REFLECTIONS

Taken from *PERSPECTIVE DRAWING AND APPLICATIONS* by Charles A. O'Connor, Jr.

REFLECTIONS

Reflections can be either simple or complex. Everyone can appreciate the serene symmetry of nature reflected in a pond. In contrast, many have experienced the excitement and confusion prevalent in a carnival house of mirrors. This chapter covers the basic principles necessary to draw these and any other reflection.

The clarity of a reflection is dependent upon several inter-related conditions. The intensity of light and quality of the reflective surface are the main factors. In addition, two other important considerations when drawing reflections are the angle of the mirror to the picture plane and the distance of the object from the mirror.

The common glass mirror is only one example of a reflective surface. Water, chrome and silver are a few of the countless other reflective materials we encounter daily. In the following text, this multitude of reflective surfaces are all referred to as mirrors.

For the sake of explanation, the topic of reflections has been divided into categories of: horizontal, vertical, diagonal, multiple and curved mirrors.HORIZONTAL

ILLUSTRATION 53a:

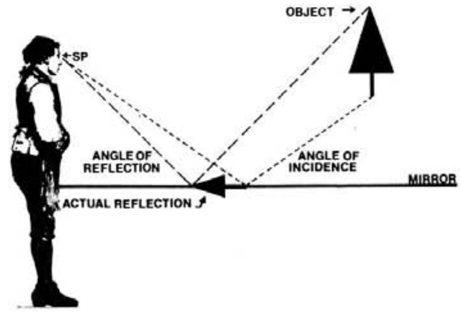
The theory of reflection is based on the optical rule that the angle of incidence equals the angle of reflection. This illustration is a diagram of that principle. The object, represented here by a triangle, is actually reflected where the dotted lines of sight touch the surface of the mirror.

ILLUSTRATION 53b:

In practice, the reflection of the object does not really appear to be on the surface of the mirror as diagramed above. Instead, the reflection of the object appears to be the same distance below the surface of the mirror as the object is above the mirror. It is the illusion on which the construction of all reflections in perspective is based.

ILLUSTRATION 53c:

This diagram illustrates the basic principle used to locate reflections in perspective. All reflections, regardless of their complexity, are based on this simple diagram. Reflections of objects are drawn by locating the reflection of specific points, one at a time, then connecting these points to complete the reflection of the object.The distance from a point on the object to the mirror is always measured along a line perpendicular to the mirror. This distance is then duplicated behind the mirror locating the reflection of the original point.



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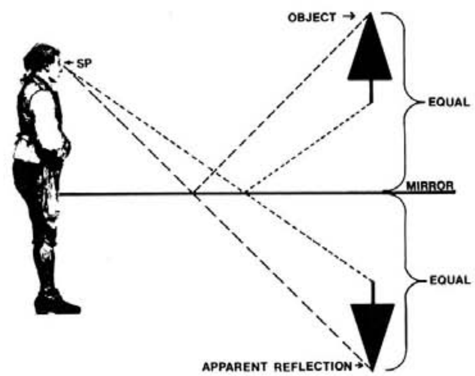

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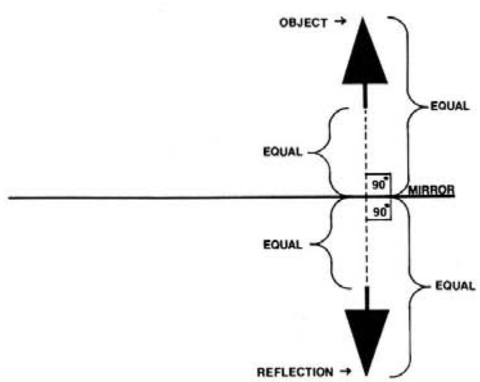

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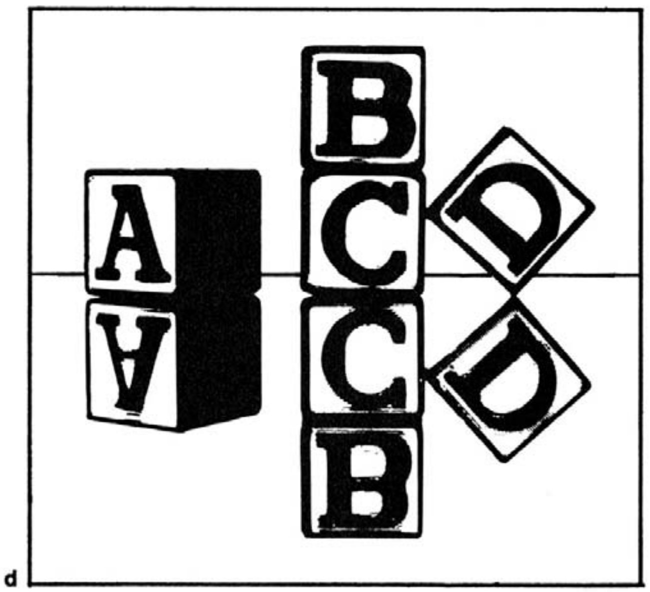
ILLUSTRATION 53d:

Several reflection constants are apparent in this photo. The horizontal reflection is an exact reverse image of the original blocks. The blocks and their reflections are symmetrical because the eye level is close to the surface of the mirror. The reflection of the blocks appear to be the same distance below the mirror as the blocks are above the mirror.



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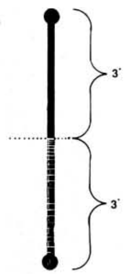

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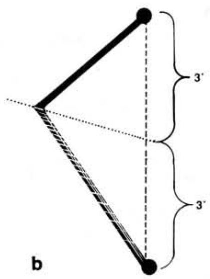

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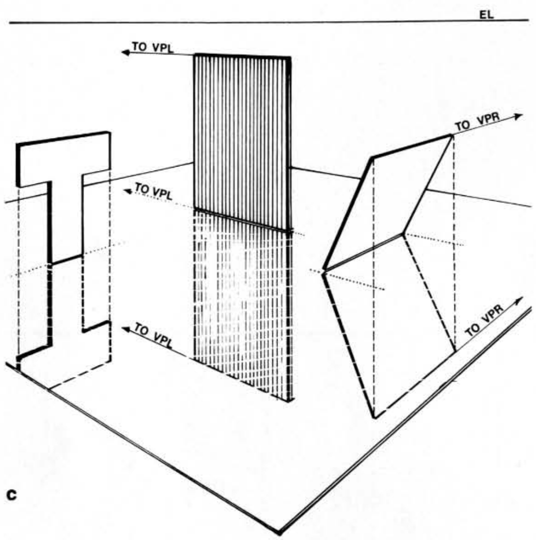

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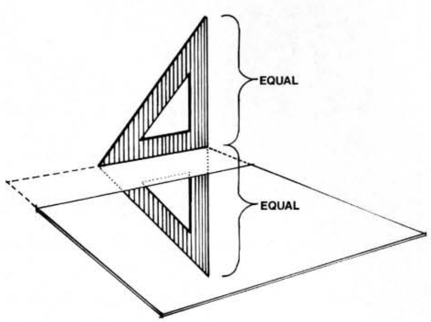

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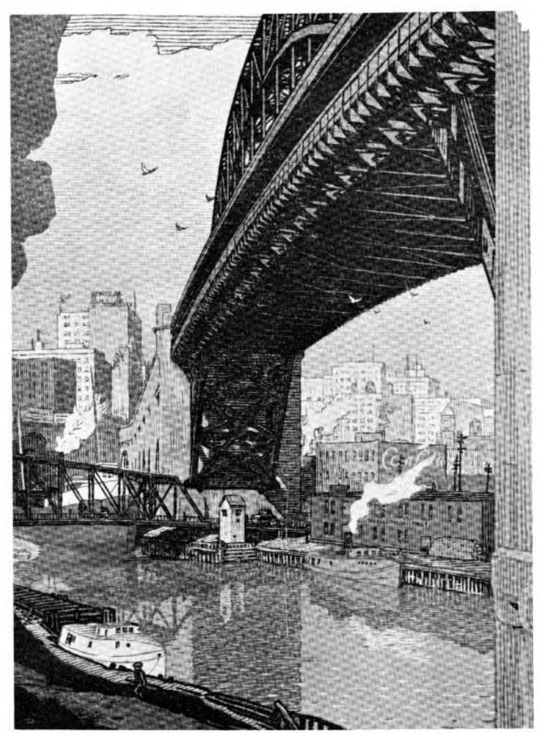
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MIRRORS:

ILLUSTRATION 54a:

An example of a simple reflection is this vertical object on a horizontal mirror. Only the reflection of two essential points, the top and bottom of the post, are needed to locate the reflection of the entire post. The bottom is touching the mirror, therefore its reflection is directly under itself. To find the reflection of the post's top, a perpendicular measurement is taken from a point on the top to the mirror. This length is then measured below the mirror to find the reflection of the top of the post. In this example, all measurements can be made with a ruler as no foreshortening is involved.

ILLUSTRATION 54b:

This drawing is similar to the previous illustration, except that the post is no longer vertical. The reflection of the bottom remains directly under the post because the post is still touching the mirror. The measurement from the post's top to the mirror requires an imaginary line be drawn perpendicular to the mirror. A construction line on the mirror's surface in the same plane as the post locates the point where the vertical dotted line intersects the mirror. Observe that the dotted line is bisected by the mirror, much like the reflection of the post in Illustration 54a.

ILLUSTRATION 54c:

Several objects are shown on a horizontal mirror. Some general rules which apply to all reflections can be observed: lines perpendicular to the mirror have reflections perpendicular to the mirror. Lines parallel to the mirror have reflections which remain parallel to the mirror and therefore converge toward common vanishing points on the eye level.

ILLUSTRATION 54d:

Only the top portion of the object can be seen in the mirror. The triangle is not touching the surface of the mirror as are the objects in Illustration 54c. The triangle is sitting on the ground beside the mirror. The reflection is constructed as if the mirror did extend back under the object, but only that portion of the reflection which occurs within the frame of the mirror is darkened.

WATER REFLECTIONS:

ILLUSTRATIONS 54e, f:

Water reflections are the same as horizontal mirrors. Slight variations in the reflective surface distort the reflected image. Each ripple in the water acts as a separate convex mirror. This accounts for the apparent breaking up of the reflection in water. The diminution of the ripples in the background creates rather distinct reflections; while the ripples in the foreground are farther apart, especially in rougher water, and reflect less accurate images. In addition, the movement of the water tends to obliterate the already vague foreground reflections.

VERTICAL MIRRORS:

ILLUSTRATIONS 55a, b, c, d:

These four drawings illustrate the sequence used to draw the reflection of the triangle and base.

The drawings are self explanatory, but a few general comments will assist in relating this sequence to other situations.

Normally, the first step in drawing reflections in non-horizontal mirrors is to find the vanishing point for lines perpendicular to the mirror. In all vertical mirror examples, the lines perpendicular to the mirror are horizontal and therefore their vanishing point is always on the eye level. In this example, vanishing point right is also the vanishing point for lines perpendicular to the mirror.

In each step, the problem is reduced to finding the reflection of specific points on the object. A rectangle, real or imaginary, is used to perform multiplication procedures.

Observe that lines parallel to the mirror have reflections parallel to the mirror and recede to a common vanishing point.

Lines perpendicular to the mirror have reflections perpendicular to the mirror. These lines and their reflections appear to be a continuous straight line when the original line is touching the surface of the mirror.

In this illustration, the base is the common ground used as a reference to establish the special relationship of the triangle with the mirror.

ILLUSTRATION 55d:

The perspective measurements for this drawing were made perpendicular to the plane of the mirror even though all of these measurements did not occur on the actual surface of the mirror. For construction purposes, it might be imagined that the mirror actually extends beyond its frame until it intersects with the common ground.

The size and shape of the mirror only affects how much of the object is seen in the reflection. The location of the reflection is determined by the angle of the mirror to the picture plane, the distance of the object from the mirror and their relationship to the cone of vision.

ILLUSTRATION 55e:

The distance of the object in front of the mirror is duplicated behind the mirror by the special vanishing point method. (Explained on page 35). This could be substituted for the diagonal method used in the other illustrations. Note the layout along the measuring line. The dimensions in back of the mirror are equal to those in front of the mirror, as diagramed in Illustration 53c.

ILLUSTRATION 55f:

The reflection of the X-ACTO knife and blade dispenser was drawn using the procedures outlined on this page. Note how the reflection of every point appears exactly the same distance behind the mirror as the corresponding point on the object is in front of the mirror.

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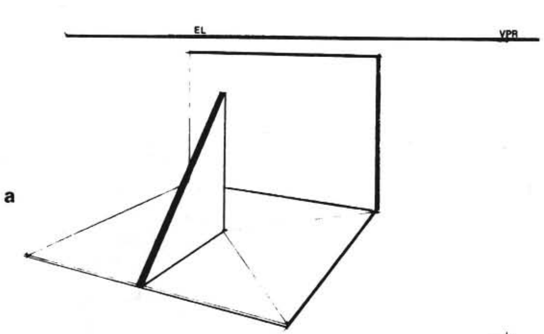

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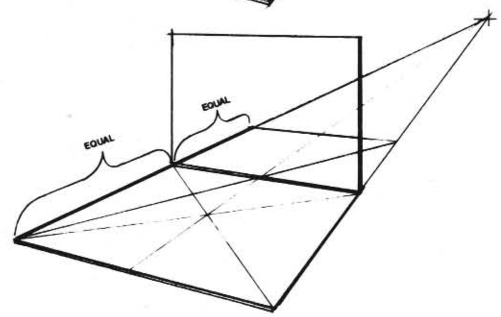

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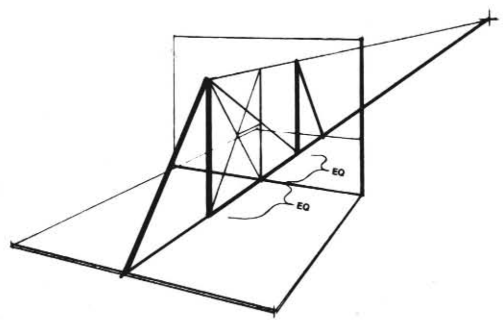

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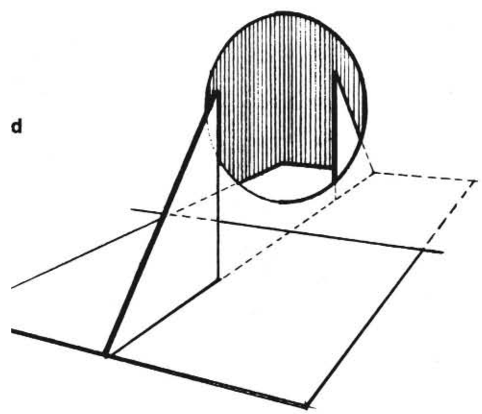

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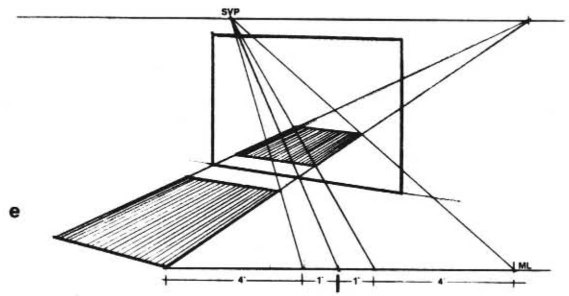

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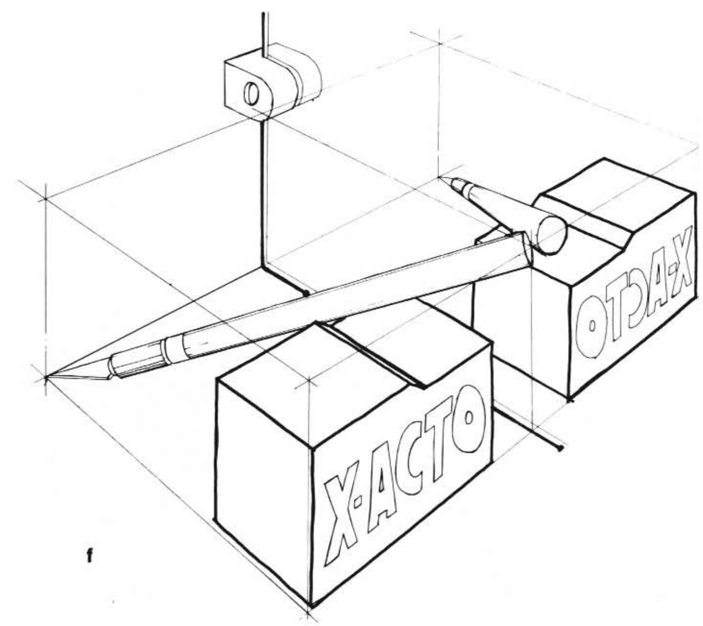


WORKBOOK ASSIGNMENT:

On top of Illustration 56c and 56d, draw the construction lines necessary to locate the reflection of the blocks. Next, find four other photographic examples of reflections and complete the same exercise. Include an example of a horizontal, vertical, diagonal and curved reflective surface.

Mount the photographs on blank paper and draw either directly on the photos or on a parchment overlay the construction lines needed to locate the reflection of a few critical points.

ILLUSTRATION 56a:

When a line is at an acute angle to the mirror, the line and its reflection make equal angles with the plane of the mirror. If extended, they will intersect at the mirror, as if the object were leaning against the mirror's surface.

ILLUSTRATION 56b:

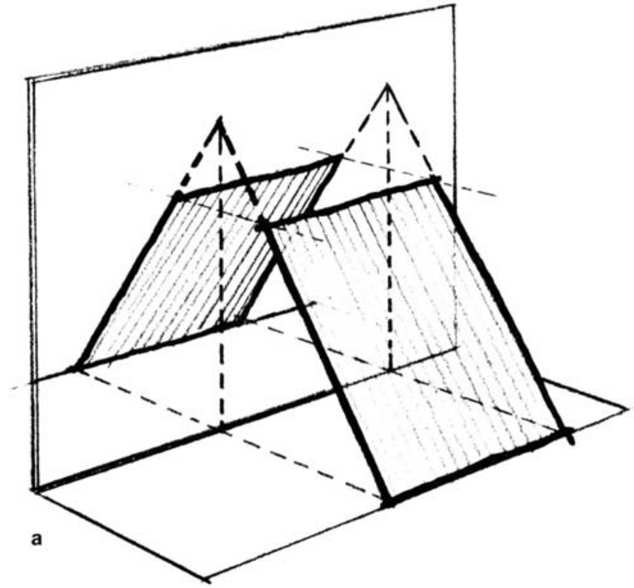
The reflection of more complex forms can be drawn by locating the reflection of a simpler shape which outlines the form. As in this illustration, the reflection was constructed for only the grid. Then the letter was plotted onto the reflected grid, being careful to reverse the image.

ILLUSTRATION 56c:

Note that one side of the block is touching the surface of the glass mirror. Observe the small space that exists between the block and its reflection. This is due to the glass thickness and the reflective coating being on the back side of the glass. This also causes ghost images or double reflections. One image is reflected from the mirrored surface while a second less brilliant "ghost image" is reflected from the front surface of the glass.
The nominal space between object and image is usually ignored during perspective construction. Any adjustments for the slight discrepancy are estimated after construction is complete. Front surfaced mirrors, such as chromed metal, will not show any space between the point touching the mirror and its reflection.

ILLUSTRATION 56d:

Compare this photo with illustration 56c. As the object I s moved farther from the surface of the mirror, its reflection appears to move behind the mirror an equal distance.



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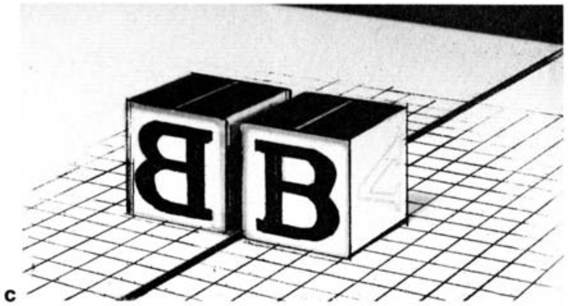

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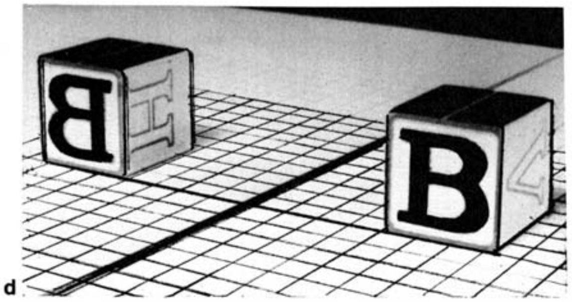

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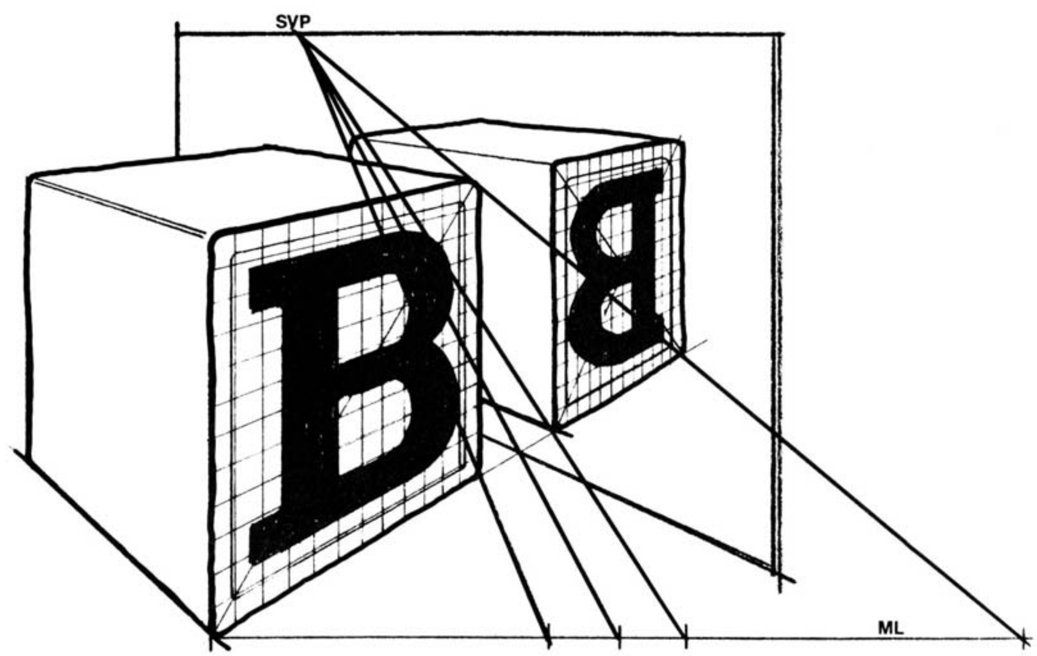

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DIAGONAL MIRRORS

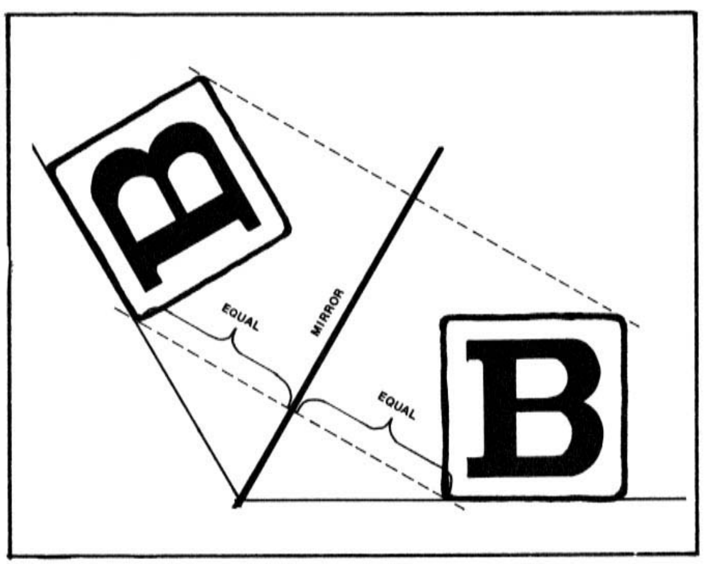
ILLUSTRATIONS 57a, b:
These illustrations, taken from a photograph, confirm certain perspective construction procedures for diagonal mirrors.

Illustration 57a is a side view of illustration 57b. Mechanical construction of a diagonal reflection requires first laying out the object, mirror and reflection in a side view such as this.

Illustration 57b: A line drawn from any point on the object to its reflection is perpendicular to the mirror. The dotted lines are perpendicular to the tilted mirror. All lines perpendicular to the mirror converge at an auxiliary vanishing point, in this example above eye level.

The brackets show that the lengths of the dotted line in front and behind the mirror are equal. This reinforces the theory which applies to all reflections: "The reflection of an object appears to be the same distance behind the mirror as the object is in front of the mirror." Note that the lines of the block which are parallel to the mirror remain parallel in the reflection.

On the following page is a more complete step by step procedure for constructing a simple reflection on a diagonal mirror.



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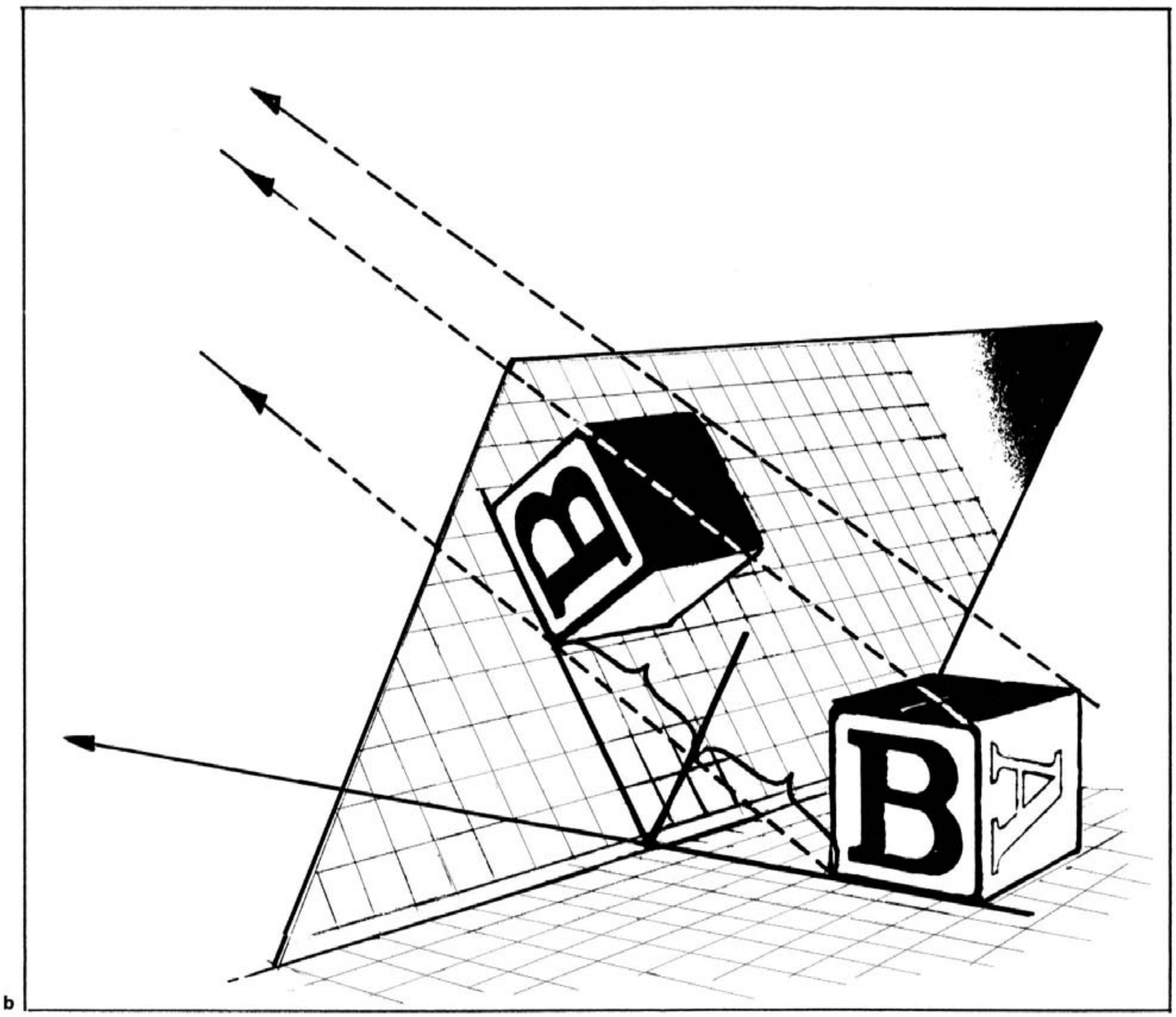

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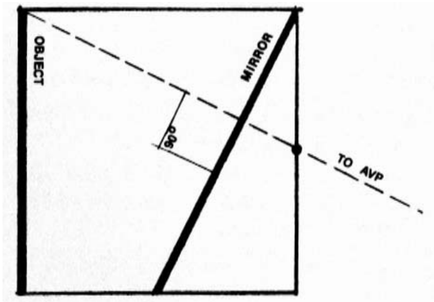

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ILLUSTRATIONS 58a, b, c, d, e, f, g:

Illustration 58a is a side view of the object, a rectangular panel, and reflection. This information is used to draw the object in relation to the mirror and locate the auxiliary vanishing point for lines perpendicular to the mirror in perspective.

Illustration 58b: The procedure begins with the drawing of an eight inch cube and positioning of the object (dark panel). Using the information from illustration 58a plot the top and bottom sides on the right face of the cube. Using these reference points draw in the outline of the mirror.

Illustration 58c: Draw a line (dotted) from the top corner of the cube through the point four inches up on the right vertical of the cube. Extend this line back until it intersects with a vertical line drawn down from vanishing point right. This locates the auxiliary vanishing point for ALL lines perpendicular to the mirror.

Illustration 58d: Draw dotted lines from the corners of the object to the auxiliary vanishing point. The reflection of the corners will appear somewhere along these dotted lines.

Next, determine where the dotted lines intersect the mirror by drawing a line to the surface of the mirror in the same plane as the dotted lines.

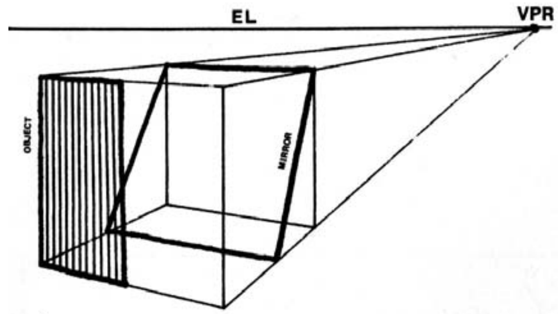
The length of the dotted line which intersects the line on the mirror's surface establishes the perpendicular distance the corner of the object is from the mirror.

Illustration 58e: In this example the special vanishing point method is used to duplicate the distance from the corner of the object to the mirror along the same dotted line behind the mirror. The side of the object is used as a vertical measuring line. (Review special vanishing point illustration 36c.)

Illustration 58f: Now that the reflection of the top front corner has been located the complete reflection can be drawn. The top edge of the object is parallel to the mirror's surface, therefore, its reflection remains parallel to the mirror.
Where the reflection of the top edge intersects the dotted line drawn from the other top corner of the object is the reflection of that corner.

Illustration 58g: Drawing the verticals of the object down until they intersect with the extended plane of the mirror locates two reference points from which the reflections of the sides can be drawn.

The illustration is completed by drawing the reflection of the sides, they extend from the reflection of the top corners to the reference points below the mirror.



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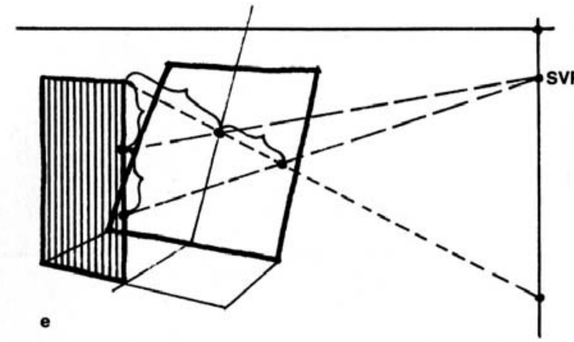

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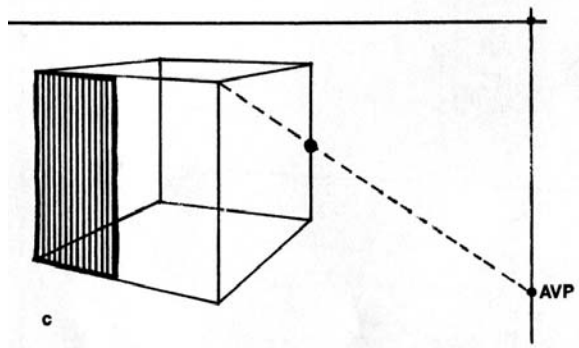

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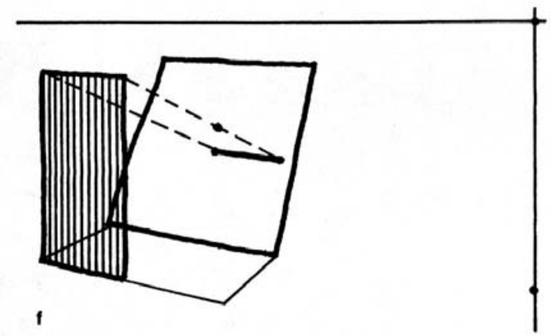

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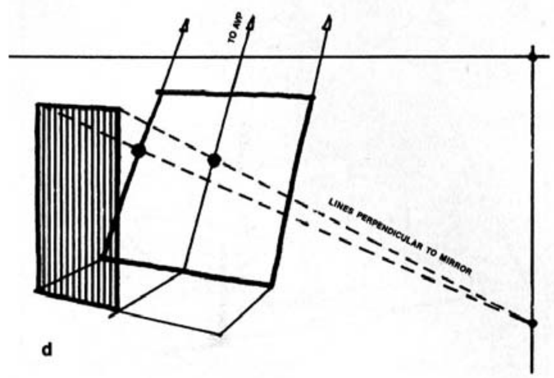

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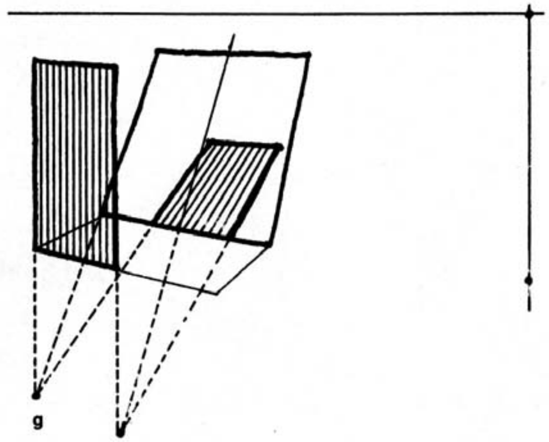

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MULTIPLE REFLECTIONS

An interesting phenomenon is the multiple reflection. The confusion caused by the endless reflections in a House of Mirrors and the beauty of a kaleidoscope are both dependent on multiple reflections. All reflections are based on the concept that the angle of incident equals the angle of reflection. Therefore, if two mirrors are 90° to each other a series of 90° reflections will occur. Should the angle between the mirrors be 60° so will the reflections. The total of the original angle and all of the reflections is always 360°. Consequently, mirrors at 90° have three reflections. (Three times 90° plus the original 90° equals 360°.) Mirrors at 60° have five reflections and so on. When the angle between the mirrors is not evenly divisible into 360°, the remainder would appear as a fragment of an additional image midway in the reflection.

ILLUSTRATION 59a:

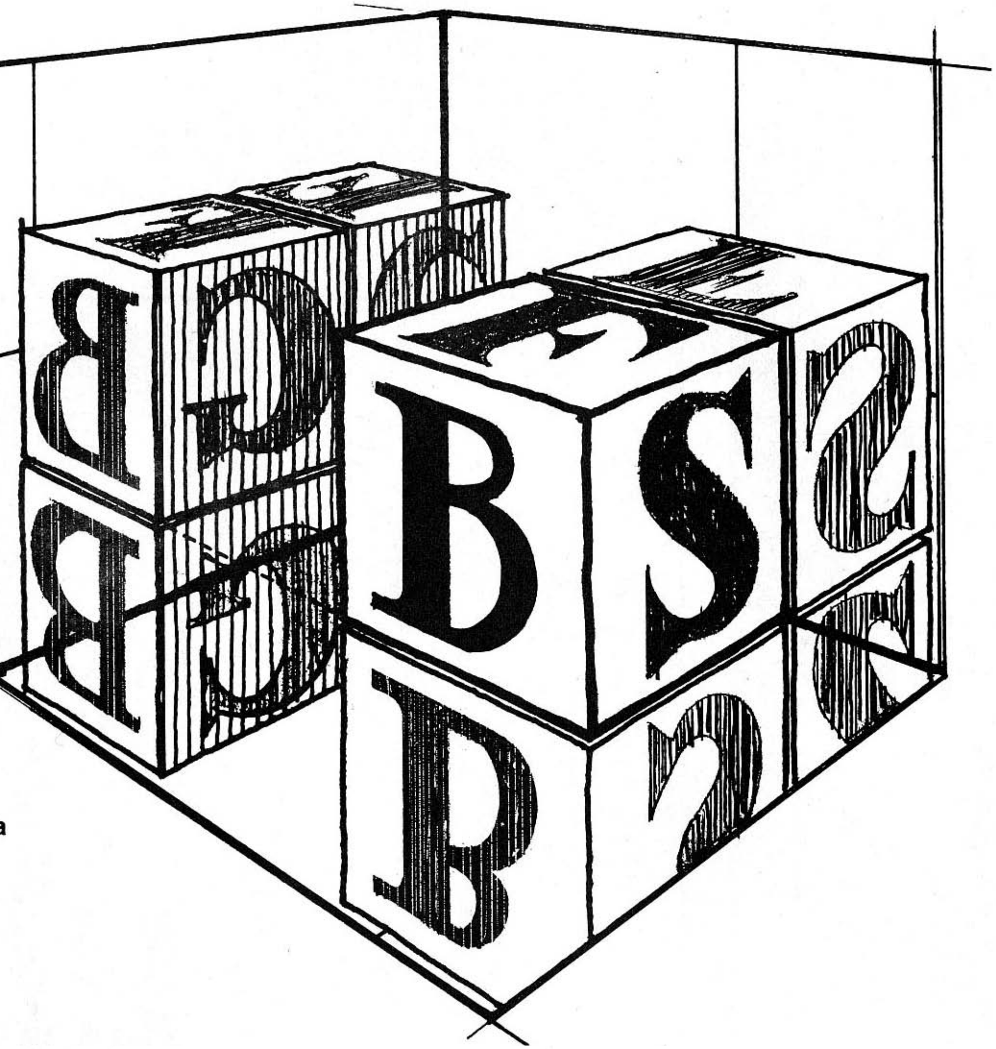
This multiple image reflection contains three mirrors, all perpendicular to one another. Two vertical and one horizontal mirror which are joined much like the inside corner of a box. The child's block shown in heavy line is the only object, all of the other images are reflections that remain aligned creating somewhat of an optical illusion. The reflected images seem to pass from one mirror's surface to another without changing direction, this is caused by the alignment of the various reflections.

Construction methods for this example and the others on this page are outlined on the previous pages. When drawing the reflections of reflections remember that the image does not appear to be on the surface of the mirror, rather it seems to be the same distance behind the mirror as the original object is in front of the mirror. In other words assume that each subsequent reflection is a real object existing behind the mirror's surface . . . and proceed as usual.

ILLUSTRATIONS 59b, c, d:

This series of sketches shows the effect of changing the angle between two mirrors. When drawing such an example consider one mirror at a time and continue to find the reflections until the "circle" is complete. Observe that the total of the mirror's angle and reflections always equals 3600.

Illustration 59d: The angle between these mirrors cannot be divided evenly into 3600. Note how this causes a fragmentation of the middle image in order for the reflections to total 3600.



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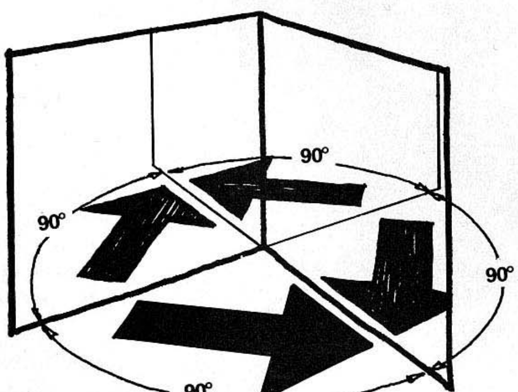

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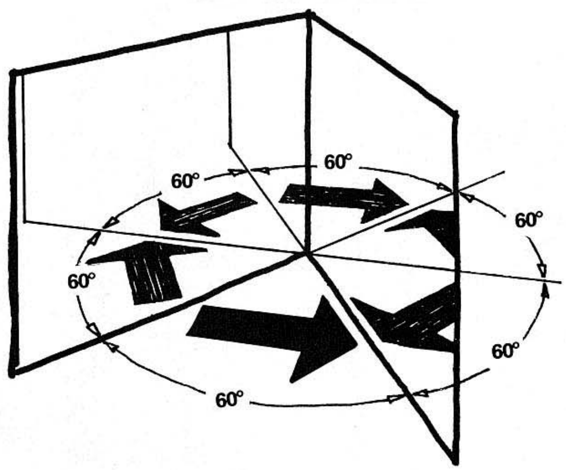

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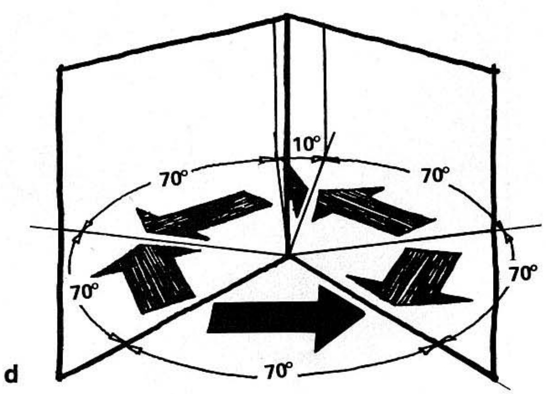

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CURVED MIRRORS

The reflections on curved surfaces are subject to the same laws of optics governing any reflection. However, the complexity and distortion of the curved reflection make mechanical construction difficult. Locating lines perpendicular to the surface of a curved mirror can be most time consuming. In addition, a curved surface reflects much more than we can see within our normal cone of vision, further complicating the assignment.

The simplest way to draw reflections in curved mirrors seems to be from life. Recalling the procedures regarding flat mirrors will aid in maintaining realism even in the roughest sketch, especially when a model is not available.

ILLUSTRATION 60a:

This self portrait by M. C. Escher was drawn from life. The background includes an extremely distorted reflection of almost the entire room. The spherical reflection is like a photographic image taken with a fish-eye lens.

ILLUSTRATION 60b:

It is evident in this still life that the reflection of the spoon does not appear to wrap around the surface of the cylinder. The reflection seems to twist back into the cylindrical mirror. This is due to the variable distance from points along the spoon to the cylinder. As in any reflection, the distance from a point on the object to the mirror is equal to the apparent distance from the surface of the mirror back to the reflection.

ILLUSTRATION 60c:

In this example the artist captures herself as well as the surrounding interior. We can see the difference between the reflection in a cylinder and a sphere. The bottom portion of the container is a cylinder, and while the reflection is condensed, vertical lines remain vertical in the reflection because they are parallel to the mirror. In contrast, the top of the container is a truncated sphere. In this area the reflections of all straight lines are curved.

The nominal space between object and image is usually ignored during perspective construction. Any adjustments for the slight discrepancy are estimated after construction is complete. Front surfaced mirrors, such as chromed metal, will not show any space between the point touching the mirror and its reflection.

ILLUSTRATION 56d:

Compare this photo with illustration 56c. As the object is moved farther from the surface of the mirror, its reflection appears to move behind the mirror an equal distance.


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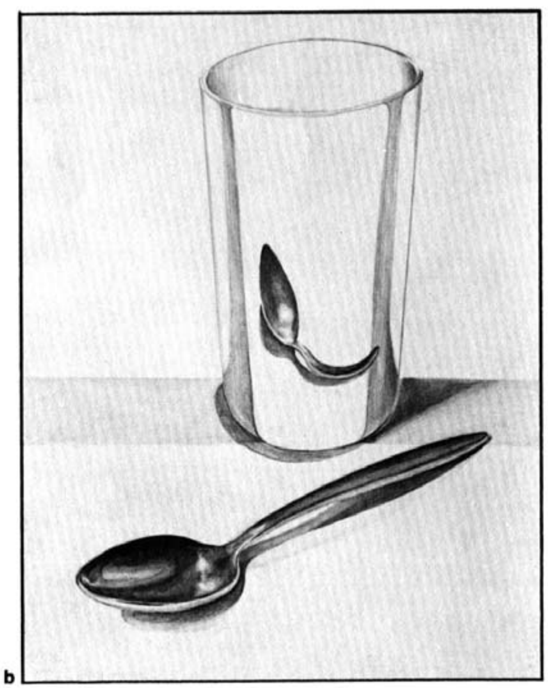
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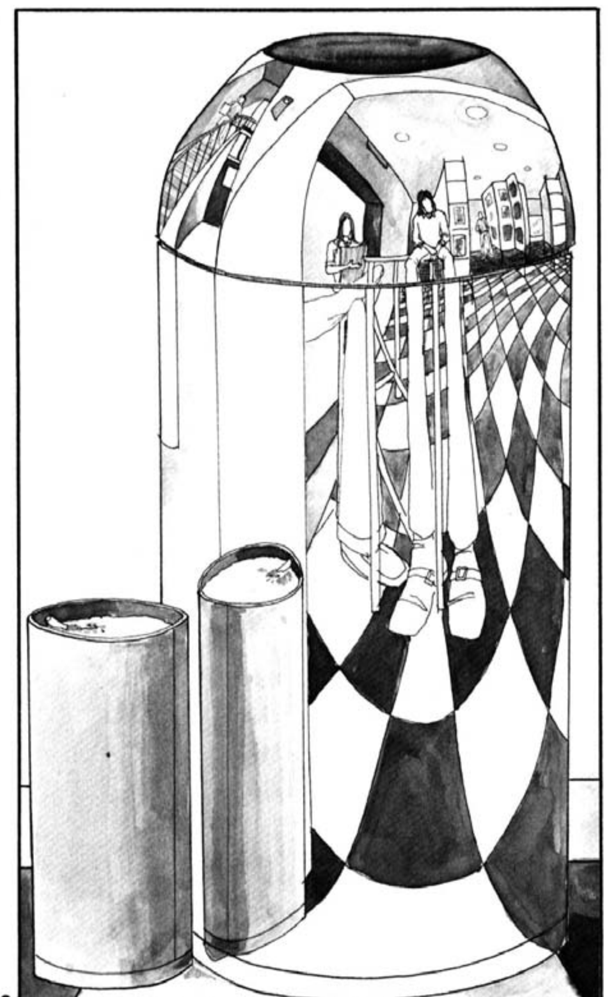
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