; R3; R4}. These circles are formed by rivers belonging to the sector block for any MP - distribution. To get a reference point "X1" and "X2" sector data blocks to make the fold "1-2" and spend bisectors of the angles of "1" and "2" within sectors «D» and «B» (to the desired point of intersection of rice .6.16.2). "Foldability" of this simple design is easy to check. It follows from the form of a quadrangle «X1Y1X2Y2», which is similar to quadrilateral ABCD and is also described, which means that the amount of its opposite sides are equal. On this basis,

easy to show that the circle of "1" and "2" diagonal touch "X1X2" at one point, that is, the line "1-2" and "X1-X2" - perpendicular. According to the rules of Kawasaki, it will be enough if the difference between the mountains and valleys on the module will be equal to two. Remaining amount to paint the opposite corners of the nodes {X1, X2, Y1, Y2} and verification is complete.

Please note that these blocks after sector in building high-rise wing, such as in Figure 3.17, but now they will have a complex shape (a "fan" at the top). These "branch" can be used to generate additional decorations look tall sash and, if desired, to plan them in advance (for example, to drill the tail or mane of a horse, etc.). The range of such combinations within a sector unit correct form is limitless, whether it is a Steiner chain (Figure 6.17.1), or simply a set of high-rise wings (Figure 6.17.2) - here you can give free rein to your imagination, experiment and choose anything. The main thing that the input and output of the river matches the original wood doors. With a knowledge of the fundamentals of sectoral methodologies which options you choose - this is, as they say, "a trick."

* 80Danny sector unit and its variations are described and origamistom American scientist Robert Lang in the book «Origami Design Secrets» http://www.langorigami.com/

6.17 Complex Orientation sector

Certainly, those who are fond of origami mathematics, will find a lot more interesting in the "settlement" replacements. Each new element creates a "new" problem, and the solution may be quite different from previous ones. From a practical point of view, this deepening often is not justified because of the amount of time spent on the decision. But sometimes it is the opposite, when hard to get the coordinates of only one or two unknown circles, you can easily restore all lines Orientation entire sector units and the whole of a given structure.

This concludes our tour of the world of theory origami ends. In future releases, we will continue to explore various design methods. And now I would like to suggest you to try your hand at folding models and solving a puzzle prize origami «OriGame».

I wish you luck and success!