

M.C. ESCHER

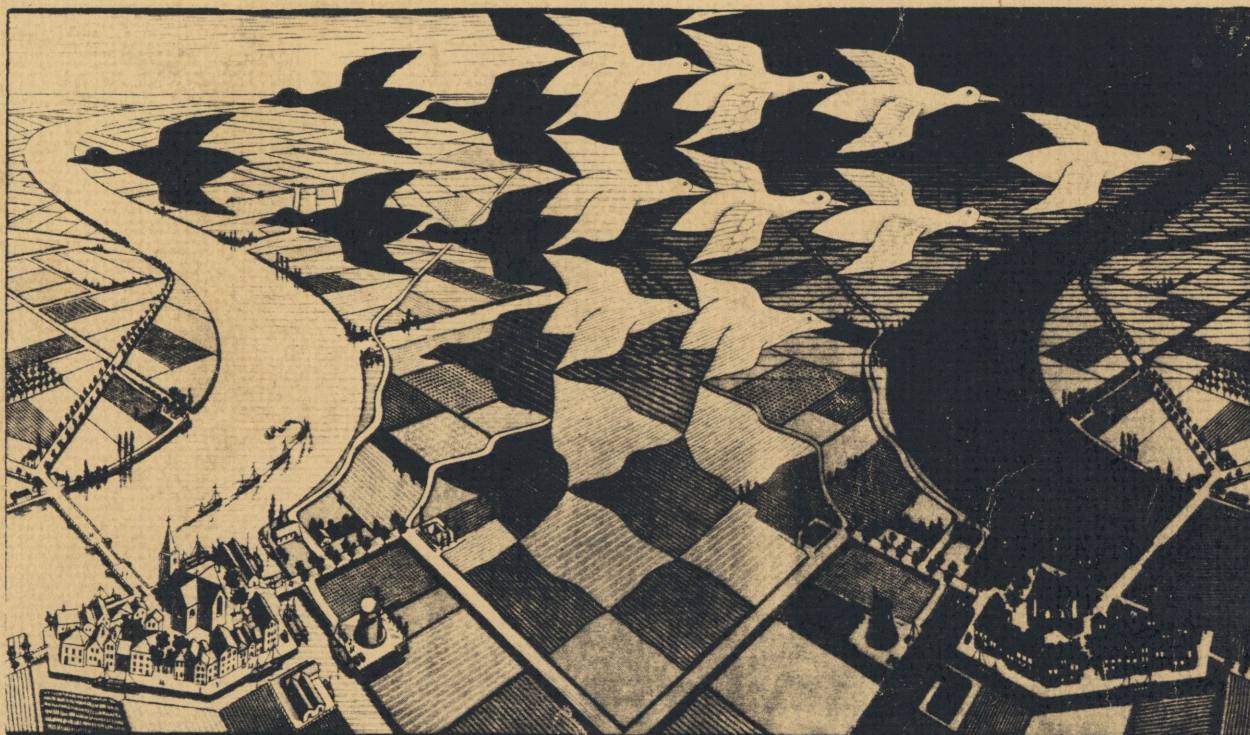


Figure 1. Day and Night¹

Architectural Thesis
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STUDY OF M. C. ESCHER

BY

ROBERT AXFORD

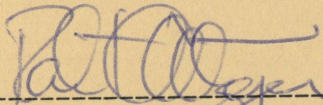
A professional paper submitted in partial fulfillment of the requirements
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of

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Approved

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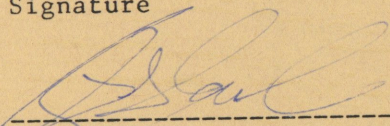
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Introduction

From my very first encounter, I have been inspired by the graphic works of M.C. Escher. This inspiration is both visual and intellectual. I find the images to be striking. I can not help but wonder how they were created. What stands out particularly in my mind was Escher's ability to perceive this world with an unencumbered open mind. He seems to have viewed life from a different point of view - to have seen things as no one else has seen them before. Throughout his life, he was inspired by many discoveries. Each one of his prints is a recording of these discoveries. As they are often mathematical in nature, they can be appreciated for their intellectual as well as their artistic achievements. His work sharpens our awareness of visual perception, and heightens our insight into the world around us. They are a refreshing challenge to our preconceived notions of reality. With these thoughts in mind, it is my hope that a study of Escher's way of thinking will provide a valuable avenue of exploration into the field of architecture.

Premises

This thesis has been set up according to the following premises. The project has been initiated by a wealthy benefactor through the M.C. Escher Foundation, Haags Gemeentemuseum, The Hague, Netherlands. In recognition of his appreciation for the delight and inspiration which Escher has given him, this benefactor has agreed to fund a project, the intent of which is to:

1. Gain insight into M.C. Escher's character and art works.
2. Using the three hundred block of the Eighth Avenue Mall in Calgary, Alberta, redesign the mall based on the analysis of M.C. Escher's character and art works. The design should be considered an opportunity to create an "architectural playground." The only restriction will be that all of the functions which presently exist within the mall must be incorporated into the final design. The project will include the vacant lot (dimensions 100 feet wide by 130 feet deep) located in the

middle of the block on the south side of the mall. This lot should be treated as an extension of the mall. As the intent of the project is to provide as free an opportunity as possible to create this "architectural playground", contextural considerations will be considered secondary.

M.C. Escher's Character

In order to facilitate an understanding of M.C. Escher's character, and provide a concise representation of it, I have divided my analysis into two separate parts. First, I have broken his character down into three interacting elements; his intellectual nature, his artistic nature, and his intrinsically striving nature. Second, I have provided a series of quotations intended to support my analysis, and give further insight into Escher's character.

The first element, Escher's intellectual nature, forms the basis for almost all of his prints. With a keen awareness, Escher took tremendous delight in observing the natural environment and the order which it revealed. He became fascinated not only by the rules which governed this order, but also by the rules which governed our perception of it. Throughout his life, Escher maintained this observation with an open and objective mind. Whenever he doubted, he questioned. His approach was neither cold or impersonal. It was warm and caring.

Escher maintained throughout his life that he found it very difficult to grasp scientific principles. Yet, he devoted a great deal of effort trying to understand the rules of mathematics, geometry, and perception which guided his interests in space, order, symmetry, repetition, metamorphosis, growth, and infinity. This effort can be viewed in terms of three stages; discovery, exploration, and understanding. The first stage, discovery, is the spark which set his intellectual nature into motion. It is the step without which none of his creations could have occurred, for Escher maintained that he was never creating anything new. In fact, he considered his prints insignificant since they were only expressions of his findings. As such, anyone could have produced them. The second stage, exploration, was the tool which Escher used to expand his knowledge of the discoveries he had made. This stage forms a cyclical process with the discovery stage, for new explorations would lead him to new discoveries, and new

discoveries would lead him to new explorations. The third and final stage, understanding, was achieved only after sufficient exploration of his discoveries. The thoroughness of his explorations determined the level of his understanding.

The second element of M.C. Escher's character is his artistic nature. Though much insight can be gained through a perusal of his prints, a more complete understanding of Escher's artistic nature requires further explanation. Throughout his life, Escher had difficulty considering himself an artist, especially in relation to other artists. Indeed, his inquisitive nature often questioned the concept of art. As his creations served mainly to express his discoveries, explorations, and understandings, their artistic content remained subservient to their intellectual content. If ever a conflict arose between his artistic intentions and his intellectual intentions, the latter always won.

Escher's artistic nature can be broken

down into four stages: wonder, inspiration, creativity, and expression. The first stage, wonder, is analogous to the discovery stage of Escher's intellectual nature. It is the spark which set his creative nature into motion. This stage was essential to the realization of his prints. Once ignited by wonder, the second stage, inspiration, was set into motion. It, in turn, formed a cyclical process with the third stage, creativity, for inspiration fueled his creativity, and his creativity led to further inspirations. From creativity came the fourth stage of Escher's artistic nature, expression. Throughout his lifetime, this fourth stage produced close to four hundred fifty illustrations and a handful of three dimensional carvings.

The third and final element of M.C. Escher's character is his intrinsically striving nature. In his final years, Escher enjoyed widespread appreciation and financial reward for his artworks. However, this was not always the case. Throughout the majority of his life,

Escher's works received very little recognition. Few of his prints were bought by the public. Fellow artists and close associates gave him little support. Official art criticism ignored him. Only recently have Dutch print collections made any effort to build comprehensive collections of his works. With such little encouragement, it is amazing that Escher persevered in producing his unique form of art. That he did persevere is evidence of his intrinsically striving nature. It provided the driving force behind both his intellectual and artistic natures.

Intellectual Nature

"Repetition and multiplication - two simple words. However, the whole world of the senses would collapse into chaos without these two concepts. As soon as we lose sight of them, the world seems hopeless and merciless. Everything we love, learn, recognize, accept and put into order we owe to them. The marvelous and mysterious natural laws surrounding us depend on them. The whole world is kept going by them; if they ceased, the universe would fall apart at once."²

"I can rejoice over this perfection and bear witness to it with a clear conscience, for it was not I who invented it or even discovered it. The laws of mathematics are not merely human inventions or creations. They simply 'are'; they exist quite independently of the human intellect. The most that any man with a keen intellect can do is to find out that they are there and to take cognizance of them."³

"It seems to me that feeling and analysis are not incompatible, and ought to be complementary.

You do not have to be a physicist to experience the miracle of gravity, but with the help of the intellect, your awareness of the wonder may be deeper."⁴

"I have played a lot of tricks, and I have had a fine old time expressing concepts in visual terms, with no other aim than to find out ways of putting them onto paper. All I am doing in my prints is to offer a report of my discoveries."⁵

Discovery

"I was walking over a little bridge in the woods at Baarn, and there is was right before my eyes. I simply had to make a print of it! The title emerged directly from the scene itself. I returned home and started straight away on the drawing."⁶

"On the train to Utrecht I was suddenly overwhelmed and enormously moved by a sky full of clouds at different levels. I experienced a sense of space and three-dimensionality such as I'd not experienced for a long time. It's possible to become suddenly aware of these things, even in an overpopulated country like Holland. Provided that you are looking up, you'll suddenly see that timeless and unbounded eternity. Do you think it silly, or can you imagine what I mean?"⁷

Exploration

" - I came to the open gate, the open gate of mathematics. From there, well-trodden paths led in every direction, and since then I have often spent time there. Sometimes I think I have covered the whole area; I think I have trodden all the paths and admired all the views; and then I suddenly discover a new path and experience fresh delights."⁸

"At first I had no idea at all of the possibility of systematically building up my figures. I did not know any 'ground-rules' and tried, almost without knowing what I was doing, to fit together congruent shapes that I attempted to give the form of animals. Gradually, designing new motifs became easier as a result of my study of the literature on the subject, as far as this was possible for someone untrained in mathematics, and especially as a result of my putting forward my own layman's theory, which forced me to think through the possibilities."⁹

Understanding

"Yet my images require an explanation, because without one they are too hermetic, too much a formula, for the uninitiated. At the same time the play of thoughts they express, though essentially quite factual and impersonal, seems to my constant amazement to be so unusual and, in a sense, so new that I could not find an 'expert' with sufficient understanding to write about it, apart from myself."¹⁰

"...I had a nice visit from a professor from Baltimore and his wife, both ardent crystallographers, who insist I give a speech on my R D in London next summer at an international gathering of crystal-gazers (or sym- and antisymmetrists. Antisymmetry involves using contrasting shades in a design of repeated motifs in space or on a plane. Russian scientists have been interested in this recently, and I myself have not been able to do without it since I started on the regular division of the plane, thirty years ago). When I told them my usual story about not knowing anything about mathematics, they answered: 'You obviously know more about it than any of us.'¹¹

Artistic Nature

"To tell you the truth, I am rather perplexed about the concept of 'art'. What one person considers to be 'art' is often not 'art' to another. 'Beautiful' and 'ugly' are old-fashioned concepts which are seldom applied these days: perhaps justifiably, who knows? Something repulsive, which gives you a moral hangover, and hurts your ears or eyes, may well be art."¹²

"These prints, which, to be quite honest, were none of them turned out with the primary aim of producing 'something beautiful', have certainly caused me some almighty headaches. Indeed, it is for this reason that I never feel quite at home among my artist colleagues; what they are striving for, first and foremost, is 'beauty'-albeit the definition of that has changed a great deal since the seventeenth century! I guess the thing I mainly strive after is wonder, so I try to awaken wonder in the minds of my viewers."¹³

"I find my work to be the most beautiful and the most ugly!"¹⁴

Wonder

"To me the moon is a symbol of apathy, the lack of wonderment which is the lot of most people. Who feels a sense of wonder anymore, when they see her hanging there in the heavens? For most people she is a flat disc, now and then with a bite out of her, nothing more than a substitute for a street lamp. Leonardo da Vinci wrote of the moon, 'La luna grave a densa, come sta, la luna?' With these words Leonardo gives accurate expression to the breathless wonder that takes hold of us when we gaze at that object, that enormous, compact sphere floating along up there."¹⁵

"How is it that a phenomenon like this should move us so? Undoubtedly a good deal of child-like wonder is necessary.

And this I do possess in fair quantity; wonderment is the salt of the earth."¹⁶

Inspiration/Creativity

"If only you knew the things I have seen in the darkness of night...at times I have been nearly demented with wretchedness at being unable to express these things in visual terms. In comparison with these thoughts, every single print is a failure, and reflects not even a fraction of what might have been."¹⁷

"As far as I can observe, hearing (Bach's) music influences my feelings, yet despite or perhaps because of this, the flow of his sounds has an inspiring effect, evoking particular images or flashes of inspiration, and also, more generally, stimulating an unquenchable desire for expression. His music, more than any other classical or modern composer's, reveals something self-evident to me, something I expected without being aware of it, just as one sometimes 'recognizes' a landscape that one sees for the first time. In the middle of a sterile period, I am sometimes filled with a vague feeling of expectancy and sudden hope during a concert.

The desire for creativity precedes the desire to create something specific, and is the spark to set the process of expression in motion. In my periods of weakness and spiritual emptiness and lethargy, I reach out to Bach's music to revive and fire my desire for creativity."¹⁸

Expression

"Since you left I have been constantly struggling with my sphere-spirals woodcut. After the first proof my high expectations were, as always, greatly disappointed. I am now struggling on - with some feeling of despair - so that I at least achieve a passable result."¹⁷

"While I am on with something I think I am making the most beautiful thing in the whole world. If something comes off well, then I sit there in the evening gazing lovingly at it. And this love is far greater than any love for a person. The next day, one's eyes are opened again."²⁰

"What I produce is not anything very special. I can't understand why more people don't do it. People ought not to get infatuated by my prints; let them get on and make something for themselves; surely that would give them more enjoyment."²¹

Intrinsic Striving Nature

"A circular regular division of the plane, logically bordered on all sides by the infinitesimal, is something truly beautiful, almost as beautiful as the regular division of the surface of a sphere. At the same time I get the feeling that I am moving farther and farther away from work that would be a 'success' with the 'public', but what can I do when this sort of problem fascinates me so much that I cannot leave it alone?"²²

"I walk around all alone in this beautiful garden, which certainly does not belong only to me, but whose gate is open to everyone. I feel a revitalizing yet oppressive sense of loneliness. That is why I have been extolling the existence of this paradise for many years and why I am now compiling this book from words and images - even though I do not expect many people to wander through. For what fascinates me, what provides my experience of beauty, often seems to be considered dry and tedious by others."²³

M.C. Escher's Artworks

To gain insight into, and clarify an understanding of M.C. Escher's artworks, classification is useful. However, this is a difficult thing to do, for it is not unusual to see one of Escher's prints contain several different concepts, and these concepts do not readily respond to chronological organization. With these limitations in mind, the following system will be used. Developed by Brune Ernst, a long time associate of the artist, Escher's prints can be divided into three themes, each of which contains three separate categories.

1. Spatial Structure
 - A. Landscape prints
 - B. Interpenetration of different worlds
 - C. Abstract, mathematical solids
2. Flat Surface Structure
 - A. Metamorphoses
 - B. Cycles
 - C. Approaches to infinity
3. Pictorial representation of the relationship between space and flat surface.

-
- A. The essence of representation
 - B. Perspective
 - C. Impossible figures

Not inclusive to these themes are Escher's commissioned works, and his earliest efforts when he was still developing his techniques.²⁴

The following analysis of Escher's art works will be divided into two parts. The first part will contain a series of prints representing each category of the three themes. The second part will contain a brief analysis of the three themes.



Figure 2. Castrovalva²⁵

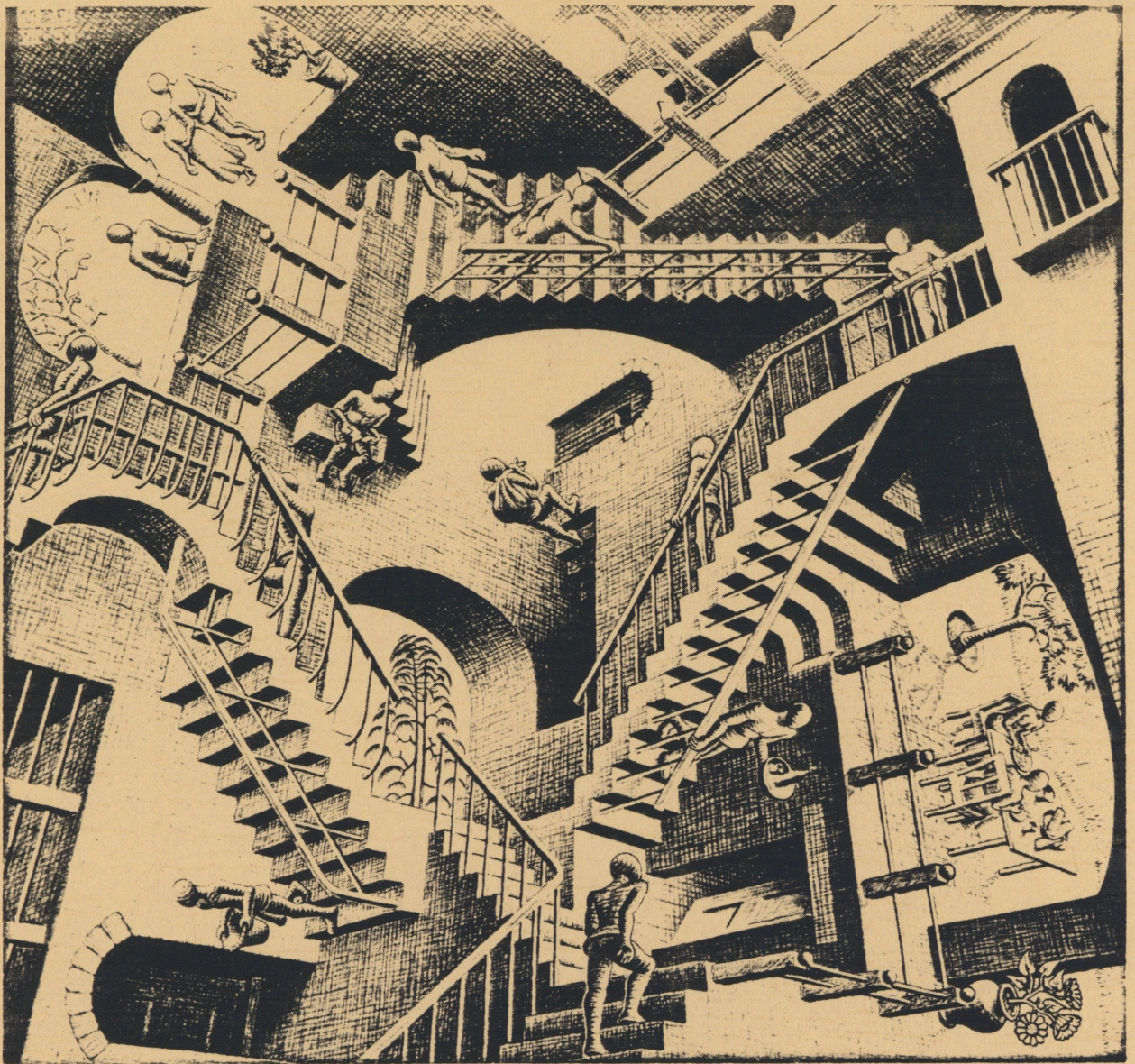


Figure 3. Relativity²⁶



Figure 4. Three Worlds²⁷

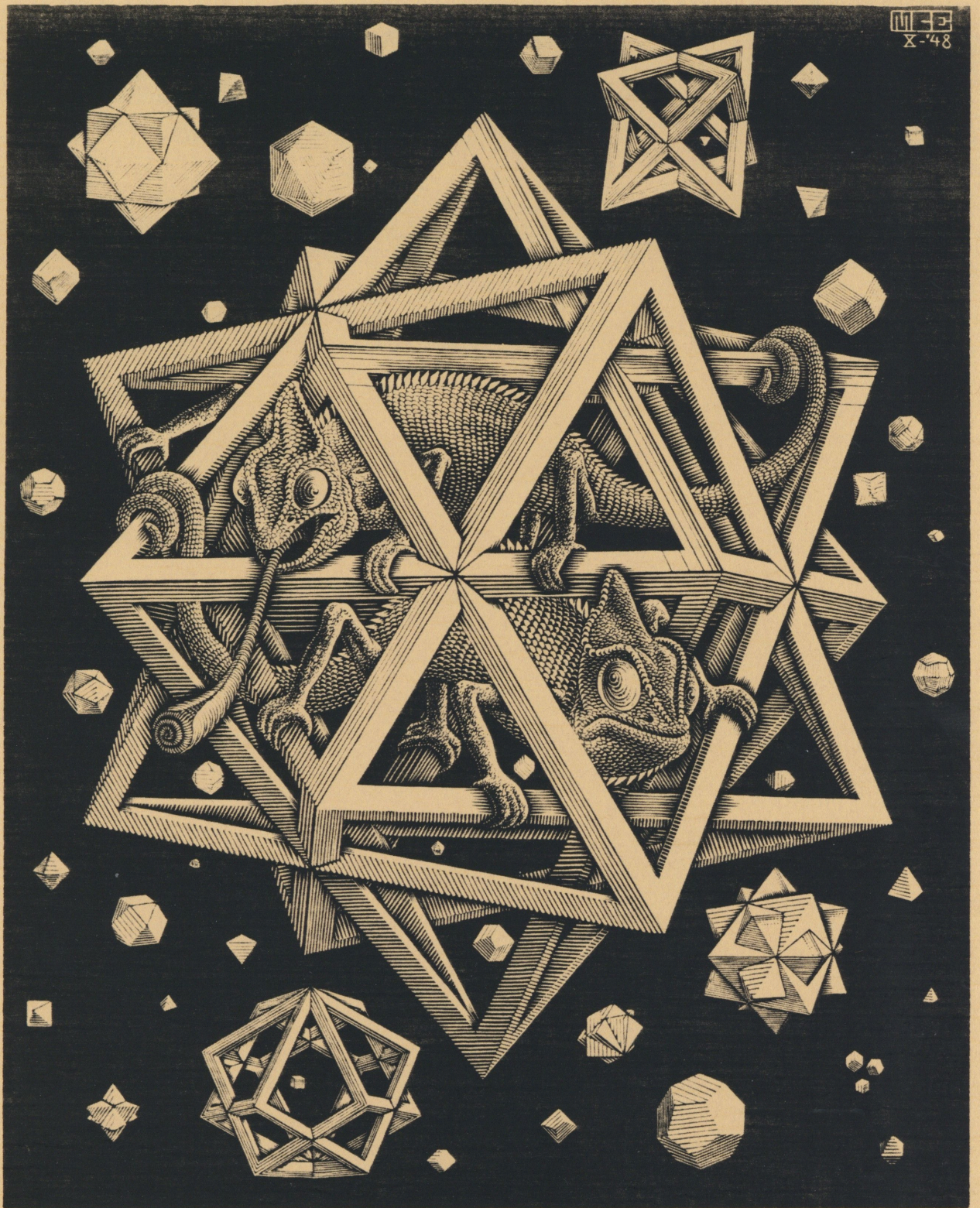


Figure 5. Stars²⁸

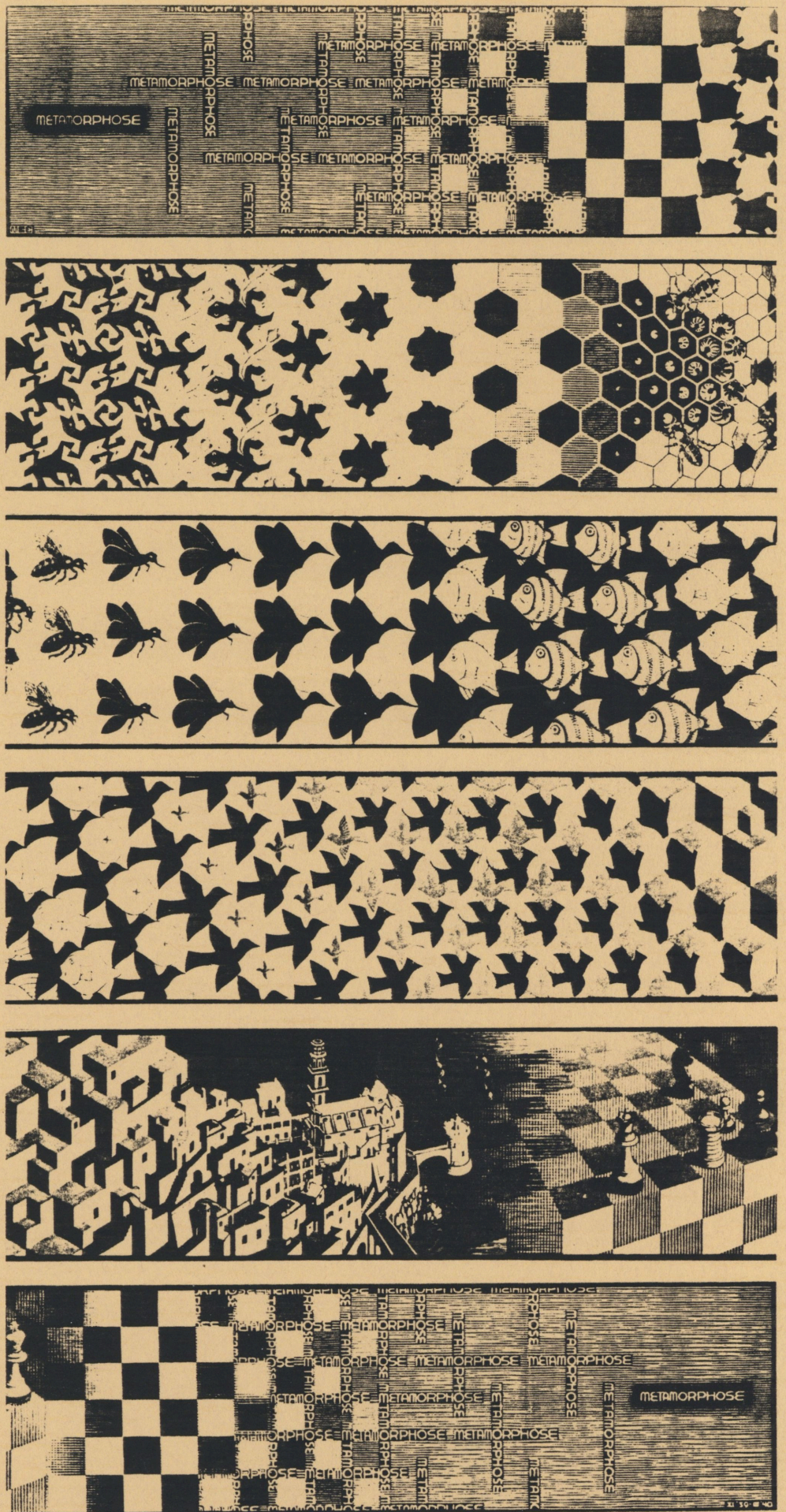


Figure 6.
Metamorphosis 2²⁹

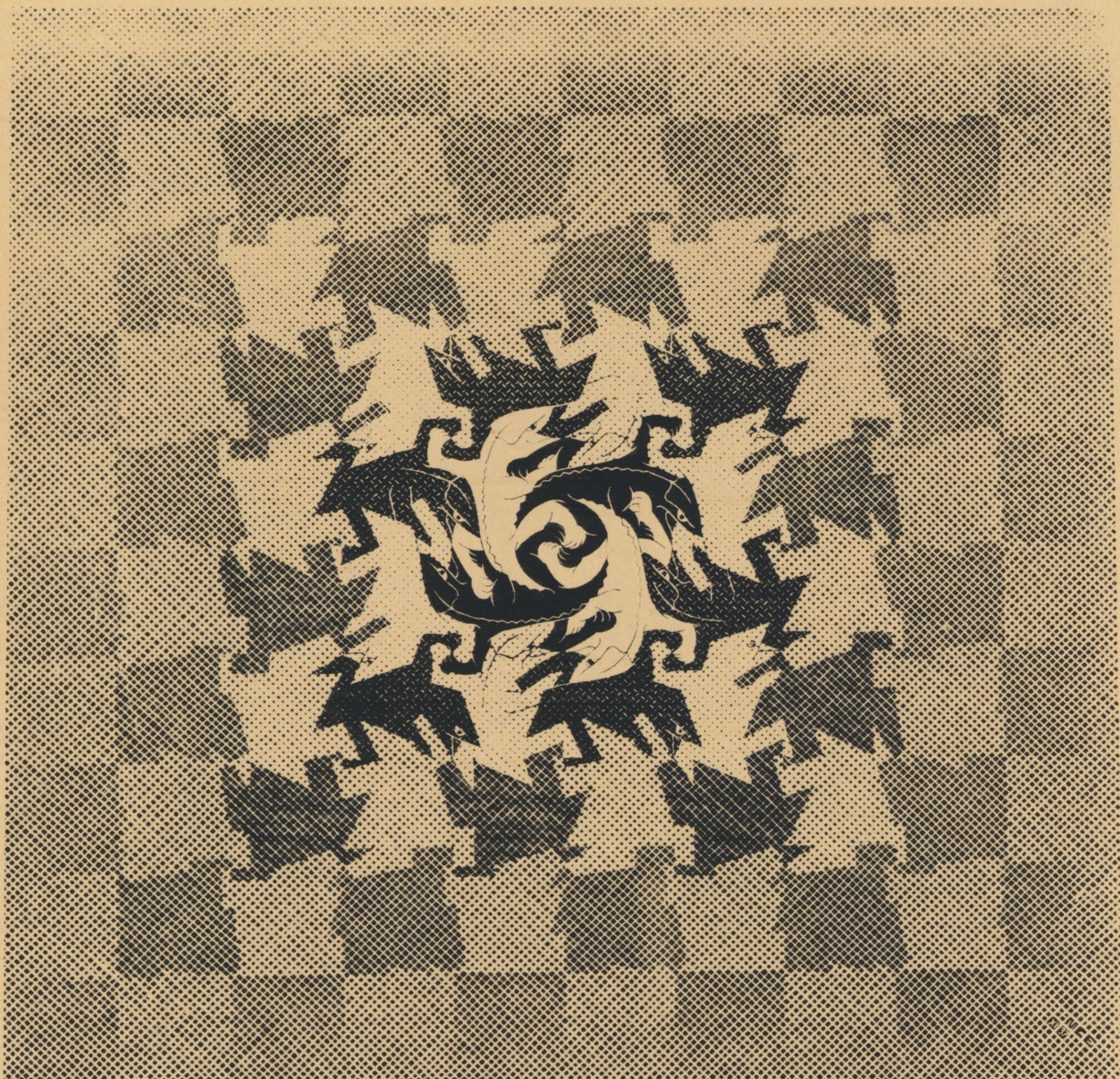


Figure 7. Development 1³⁰

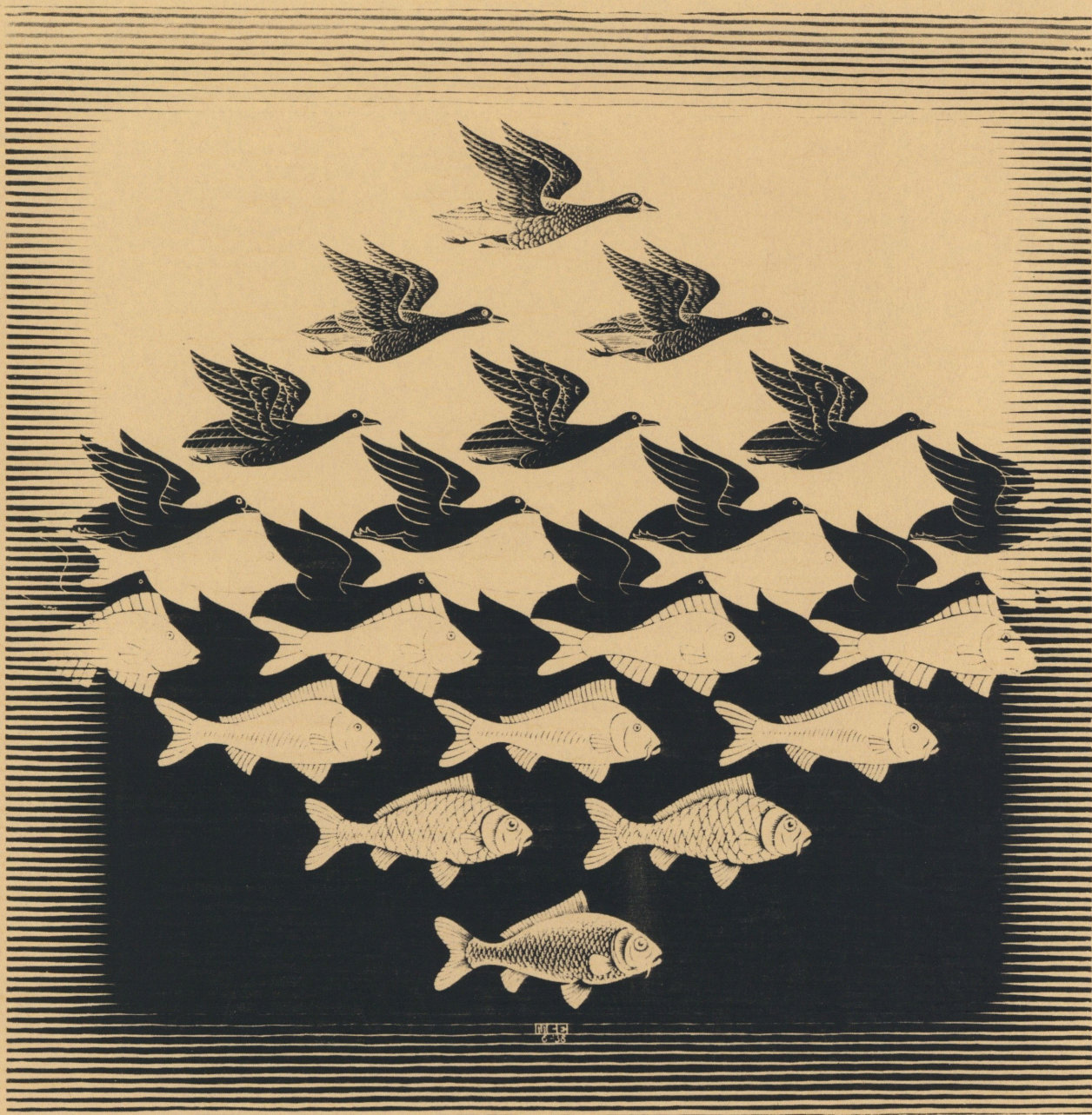


Figure 8. Sky and Water 1³¹

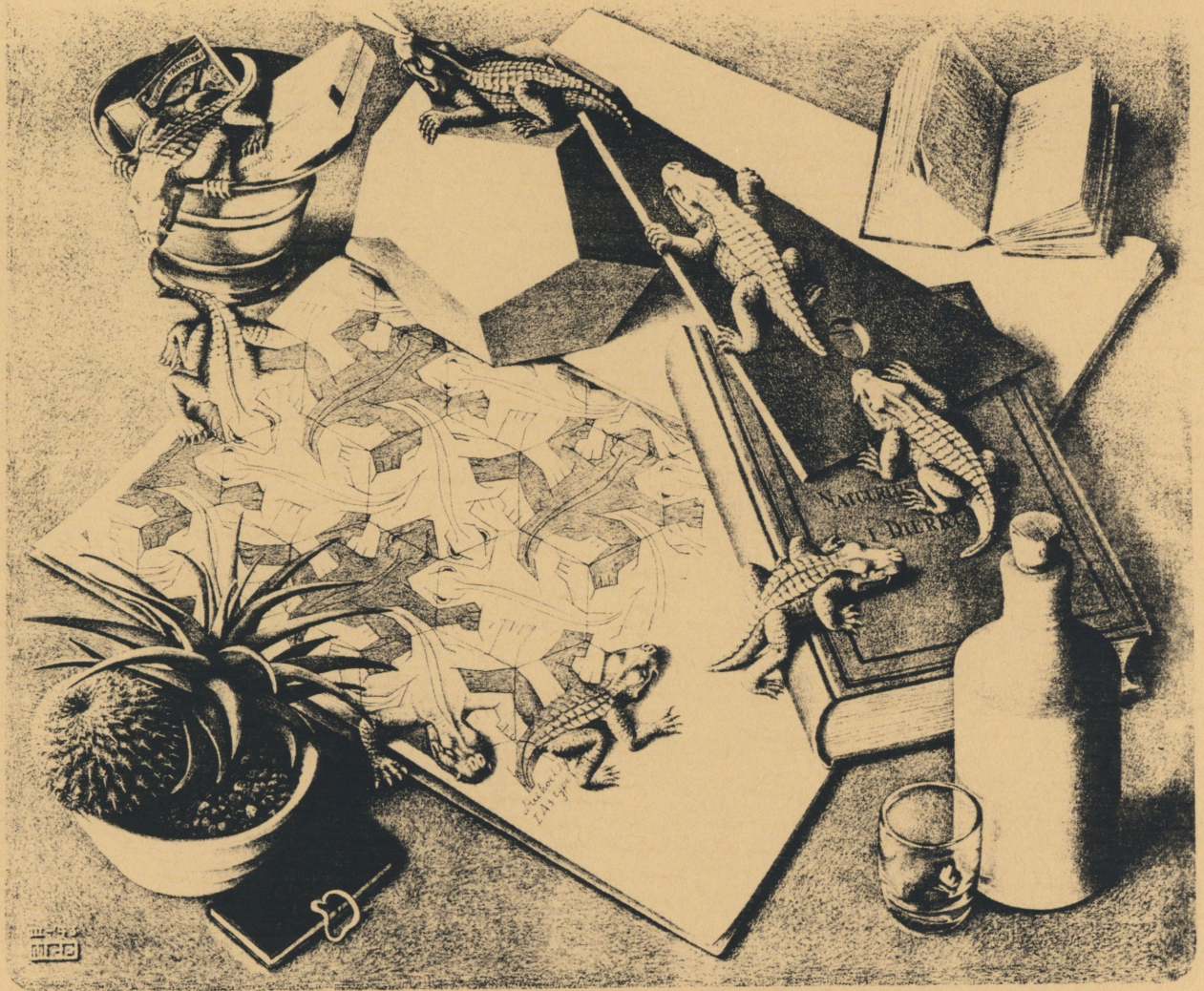


Figure 9. Reptiles³²



Figure 10. Circle Limit 4³³

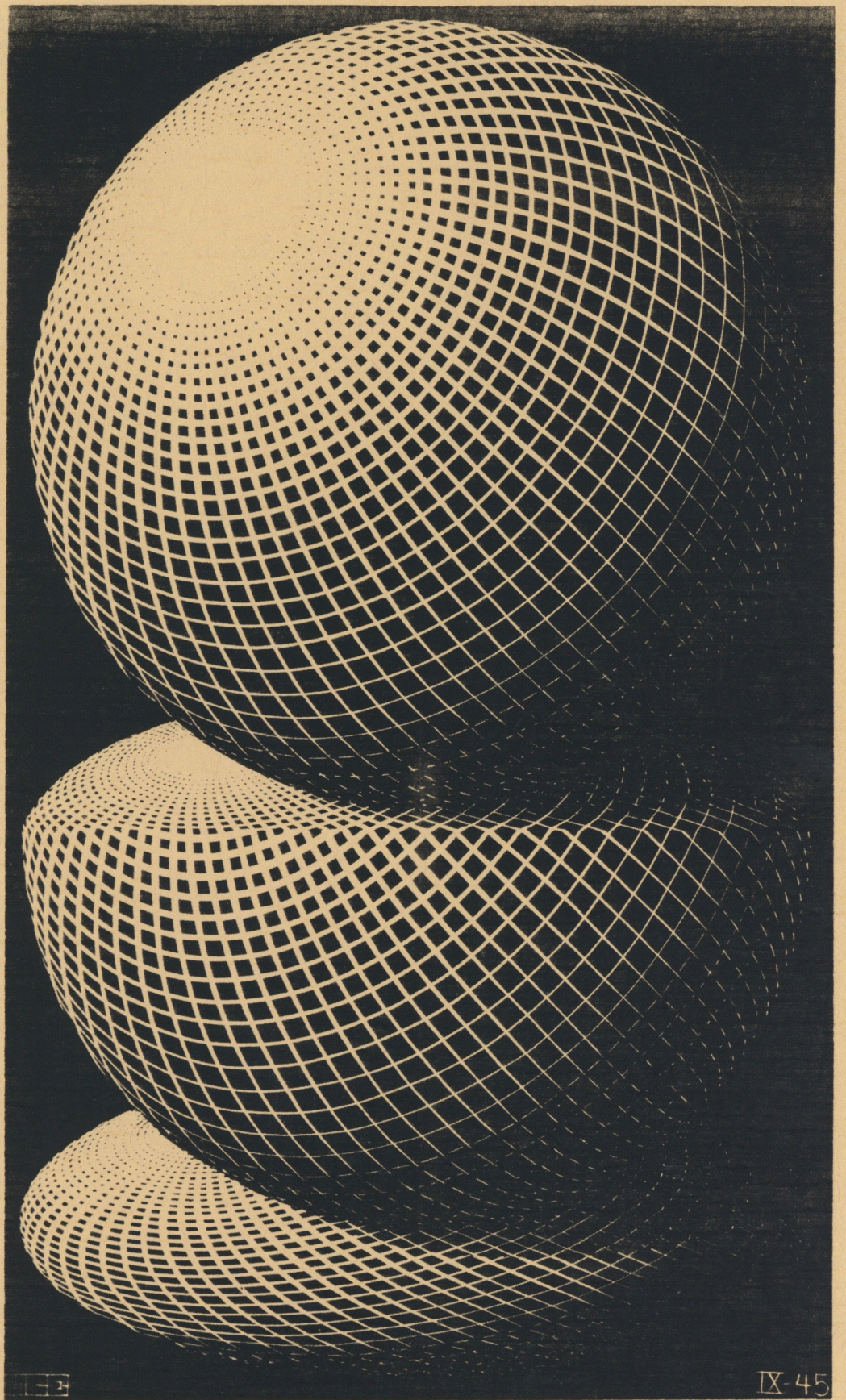


Figure 11. Three Spheres 1³⁴

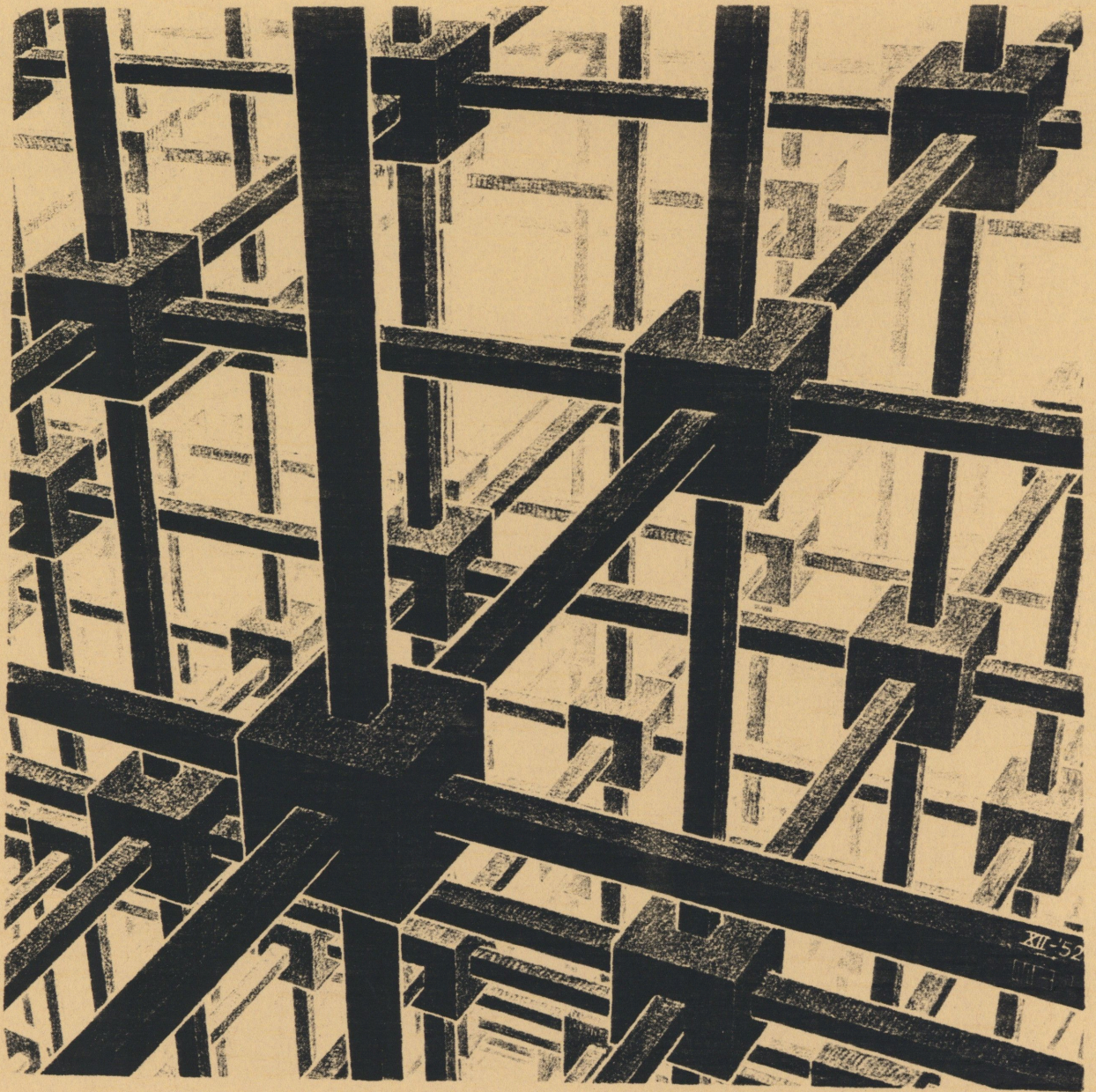


Figure 12. Cubic Space Division³⁵

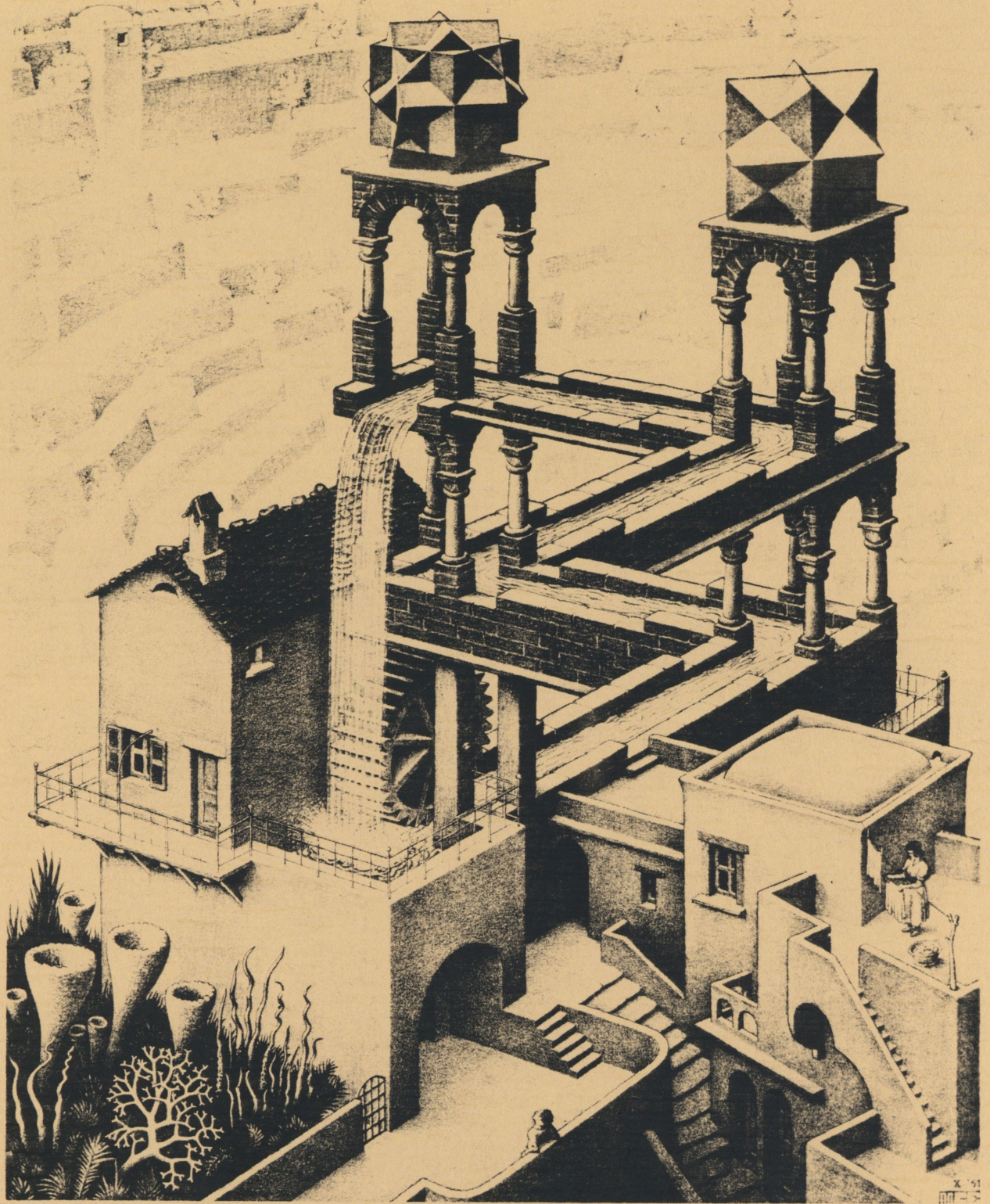


Figure 13. Waterfall³⁶

Spatial Structure

The first theme of M.C. Escher's art-works, spatial structure, is present to varying degrees in almost all of his prints. It is a theme which he never took for granted. His landscape prints (both rural and urban) are more than just recordings of picturesque countrysides and interesting buildings. They are recordings of space. This can be seen in the print Castrovalva (Page 23). Viewing it, we are constantly aware of looking up, down, right, left, near, and far. Soon however, this rather direct expression of space began to disappear from Escher's prints. His interests in expressing spatial perception deepened. Relativity (Page 24) is a print Escher used to reflect this deepening interest. Looking at this print, we become immediately aware that something is "wrong." Yet there is nothing "wrong" with the space - a three-dimensional model of this print could easily be constructed. In this case, what is "wrong" is gravity. Escher is showing us that we tend to view space with prejudices towards

gravity. With this print he tried to make us aware that space and gravity can be considered separately. We can see this separation, quite dramatically, in film clips sent to the earth from the astronauts aboard the space shuttle.

The print, Relativity, does more than differentiate between space perception and gravity. It serves to define the essence of space. There are three axes of orientation in this print. All of the stairs, floors, walls, ceilings, and people relate to these three axes. Why did Escher choose to represent exactly three axes? Space can contain an infinite number of axes. Escher could not have represented this infinite number. Therefore, he chose to represent the three extremes of space. Diagram 1a (Page 39) depicts these three extremes by using the XYZ axes. It is important to note that each axis is perpendicular to the other two. Diagram 1b (Page 40) shows the effects of expanding each axis in the direction of the other two axes. If we add

three sets of stairs to this stage of the expansion, as in Diagram 1c (Page 41), we end up with the same stair configuration as can be seen in Relativity. Diagram 1d (Page 42), shows the product of continuing this expansion to the length of each axis. As each axis was originally given the same length, a perfect cube has been formed.

A spatial perception of Diagram 1d (Page 42) can be considered in terms of three entities: the space within the cube, the space which the cube exists within, and the surface of the cube which defines the boundary between these two spaces. Using this kind of thinking, Escher became interested in showing how individual spaces might interweave through surface reflections. This can be seen in the print Three Worlds (Page 25). The direct world is the surface of the water on which leaves are floating. The underwater world is represented by the fish. The above-water world is represented by the reflections of the trees.

One final comment can be made concerning the theme spatial structure. Escher was very interested in crystalline forms such as the cube of Diagram 4d. He studied their shapes. He experimented with ways of using them to form structures. An example of this experimentation can be seen in his print Stars (Page 26).

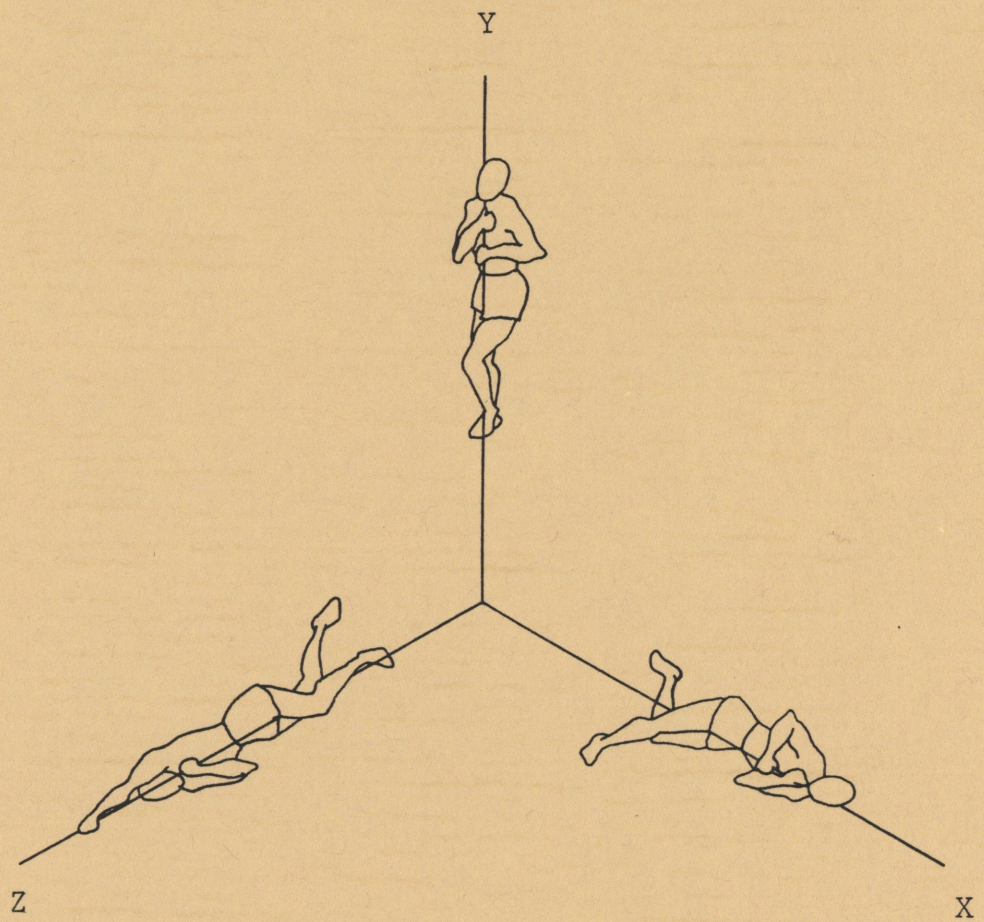


Diagram 1a.

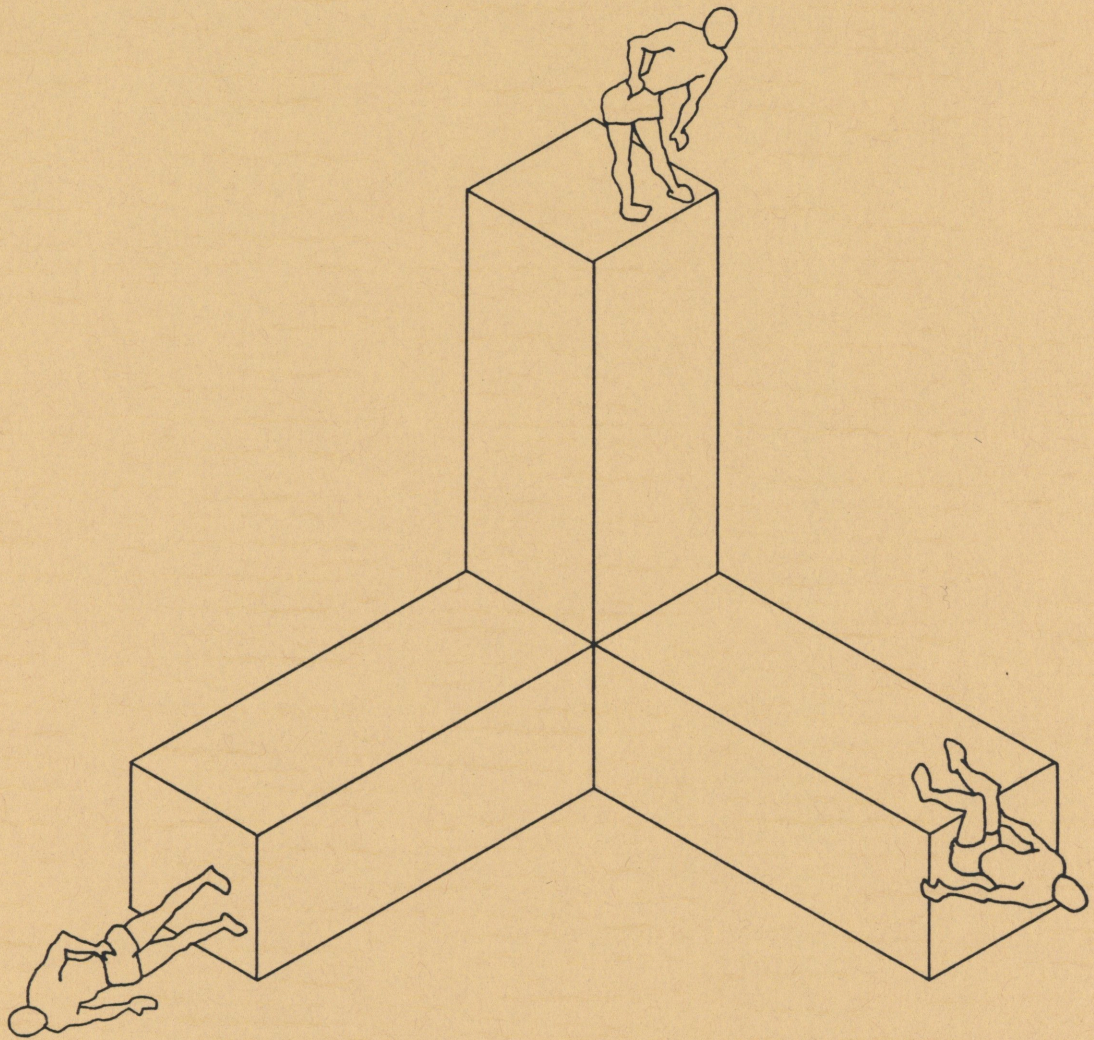


Diagram 1b.

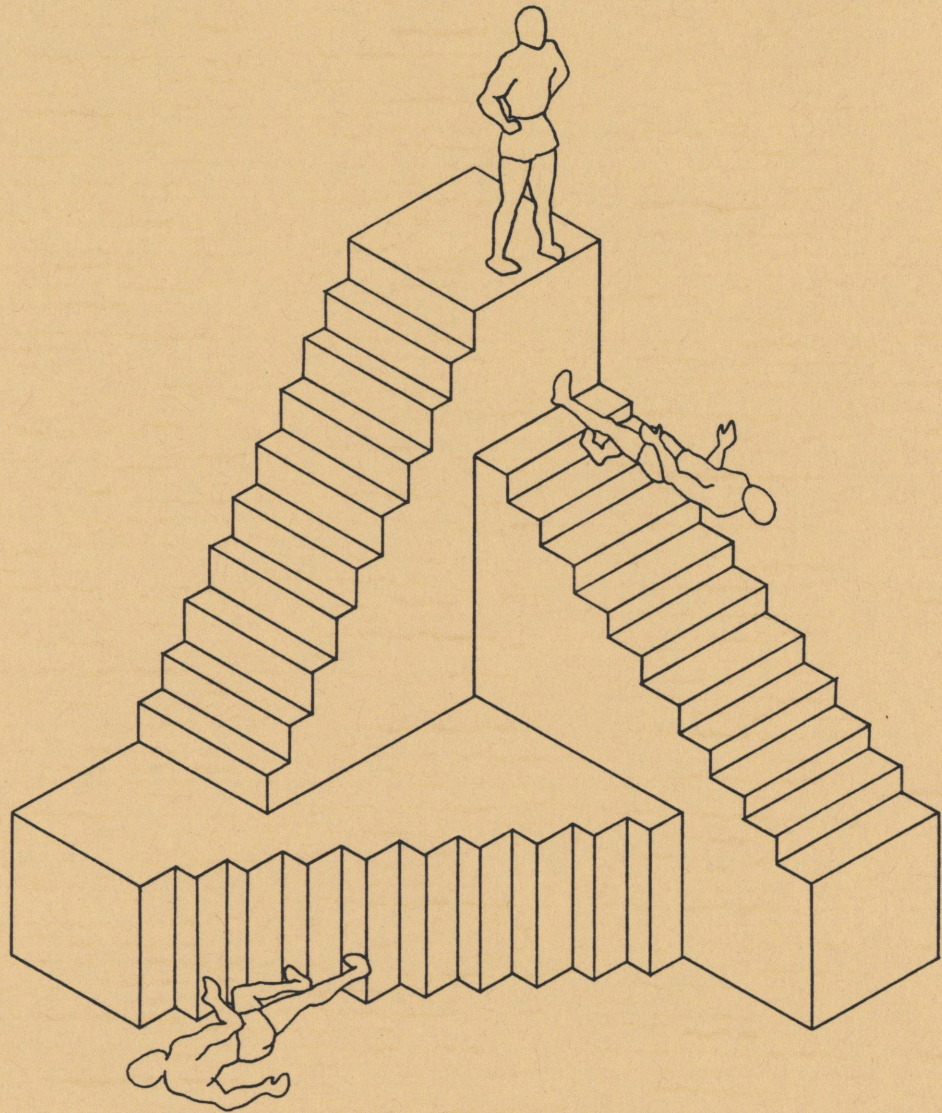


Diagram 1c.

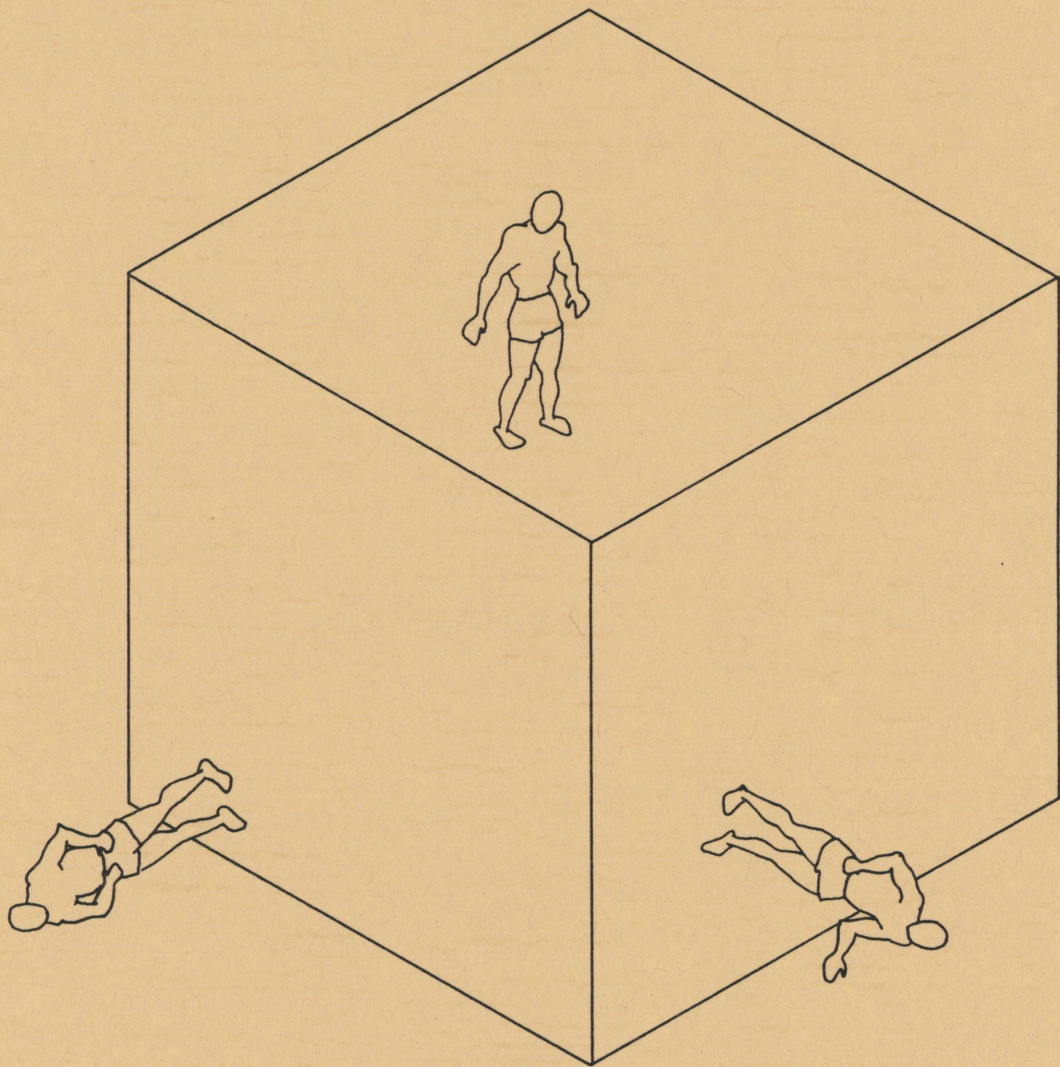


Diagram 1d.

Flat Surface Structure

Diagrams 1a through 1d reveal more to us than just a three-dimensional study of space. In these diagrams, two things have been represented; figure and background. The men, and the objects which support them comprise the figure portion of the diagrams. The space, in which these figures exist, is the background portion of the diagrams. Though no conscious effort was made to represent space in these diagrams, it nevertheless emerged as an integral part of the design. This leads us into important questions concerning the nature of figure and background. Can we represent figure without background? Can we represent background without figure? Can figure and background become interchangeable? Questions like these were of great interest to Escher, especially when they were integrated with principles of order (repetition and multiplication). This interest became particularly evident after he visited the Alhambra in 1936. There, he spent days recording the rhythmic patterns which adorned its many

surfaces. Slowly, with the help of mathematical treatises and books on crystallography (which he claimed to not understand), Escher became aware of the mathematical principles which governed symmetry. Using these principles, Escher created the prints which fall under the second theme of his artworks, flat surface structure.

Consider the following experiment. We can cut two identical motifs from a piece of paper, and allow them to fall randomly onto the floor. We can then analytically determine how each motif can be brought about to lay directly on top of the other. If we repeat this experiment several times, and continue to analyze the results, we will soon discover that there are only four different ways that a two-dimensional motif can repeat itself. "The four operations are (1) translation, in which the motif moves up or down, left or right, or diagonally while keeping the same orientation; (2) rotation, in which the motif turns;

(3) reflection, in which the motif reflects as in a mirror; and (4) glide reflection, in which the motif both translates and reflects."³⁷ Using these four operations, an infinite number of patterns can be created. However, these patterns can be categorized into only seventeen two-dimensional groups. It takes a four-hundred page book to list and describe these seventeen groups (see Handbook of Regular Patterns by Peter S. Stevens). Therefore, it will have to be sufficient to note that:

Escher discovered all these possibilities without the benefit of any appropriate previous mathematical knowledge. In her book Symmetry Aspects of M.C. Escher's Periodic Drawings (published in 1965 for use by students of crystallography), Professor C.H. McGillavray speaks of her astonishment at the fact that Escher even discovered new possibilities whereby color too might play an important role, and which had not been mentioned in scientific literature before 1956."³⁸

The following exercise will help to illustrate how Escher produced his plane filling motifs. We will begin with a square grid as

shown in Diagram 2a (Page 52). To our eyes, this grid appears as a colorless checkerboard pattern. We can imagine that this pattern has been created by a single square motif repeated several times. As there are no gaps between the squares, the pattern is composed entirely of squares; there are no extraneous spaces. Knowing the principles of symmetry, the shape of the original square motif can be altered. Then we can produce a new pattern based entirely on this altered motif. If we followed the rules correctly, the new pattern will contain no extraneous spaces. To carry out this operation requires three general rules of application. First, there must be an awareness, of which symmetry operations are being involved. This awareness is not necessarily predetermined. A certain degree of experimentation may first be required. However, in order to manipulate the motif within the rules of symmetry, that awareness is essential. Second, any addition made to the motif must be coupled with a subtraction of equal area and proportion to that

addition. The reverse of this rule also applies. One consequence of this rule is that any derivative of the original motif will have exactly the same area as that original. Third, the locations of these additions and their related subtractions must be harmonic to the symmetry operations being performed.

With these rules, we can begin to manipulate the original square motif. In response to the first rule, we will be consciously aware of using translation and rotation as our symmetry operations. Our first addition to the square will be a bump placed on the top edge. According to the second rule, we must subtract this bump from somewhere on the square. In response to the third rule, we will use translation as the operation which locates where this subtraction will occur - on the bottom edge directly in line with the bump on the top edge. Thus, the motif translates vertically as shown in diagram 2b (Page 53). In diagram 2c (Page 54), an extension to the

left edge of the motif has been added. In response to the second rule of application, an area of equal size and proportion has been subtracted. This time however, rotation was the symmetry operation used to determine the location of this subtraction. Using these same three rules of application, the motif is further manipulated in diagrams 2d, 2e, and 2f (Pages 55, 56, 57). In diagram 2f, detail has been added to give the original motif a little character. The process is complete.

A comprehensive understanding of the rules of symmetry goes far beyond the simple description of the previous exercise. A considerable amount of exploration and research would further be required. However, the following points will provide a good basis for understanding Escher's plane filling motifs.

1. The motif is always based on an organizing grid.
2. That grid does not have to be square in format. Diagrams 3a, 3b, 3c and

3d (Pages 58-59) show a plane filling motif based on a grid of equilateral triangles.

3. The formation and detailing of a pattern within the organizing grid is not restricted to a single motif. This is demonstrated in the print Sky and Water (Page 29), where both a fish and a bird have been used to create the pattern.
4. With knowledge of the four symmetry operations, and a strict adherence to the three general rules of application, testing a single motif within a pattern is not required as proof of its plane filling capabilities.

Escher's plane filling motifs provide the basis for the second theme of his artworks, flat surface structure. However, they were only used as a means for expressing two concepts which continually fascinated him - metamorphoses and infinity.

As can be seen in the print Metamorphoses 2 (Page 27), Escher used a variety of techniques to produce a metamorphoses. However, these techniques can be described in terms of two general methods; metamorphoses of a figure into a new figure, and metamorphoses of a figure into the background. The first method can be

seen in his print Development 1 (Page 28). In this print, Escher has evolved a lizard motif from its original grid through a series of progressions. The print Sky and Water (Page 29), reveals the second method Escher used to produce a metamorphoses. Two motifs, a bird and a fish, have been detailed within the organizing grid. To produce the metamorphoses, Escher simply decreased the detailing of the birds towards the bottom of the print while he simultaneously increased the detailing of the fish. As well, he slightly separated the motifs located along the patterns edge.

Escher also used two methods to represent infinity. The print Reptiles (Page 30) represents the first method. Here, Escher has created a continuous cycle. The reptile emerges from the book, makes a circular path over the obstacles, and then merges back into the book. Thus, the cycle repeats itself, presumably to infinity. The second method Escher used to represent infinity is illustrated by the print Circle Limit

4 (Page 31). Here, Escher's motifs have been modified to fit within a grid which progressively diminishes towards its perimeter. This grid was developed by the mathematician Jules Henri Poincare to demonstrate hyperbolic geometry.

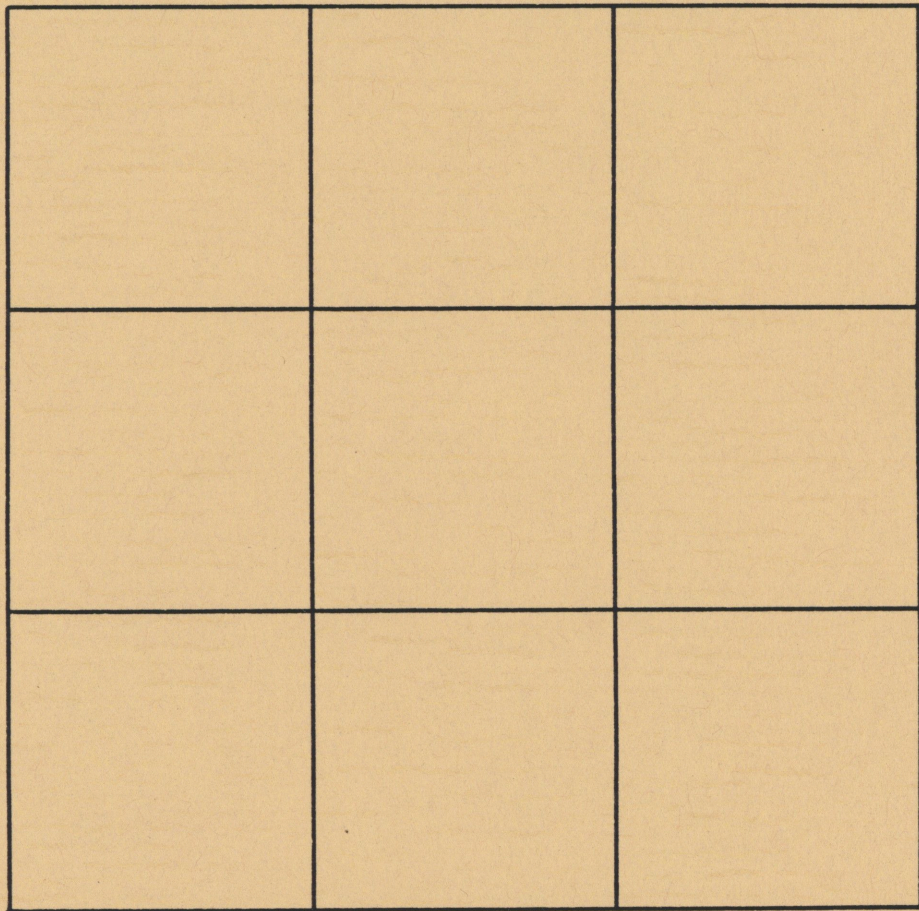
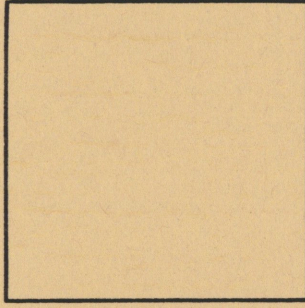


Diagram 2a.

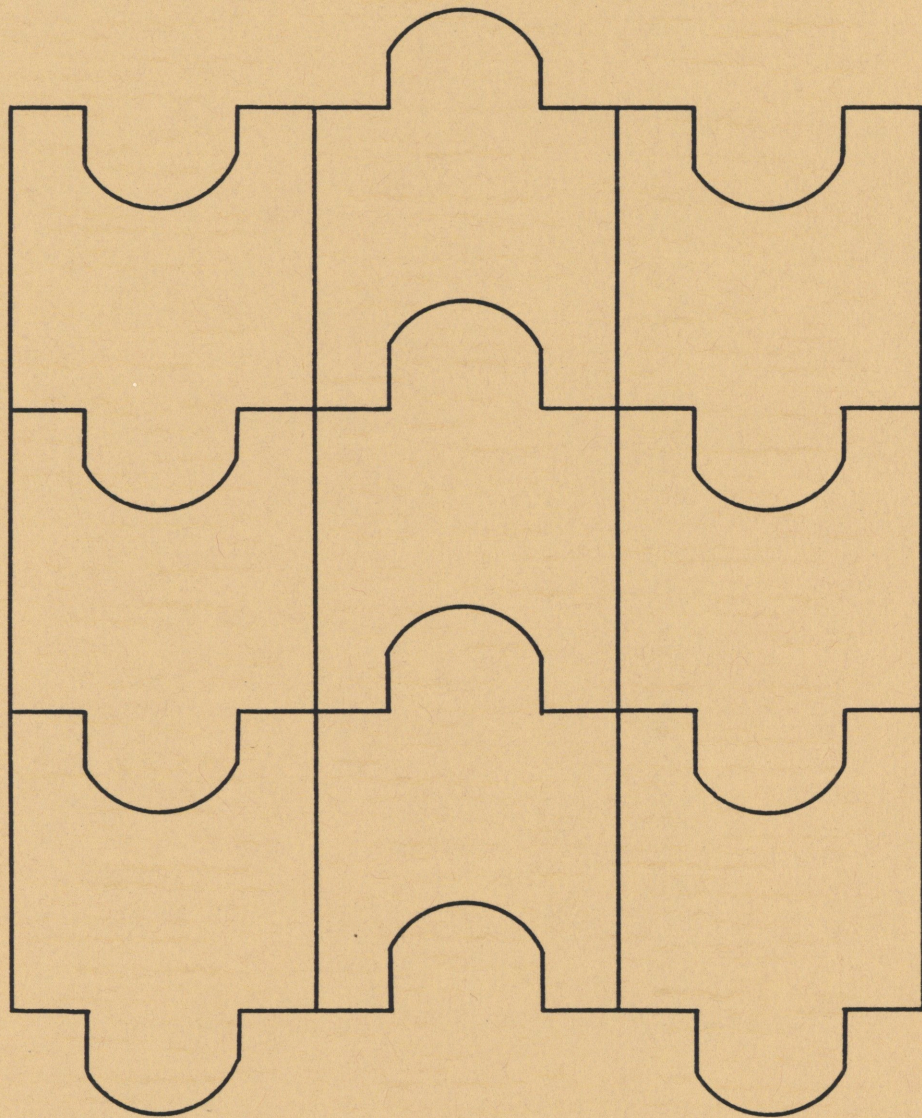
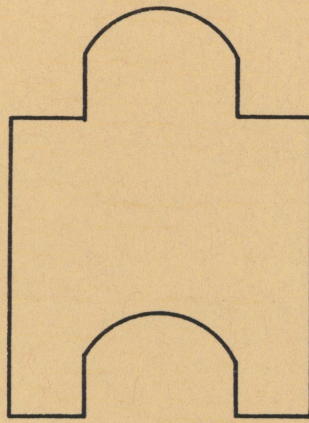


Diagram 2b.

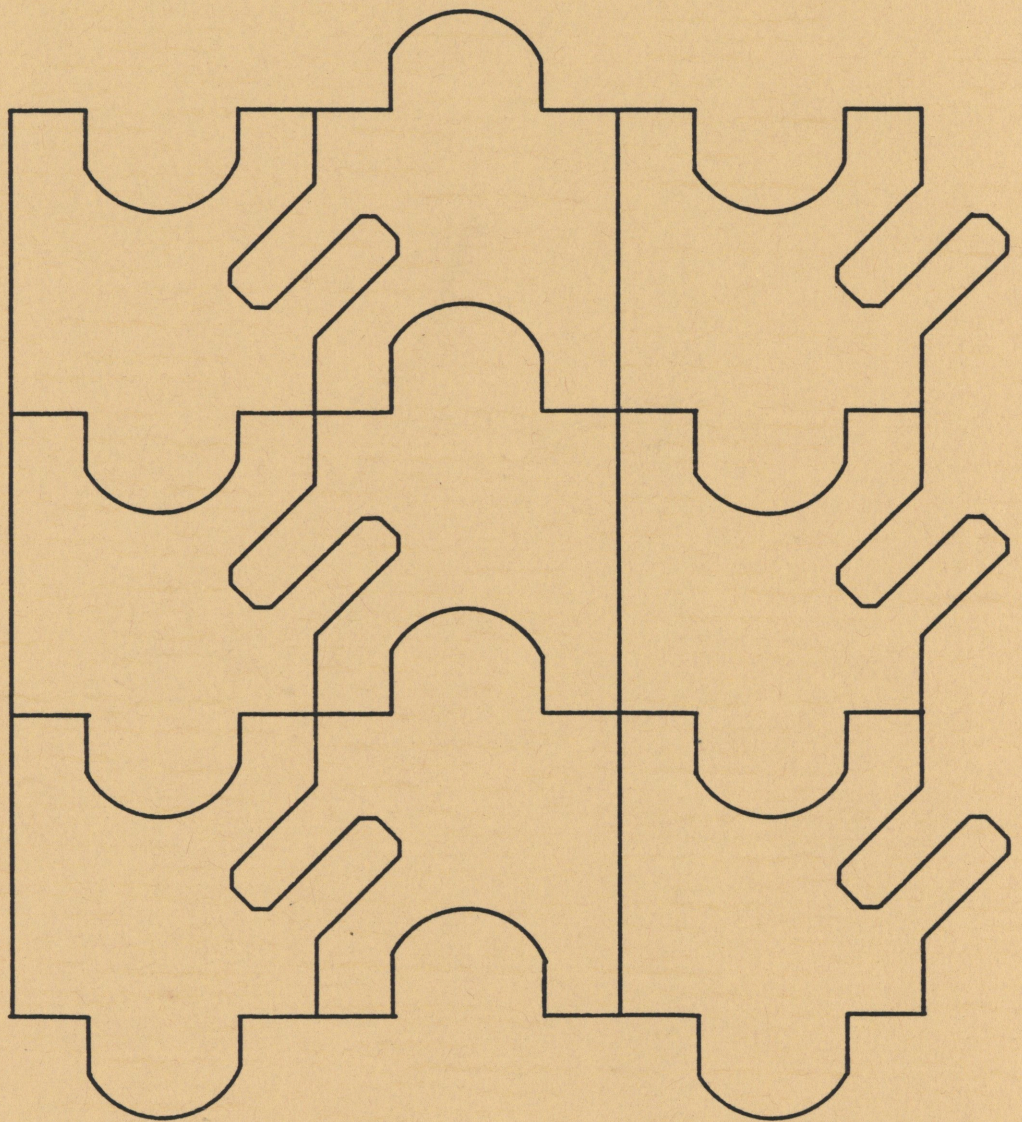
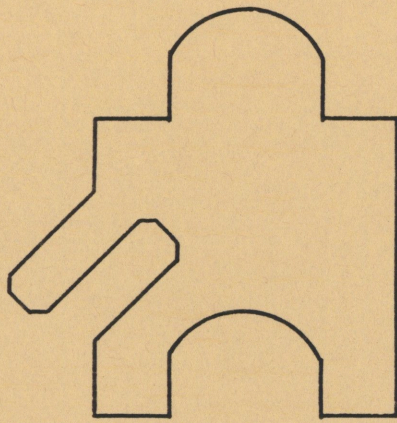


Diagram 2c.

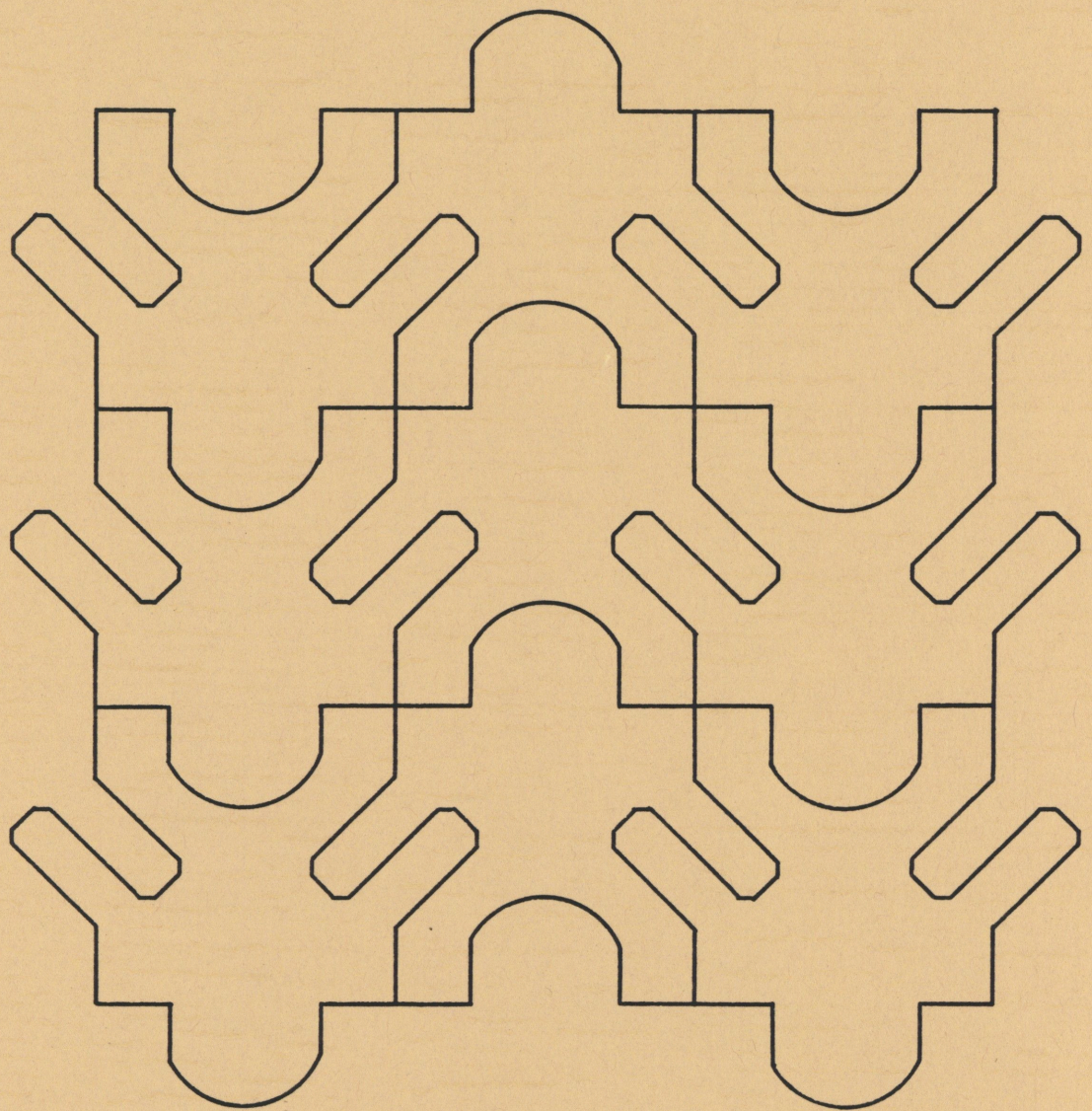
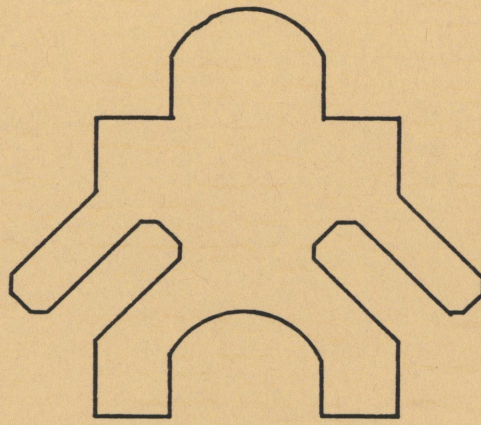


Diagram 2d.

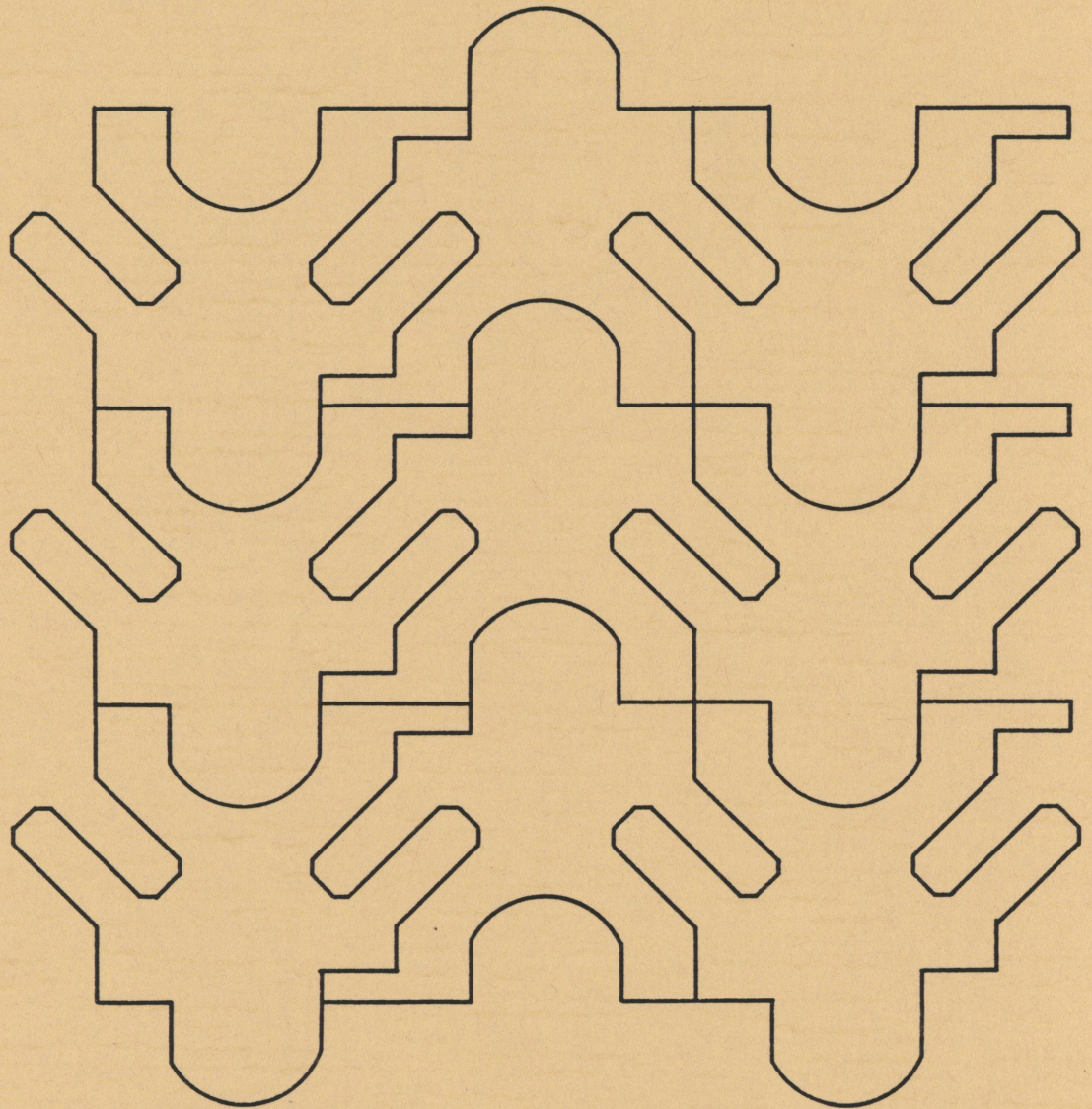
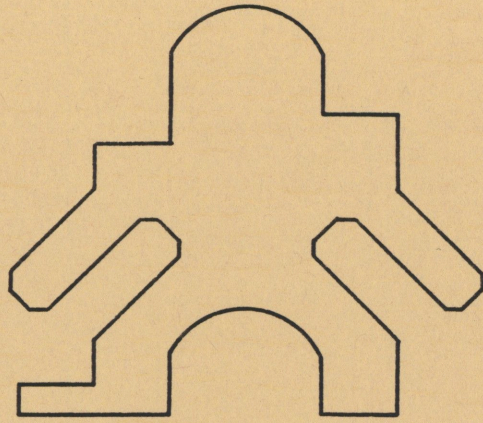


Diagram 2e.

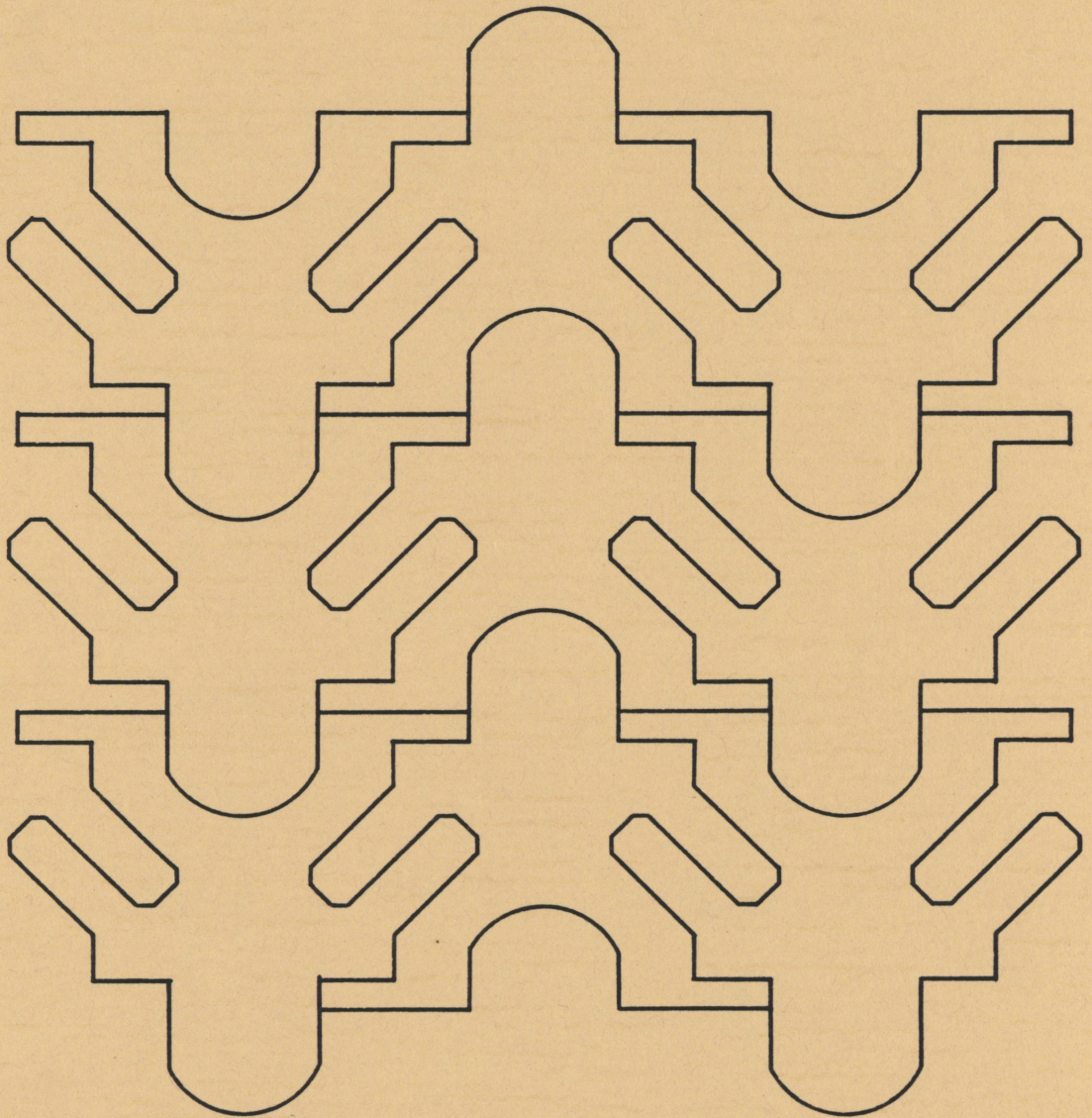
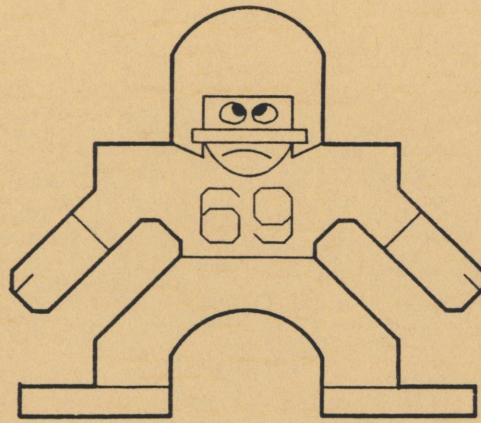


Diagram 2f.

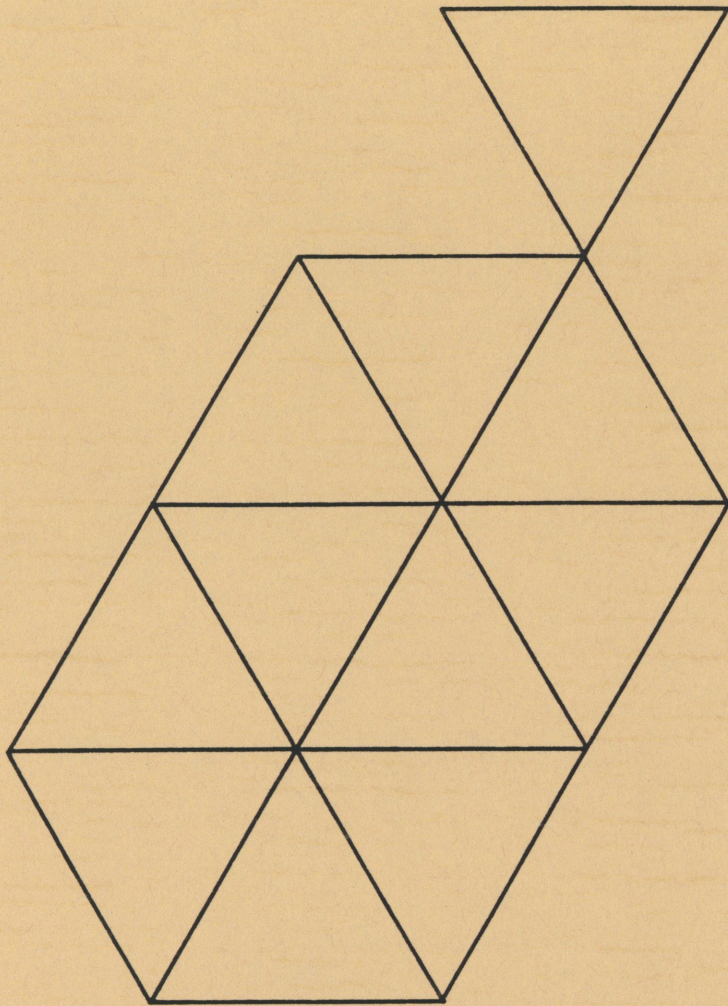


Diagram 3a.

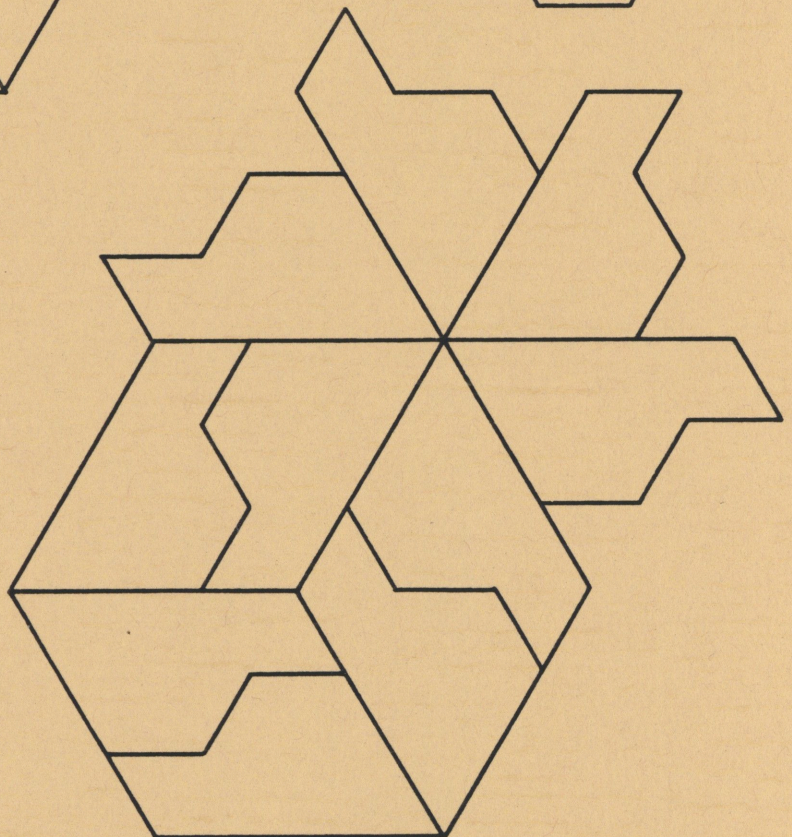


Diagram 3b.

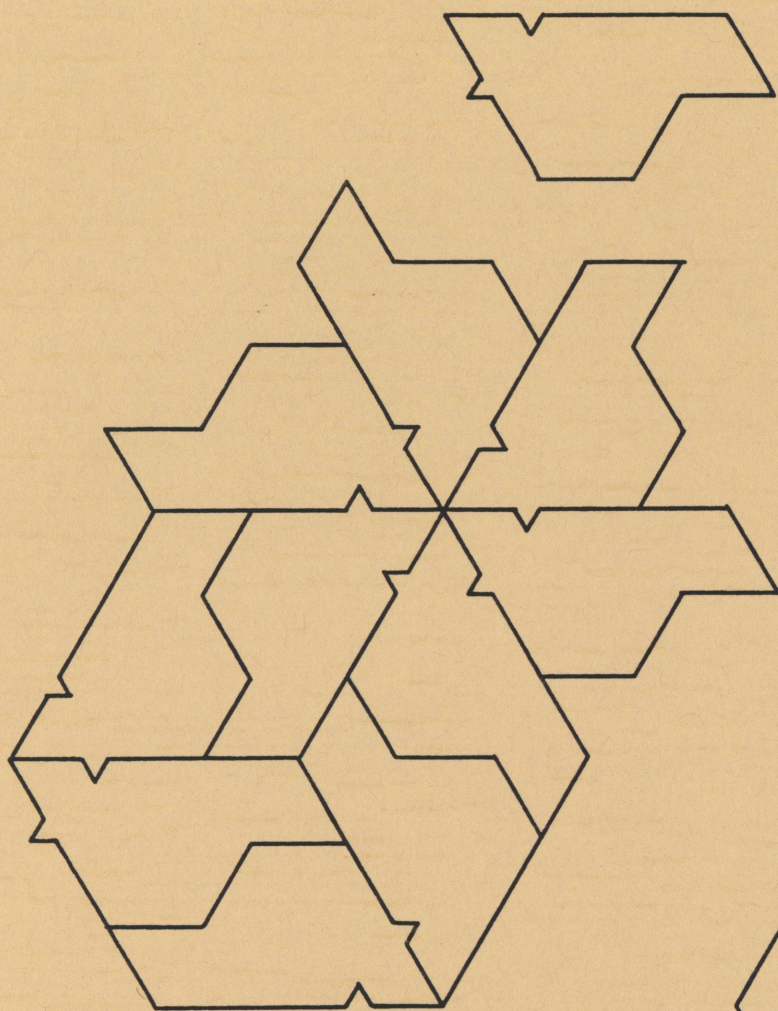


Diagram 3c.

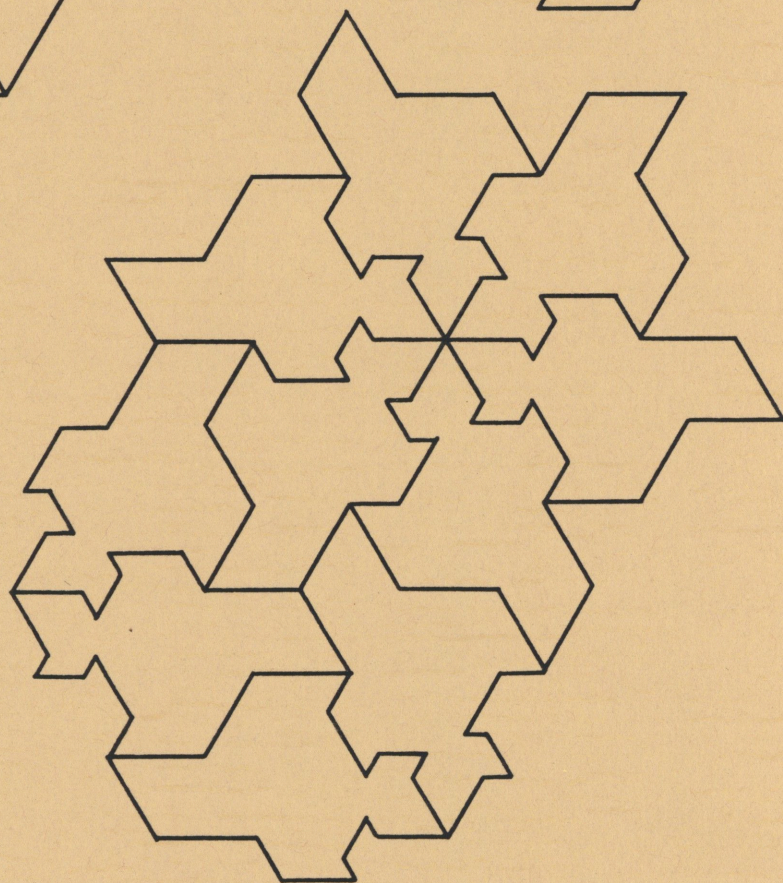
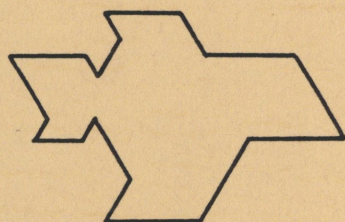


Diagram 3d.

Space/Flat Surface

The final theme of M.C. Escher's artworks is pictorial representation of the relationship between space and flat surface. With very few exceptions, Escher worked in a two-dimensional format. Always conscious of this fact, he became quite intrigued by the possibilities a two-dimensional representation of space offered. This conscious recognition can be seen in the print Three Spheres 1 (Page 32). Here, Escher has demonstrated that the object we can see at the top of the print is not a sphere. It is a flat circle. To prove this, he has folded it in half in the middle of the print, and laid it down at the bottom of the print.

As seen in the print Cubic Space Division (Page 33), Escher was a master of perspective drawing. He knew the rules intimately. Escher realized that he could misuse these rules to depict impossible three-dimensional structures. The print Waterfall (Page 34) contains one of these impossible structures. To illustrate how

Escher made this print, we will use the triangular object shown in diagram 4a (Page 62). It would be possible to construct a three-dimensional model which looks very similar to this object. However, if we erase the corners of this drawing, and then redraw them using misconstrued connections, we create what is called a tribar. A tribar can be represented two-dimensionally, as in diagram 4b (Page 62). It cannot be represented three-dimensionally. To create the print Waterfall, Escher used a series of these tribars. The arrangement of this series is shown in diagram 4c (Page 63).

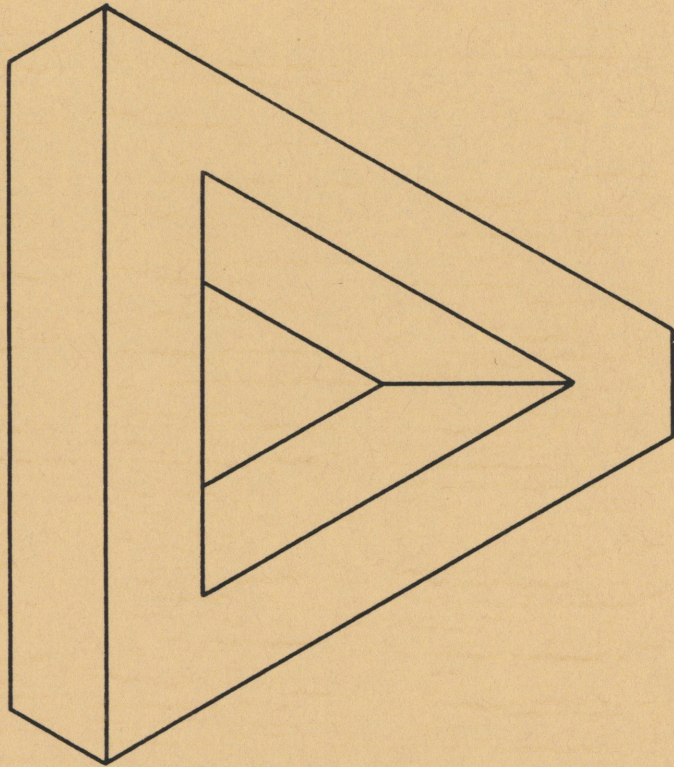


Diagram 4a.

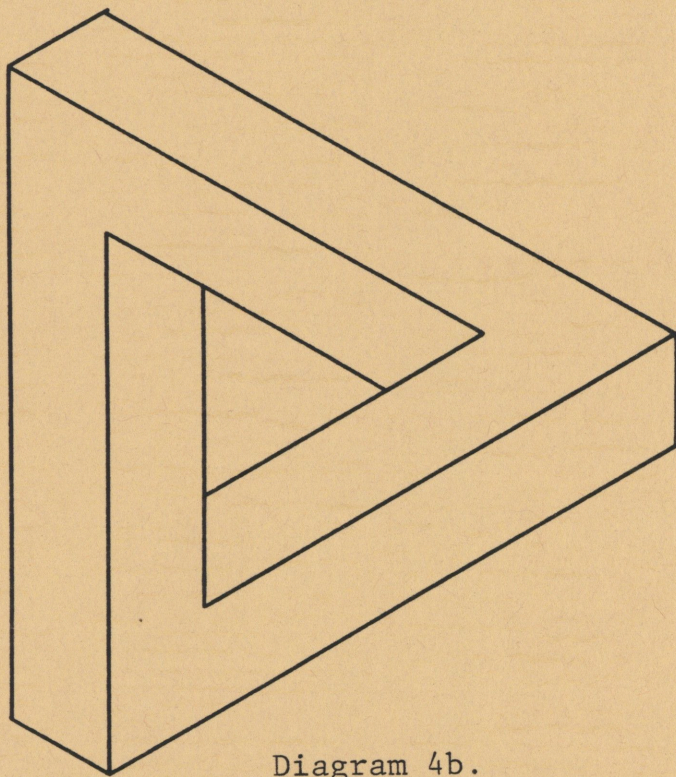


Diagram 4b.

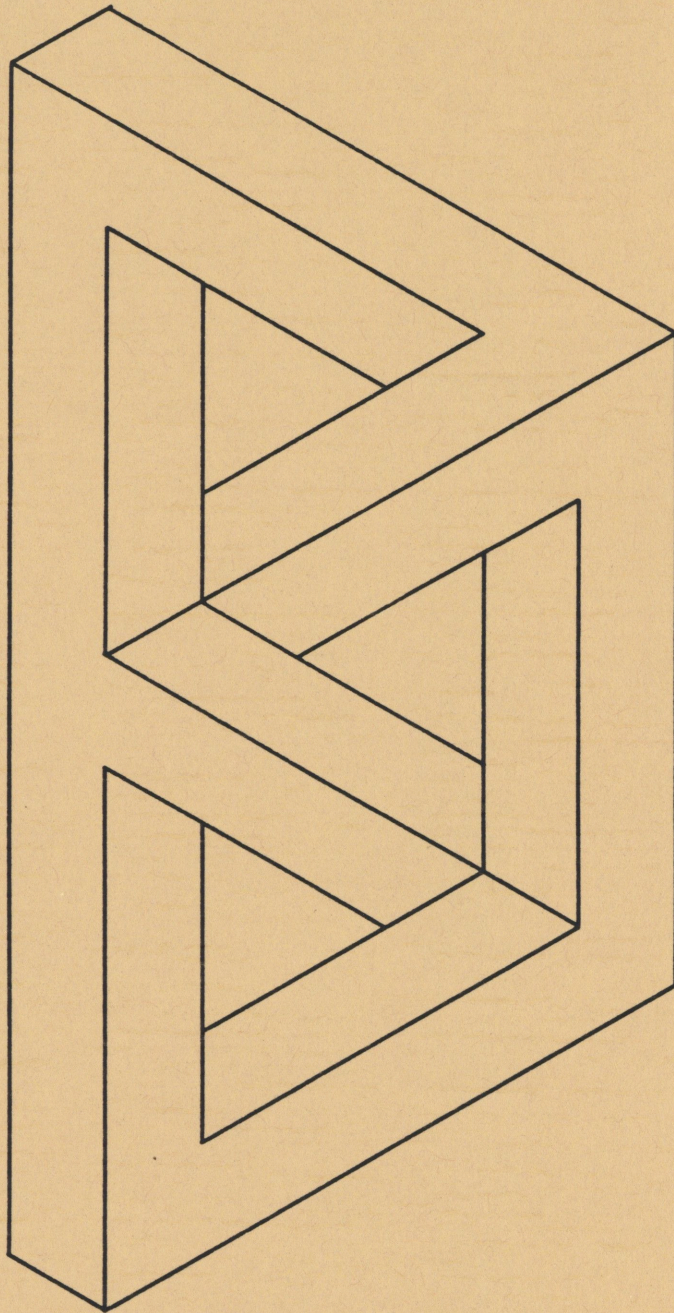


Diagram 4c.

Mall Analysis

The mall design is based on the principles of metamorphosis (pattern and color). The following points have been considered:

1. The architecture itself does not metamorphose. The perception of metamorphosis is brought about through movement of the observer.
2. Pattern metamorphosis (lines) and color metamorphosis (solids) can act independent of each other.
3. Pattern metamorphosis can be broken down as follows:
 - A) Different pattern arrangements using a single motif;
 - B) Motif to altered motif;
 - C) Figure to ground;
 - D) Two dimensional motif to two dimensional motif which appears three dimensional;
 - E) Two dimensional motif which appears three dimensional to three dimensional motif.
4. Color metamorphosis will be based on the pattern arrangement using only three mixtures of concrete.

5. Metamorphosis of the paving pattern can take place:

A) Between the buildings;

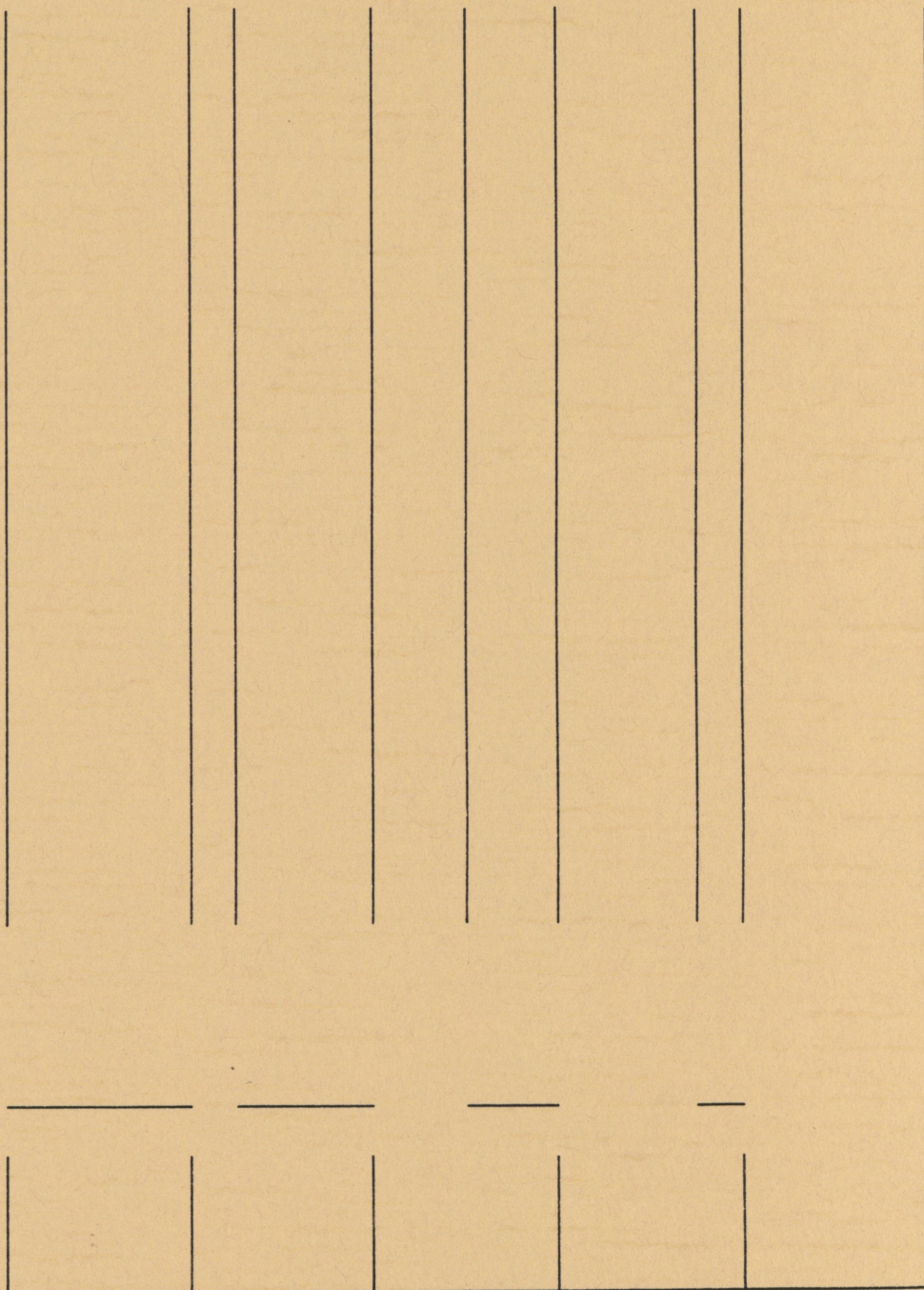
B) Building width provides the space for the metamorphosis.

Structure Analysis

The structural design is based on the following points:

1. Metamorphosis of solid and void. The architecture itself does not metamorphose. The perception of metamorphosis is brought about through movement of the observer;
2. The three extremes of space isometrically projected into a three dimensional structure.

Regular grid arithmetically manipulated to produce an equal and continuous metamorphosis of solid to void on the X axis (from this point on referred to as the organizing grid). Lines have been projected vertically from this organizing grid.

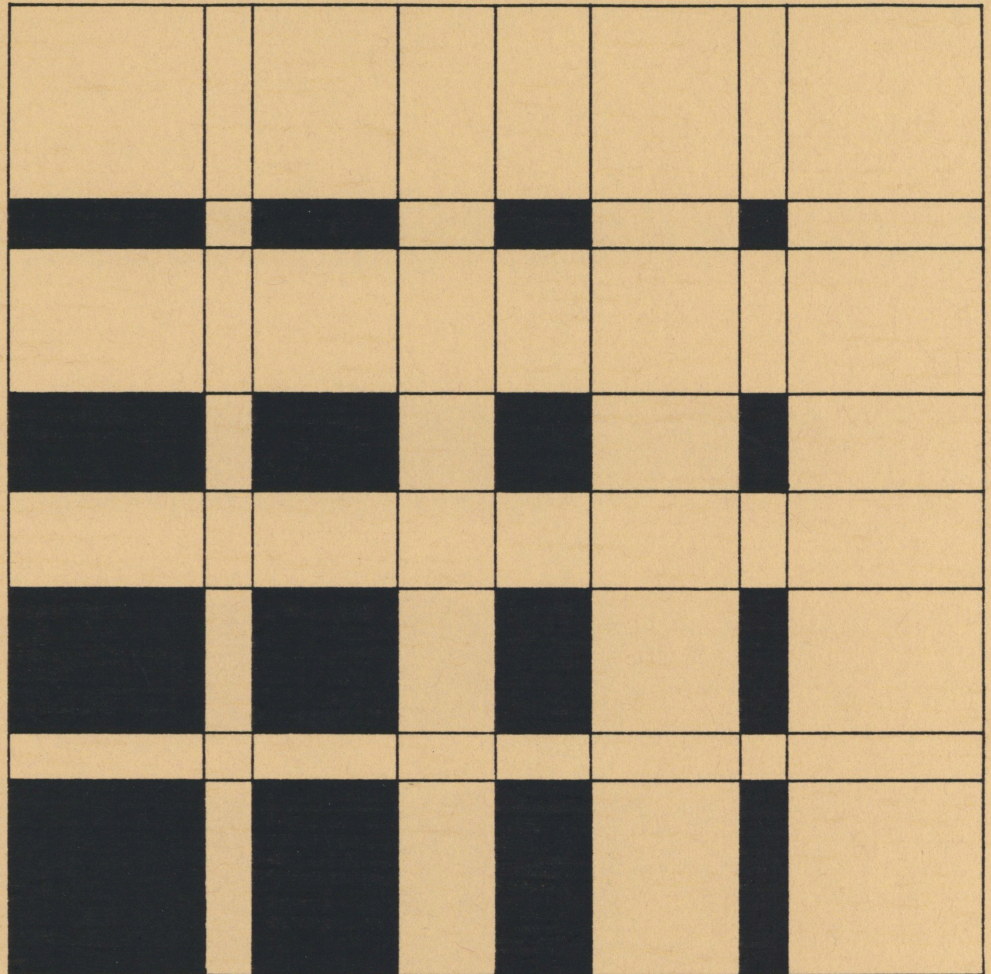


Organizing grid on the X axis projected vertically with solids filled in.

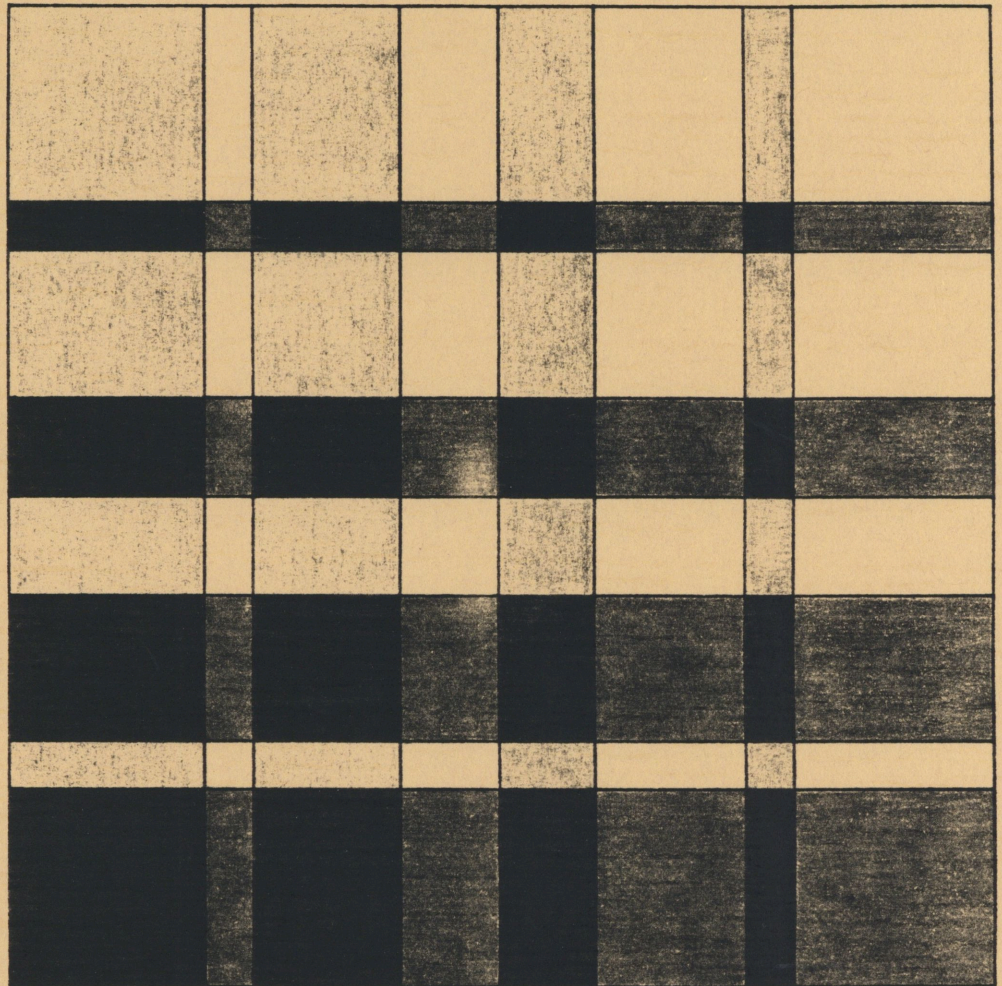


Organizing grid on the x and y axis.

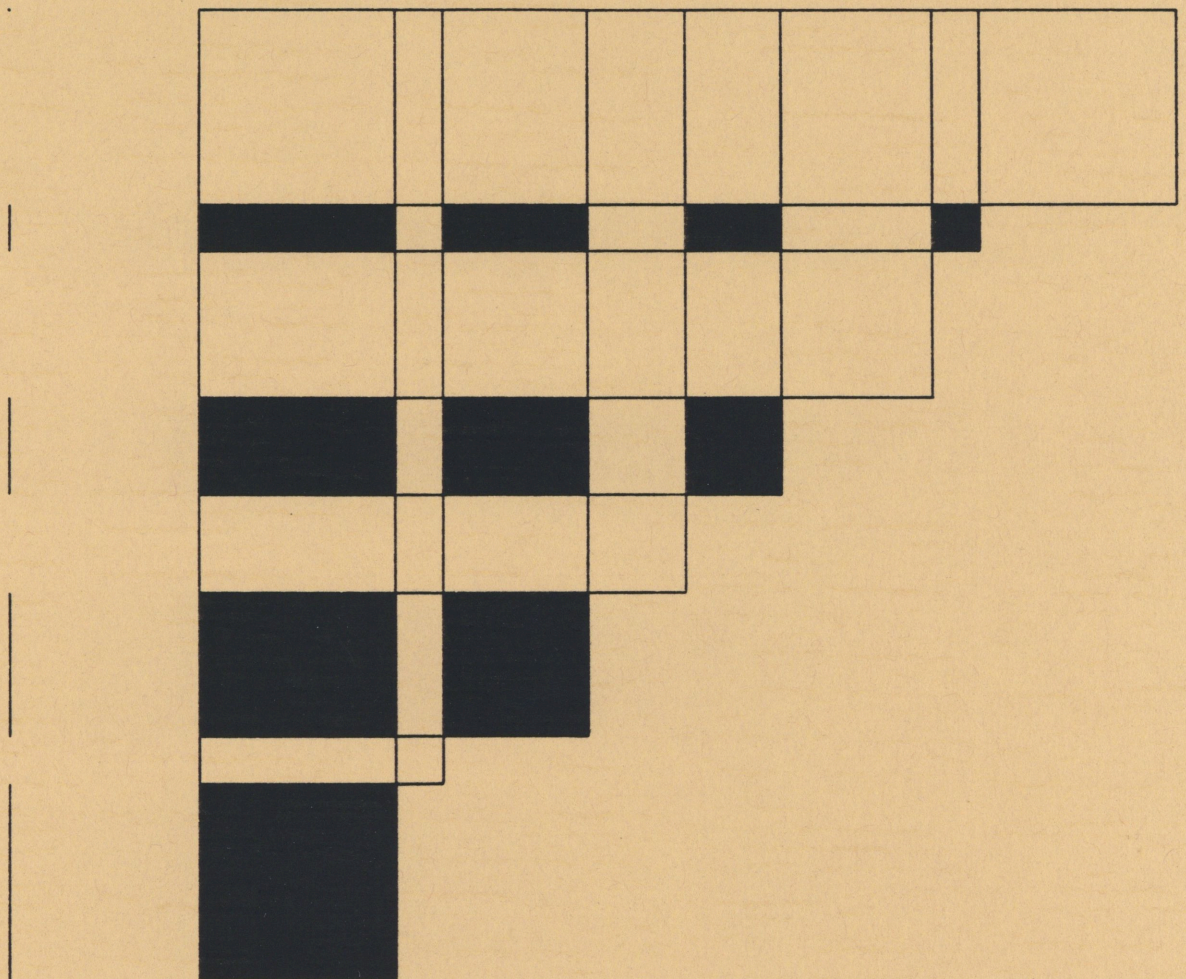
Organizing grid on the x and y axis with voids emphasized.



Organizing grid on the x and y axis showing the four identical motifs which comprise the pattern.



Organizing grid on the x and y axis with the solid redundants removed.



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Notes

¹J.L. Locher, ed., The World of M.C. Escher. (New York: Harry N. Abrams, Inc., 1971) p. 79.

²J.L. Locher, ed., M.C. Escher, (New York: Harry N. Abrams, Inc., 1982) p. 155.

³Bruno Ernst, The Magic Mirror of M.C. Escher, (New York: Ballantine Books, 1976) p. 35.

⁴Locher, ed., M.C. Escher, p. 114.

⁵Ernst, Magic Mirror, p. 14.

⁶Ibid., p. 77.

⁷Locher, ed., M.C. Escher, p. 123.

⁸Ibid., p. 156.

⁹Ibid., p. 164.

¹⁰Ibid., p. 155.

¹¹Ibid., p. 94.

¹²Ibid., p. 125.

¹³Ernst, Magic Mirror, p. 33.

¹⁴Ibid., p. 18.

¹⁵Ibid., p. 17.

¹⁶Ibid., p. 17.

¹⁷Ibid., p. 16.

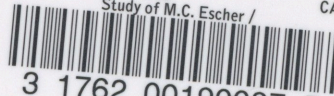
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- ¹⁸Locher, ed., M.C. Escher, p. 172.
- ¹⁹*Ibid.*, p. 91.
- ²⁰Ernst, Magic Mirror, p. 18.
- ²¹*Ibid.*, p. 18.
- ²²Locher, ed., M.C. Escher, p. 91.
- ²³*Ibid.*, p. 156.
- ²⁴Ernst, Magic Mirror, p. 20.
- ²⁵Locher, ed., The World of M.C. Escher,
p. 44.
- ²⁶*Ibid.*, p. 119.
- ²⁷*Ibid.*, p. 124.
- ²⁸*Ibid.*, p. 104.
- ²⁹*Ibid.*, pp. 84-85
- ³⁰*Ibid.*, p. 78.
- ³¹*Ibid.*, p. 82.
- ³²*Ibid.*, p. 89.
- ³³*Ibid.*, p. 143.
- ³⁴*Ibid.*, p. 93.
- ³⁵*Ibid.*, p. 117.

³⁶Ibid., p. 147.

³⁷Peter S. Stevens, Handbook of Regular Patterns, (Cambridge, Massachusetts, and London, England: The MIT Press, 1981), p. 4.

³⁸Ernst, Magic Mirror, pp. 36-37.

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