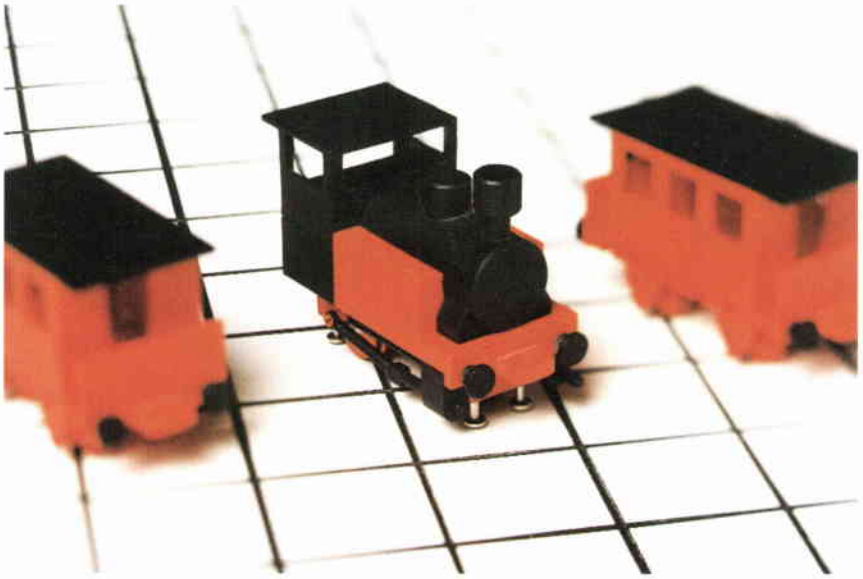
Canon TS-E Lenses

The impossible picture



The impossible picture

In normal photography the axis of the lens is mounted in a fixed position at right angles to the film plane. The lens moves to and fro only. Sharpness is *a slice of space* that moves in correspondence with the movements of the lens. A fixed lens axis keeps this zone of sharpness always parallel to the image plane.

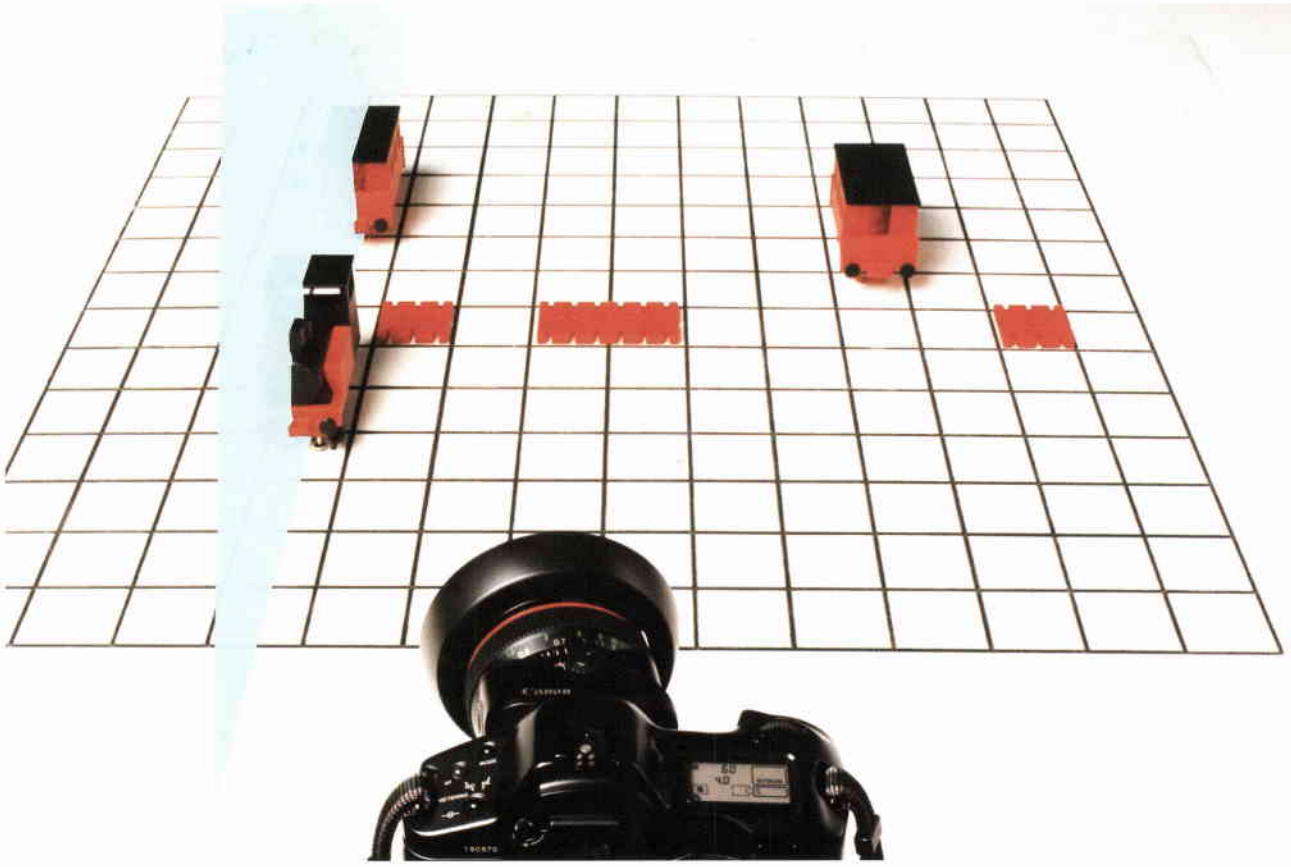
When the axis of the lens can be tilted at an angle with the film plane the slice of space can swing in any direction.

Despite its advantages lens tilt is not common in photography because the technique required expensive large-format equipment and much patience. Moreover there is no reliable description of lens tilt in photographic literature. Even for experienced photographers lens tilt is magic.

With the introduction of TS-E lenses for the 35 mm reflex camera Canon has broken the spell of magic.

As one may expect from Canon engineering TS-E lenses are first class optical instruments matching the highest standards of lens design. Moreover they are unique in their access to the slice of space allowing pictures that would be impossible for any other existing lens, lens tilt having its greatest effect with a small camera format. Canon opens up the 35 mm camera to lens tilt with its TS-E lenses that do not require additional equipment.

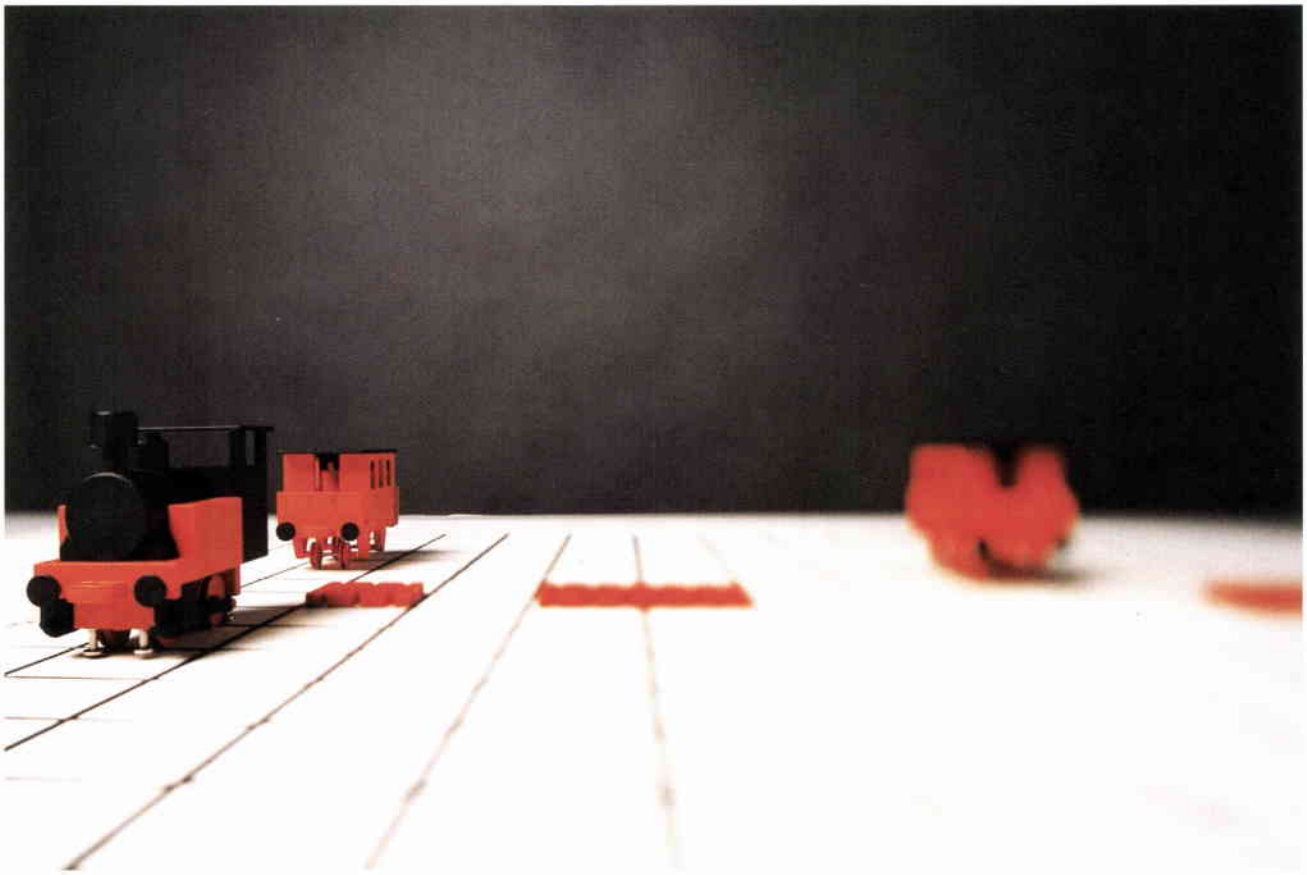
This publication demonstrates lens tilt in actual pictures and describes the technique in plain words. Nevertheless the description is precise. It even enables you to calculate the effect of lens tilt in exact figures though calculation is not necessary to learn the secret of advanced photography.



Assignment

To get a dramatic picture of the train set a photographer might choose a low point of view at a short distance which would show the proportions of the objects with a great contrast. A wide angle lens would be needed to cover such a scene.

A stopped down 24 mm lens would yield a picture with an acceptable overall sharpness whereas a wide aperture would reduce sharpness to a narrow peg. Such a shallow slice of space could add impact to our picture if it could be aligned with a substantial part of the subject e. g. the two parts of the train at the left.



TS-E 24 mm

Solution

Our task implies that the sharpness should be at right angles to the camera at a distance of 17.5 cm (3.5 squares of 5 cm each) from the principal point of the lens.

A tilted lens always has a corresponding object plane that is perpendicular to the image plane. The distance of this object plane to the principal point of the lens depends on the tilt of the lens and on the focal length. The equation expresses this relationship:

$$\text{sine angle of tilt} = \frac{\text{focal length}}{\text{distance}}$$

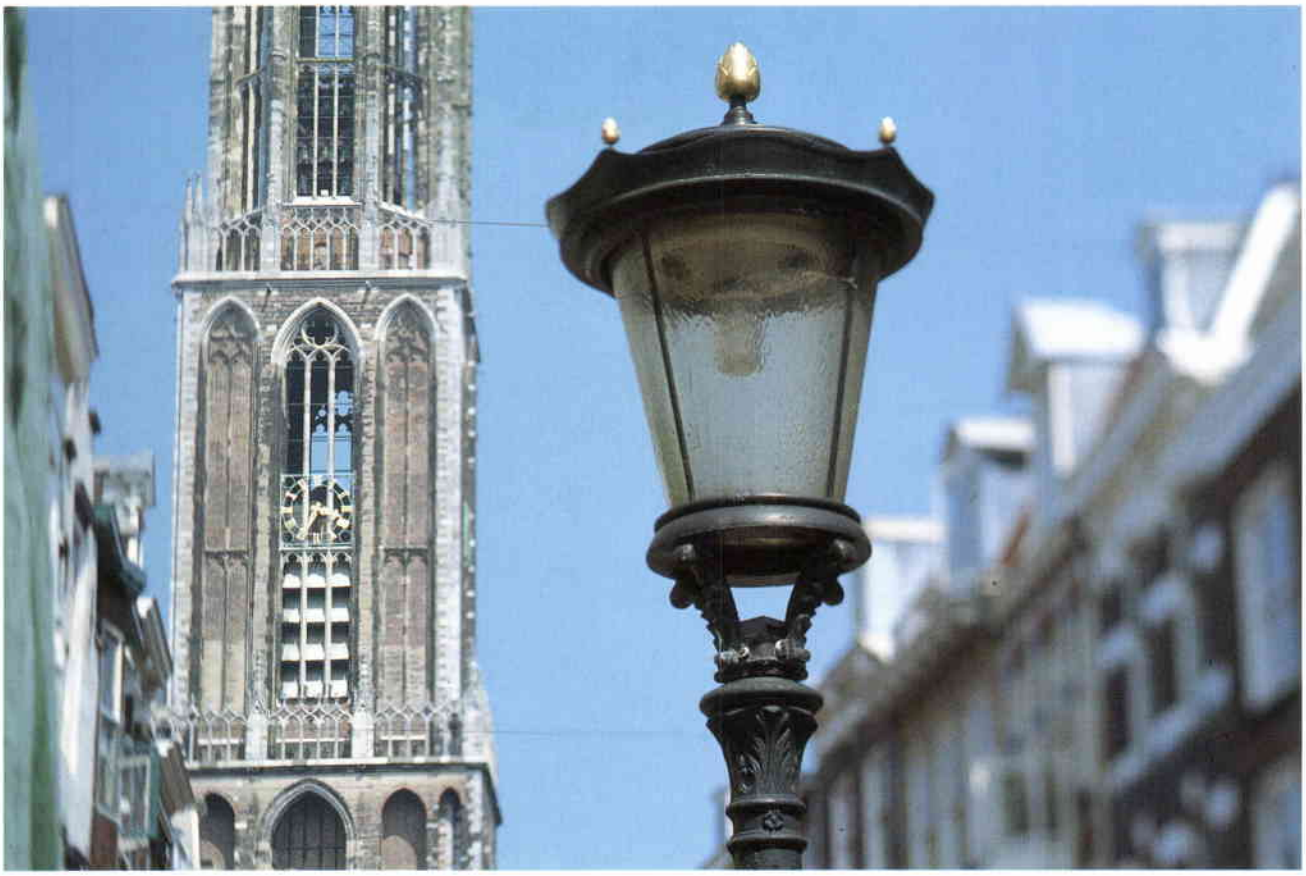
For our example the equation returns: sine angle of tilt = 24 / 175 (both values in mm).

A pocket calculator with scientific functions converts the resulting sine to 8°, the angle for our picture.

To take the picture on the previous page with a 4 × 5 inch view camera you would need a 100 mm lens tilted at an angle of 35°. If the image was not be completely obscured by vignetting its contrast and sharpness would suffer greatly from the effect of lens aberrations. For the large-format camera our photograph would be an impossible picture, indeed.
A tilt of 8° does not impair the quality of the image significantly.

Only the Canon TS-E 24 lens solves our problem. It is the most powerful tool for lens tilt.

This is the first publication of the formula of lens tilt in English literature; you might keep this brochure with your photographic books.



TS-E 90 mm

Design

The small photographs on the opposite page of the same view in the city of Utrecht represent the three main options for focusing a lens with a fixed axis. It can be focused on the background, on the foreground and, with a small aperture, in between.

The first picture was focused on the cathedral tower leaving the street lamp unsharp. In the second picture the street lamp is sharp whereas the tower is out of focus. The blurred image of the street lamp disturbs the composition of the first picture. From a designer's point of view the second picture is somewhat better in this regard but the intriguing shape of the tower deserves a sharp representation.

The third picture meets this demand by stretching sharpness from foreground to background, but now the houses are distracting our attention. This completely sharp picture is the dullest of the three. Again from a designer's point of view we must conclude that this scene is not a suitable subject for a good picture when the lens has a fixed axis. The photographer can only seek a new standpoint.

The above photograph was taken with a tilted TS-E 90 lens. The tricky arrangement with two competing subjects was worked out in a satisfying solution by blurring the house fronts. They have the role of leading our attention to the central subjects. However, to do this smoothly they should not show sharp edges.

As a specimen of design the quality of this photograph depends entirely on the lens tilt. A tilted lens can keep rival subjects in balance .

The cable running across the street behind the lamp is a disturbing element in the picture but it helps in understanding the arrangement. In the tilted slice of space depth of field appears as width of field, an expanding peg that in the distance encloses the entire tower. At the distance of the wire, however, the slice of space is still rather shallow.

Near and far

Only 17.5 cm is the distance between the toy train and the principal point of the lens on page 3, but in the proportions of the subject it is a considerable distance.

In the second picture of Utrecht cathedral the sharp slice of space is also at a distance of 17.5 cm to the principal point but in the heart of the city the same distance is far less impressive than on the table top: sharpness crosses the image plane almost in the centre of the picture.

Without the foreground a central section of the picture with its perpendicular slice of space is not at once distinguished from a picture taken with a lens in the usual parallel position: at great distances lens tilt looses meaning because the width of field finally includes everything, especially with wide angle lenses. This remark reflects the observation in the paragraph on close-up photography that lens tilt is not very effective at very short distances. A tilt lens seems to be an average lens that is not suitable for extremes. But wait, we did not really cut off the foreground of the picture. It is still there with a close-up subject in crisp sharpness.

The special feature of lens tilt is not that you can get sharp pictures of nearby or remote subjects; it is exclusive in allowing you to catch remote and nearby subjects in one shallow slice of space without stopping down the aperture of the lens.

The picture suggests a change of mind. The experienced photographer has learnt to avoid instinctively a combination of important subjects at different distances. TS-E lenses make this instinct obsolete. Everything that has become self-evident in the practice of photography needs to be reconsidered.

It may have been practical as well to look at lens tilt as studio technique and to work outdoors with fixed lenses. Here too you might think again. TS-E lenses open a new view on any subject. Do not leave them at home.

The wide aperture of the exposure makes the set-up of the picture transparent. From the pill on the tongue of the 'gaper', the traditional sign of a Dutch chemist's shop, the object plane runs to the axis of the distant tower. In this picture there is again a cable across the street but now a greater length of cable lies within the slice of space than in the previous picture which indicates shorter focal length.

You cannot break the laws of design and the rules of geometry but they do not prescribe your pictures. You are free to observe these laws of photography or to neglect them. Our story and our pictures should only show how Canon TS-E lenses can help you to tell your own story impressively.

TS-E 24 mm

Flexibility

The mount of a tilted TS-E lens can be rotated at any angle; lens tilt is not restricted to horizontal or vertical object planes. In the picture above the slice of space runs from the centre of the ball to the eyes of the player.

Though lens tilt can contribute to overall sharpness, most pictures in this brochure use a shallow slice of sharpness against overall unsharpness, because this contrast shows more clearly how the lens was adjusted. Meanwhile it suggests creative use of lens tilt too.

The photograph above was taken with the TS-E 90 lens. It has the moderate telephoto effect that contributes to well proportioned portraits.

The flexibility of Canon TS-E lenses allows lens tilt with a hand-held camera.

TS-E 45 mm

TS-E 24 mm

TS-E 90 mm

TS-E 90 mm

TS-E 45 mm

TS-E 24 mm

Cart track

A cart track in a cornfield is the subject for comparing the ranges of the Canon TS-E lenses. In the distance the slice of space widens more with a short focal length than with a long one. With the 24 mm lens it encloses at full aperture a considerable part of the horizon whereas the 90 mm lens still leaves the greater part of the central tree in unsharpness. In a subject like this one Canon TS-E lenses could improve overall sharpness too. It may run from the life size ears of corn in the foreground to the horizon.

With the camera and the lens in a normal position the horizon lies in the middle of the picture. It can be manipulated by tilting the camera out of its normal position or by cropping the picture. Sometimes this will do, but for other occasions, architecture for instance, these methods might be too crude. In some of our pictures the lens has been shifted to move the horizon.

Lens shift is an additional feature of the Canon TS-E lenses. The wide image circle is a major condition for lens tilt that can also be used for lateral movements of the lens but when a lens is shifted and tilted in the same direction the image circle is soon exhausted. This is prevented by the construction of Canon TS-E lenses. As such the lenses can be shifted in any direction; shift is as flexible as tilt. However, to make sure that any combination of adjustments is firmly held within the scope of its optimal performance a Canon TS-E lens only allows a combination of tilt and shift in directions that are at right angles to each other.

TS-E 24 mm

TS-E 45 mm

TS-E 90 mm

TS-E 90 mm

Close-up photography

In close-up photography the depth of field is shallow. Without lens tilt a plane can only appear sharp when it is parallel to the image plane. In an oblique view of the coins the greater part of the surface would be unsharp; it would not be possible to show the edge of the coins together with a sharp surface. This is a general problem of close-up photography. For the pictures on this page it was solved with the Canon life-size converter EF between the camera and a tilted TS-E lens. The surface of the coins lies in a slice of space that was extended to include the thickness of the coins by closing the aperture of the lens a few stops.

The object plane has the greatest angle with the image plane at the shortest distance between the image plane and the principal plane of the lens. By enlarging this distance the extender also reduces the effect of lens tilt. For the photographs on these pages the lens was tilted by 8°. When used with the converter all TS-E lenses can depict the same part of the same object plane, but from a different distance proportional to the focal length of the lenses. The perspective of the picture changes accordingly.

The Canon life-size converter was designed exclusively for the 50 mm Macro Compact lens. Its combination with TS-E lenses is an unorthodox experiment with, at first sight, promising results.

TS-E lenses are almost indispensable for close-up photography of three-dimensional objects. They raise the standards for scientific, technical and cultural photography.

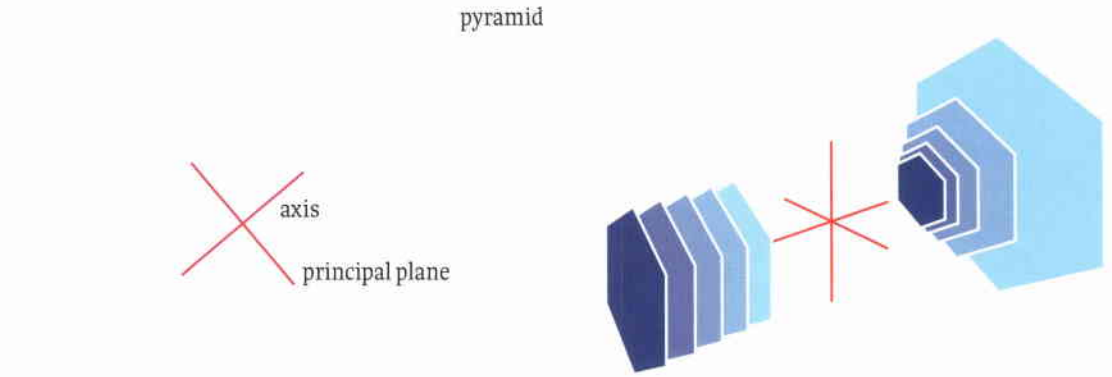


figure 1

Background

The format of the 35 mm camera has always been ideal for lens tilt but when this type of camera appeared it was not yet possible to construct lenses with a retrofocus that leaves sufficient space between the lens and the focusing screen for the movements of the lens. Moreover development concentrated for decades on automatic functions for the 35 camera without much attention to its fundamental advantages.

The drawings on these pages show the interaction of object, lens and image in schematic diagrams. The red cross marks the principal plane and the axis of the lens. The arms of the cross have the focal length of the lens. Every hexagon in the hexagonal pyramid has the same shade as its corresponding hexagon in the hexagonal prism. Every constellation was drawn in perspective and in a ground-plane.

The prism is the image of the pyramid but in the diagrams the pyramid is the image of the prism as well. In a mathematical model of physical phenomena cause and effect can often be exchanged. In reality the object is that what remains when the lens is removed.

Figure 3 shows the same constellation as figure 2, only the prism is turned. This modification distorts the pyramid. To move the nearest hexagon into the image plane the camera should be tilted at a great angle.

Figure 4 differs from figure 3 only in the focal length of the lens: the arms of the cross are shorter. Now the same subject can be depicted with a much smaller angle of tilt, which preserves more of the qualities of the lens in the picture.

The mathematical constructions of the diagrams summarise our message that Canon TS-E lenses offer the maximal effect of lens tilt with minimal loss of image quality. They do not achieve this despite the small camera format; contrarily, this format is the ideal condition for lens tilt.

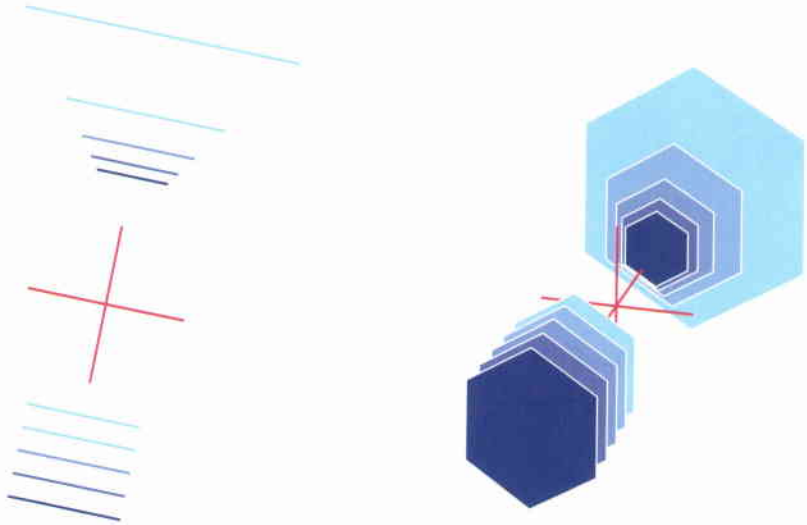


figure 2
The axes of prism and pyramid coincide.

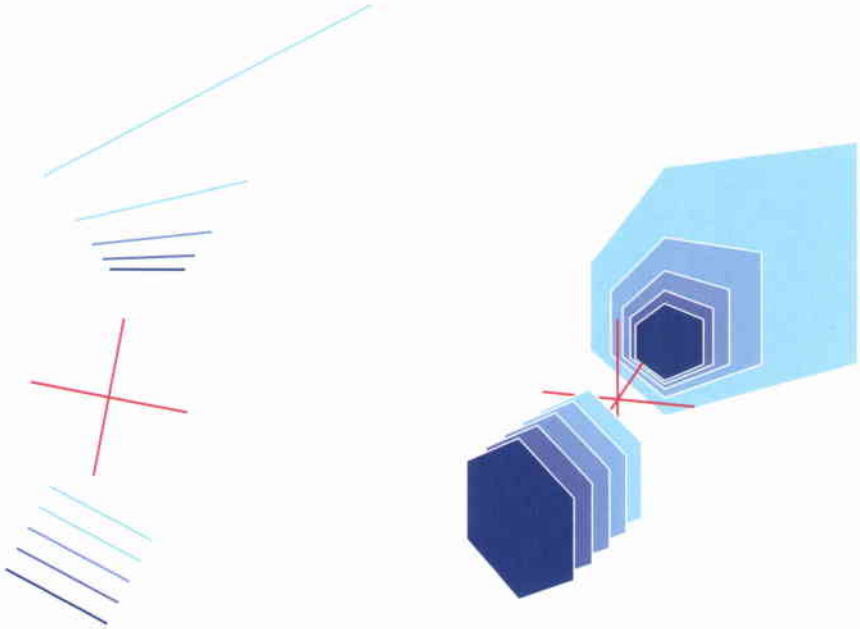


figure 3
The rotated prism distorts the pyramid.

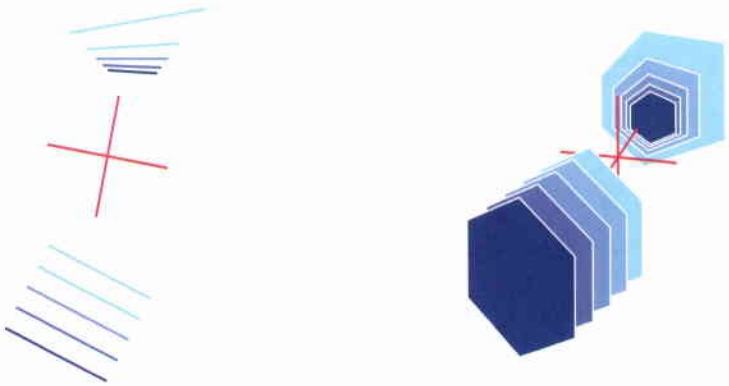


figure 4
A short focal length reduces the distortion of the prism. Accordingly it requires less lens tilt.

Tilt and shift lenses for EOS 24 × 36 mm cameras.
Specifications(subject to change without notice).

	TS-E 24 mm	TS-E 45 mm	TS-E 90 mm
Mount	Canon EF	Canon EF	Canon EF
Focal length	24 mm	45 mm	90 mm
Aperture range	3.5 – 22	2.8 – 22	2.8 – 32
Lens construction	11 elements in 9 groups	10 elements in 9 groups	6 elements in 5 groups
Focusing system	floating elements	floating elements	full extension
Super Spectra Coating			
Image circle diameter	58.6 mm	58.6 mm	58.6 mm
Image circle angle	102°	66°	36°
Diagonal angle of view	84°	51°	27°
Vertical angle of view	53°	30°	15°11′
Horizontal angle of view	74°	44°	22°37′
Field of view at the maximum	174 × 262.5 mm	150 × 226 mm	81.9 × 122.8 mm
magnification at the minimum	0.14 ×	0.16 ×	0.29 ×
focusing distance	0.3 m	0.4 m	0.5 m
Tilting range from – 8° to 8°			
Shifting range from – 11 mm to 11 mm			
Barrel rotation 360°			
Length × diameter	86.75 × 78 mm	90.1 × 81 mm	88 × 73.6 mm
Weight	570 g	645 g	565 g
Lens hood	EW-75B	EW-79B	ES-65II
Filter diameter	72 mm	72 mm	58 mm
(Other filters than those made by Canon may touch the front lens and damage it.)			

Canon

The essential photographs show the complete frame with the proportion 2 × 3

Concept, design, typefaces, close-ups, diagrams, Gerrit Noordzij
Photography, Frits van Santen
Production, Aad van Koningshoven

Printed in The Netherlands for Canon Europa, 1994

Canon

Canon Inc.
30 – 2, Shimomaruko 3 – Chome, Ohta-Ku
Tokyo 146, Japan

Canon Europa N. V.
P. O. Box 2262, 1180 EG Amstelveen
The Netherlands

Canon Hong Kong Trading Co., Ltd.
10th floor, Mirror Tower, 61 Mody Road,
Tsimshatsui East, Kowloon, Hong Kong

Canon Singapore Pte. Ltd.
79 Anson Road # 09-01/06,
Singapore 0207

Canon Australia Pty. Ltd.
1 Thomas Holt Drive,
North Ryde, N. S. W. 2113, Australia

New Zealand
Canon New Zealand Ltd.
Fred Thomasdrive, Takapuna,
Auckland

Canon U. S. A. Inc. Headquarters
One Canon Plaza,
Lake Success, N. Y. 11042, U. S. A.

Canon Canada Inc. Headquarters
6390 Dixie Road, Mississauga,
Ontario LST 1P7, Canada

Canon UK Ltd.
Units 4 & 5, Brent Trading Centre,
North Circular Road,
London NW10 0JF, United Kingdom

The Netherlands
Canon Benelux N. V.
Neptunusstraat 1
2132 JA Hoofddorp
Tel. 02503 81 603

Belgium and Luxemburg
Canon Benelux NV/SA
Bessenveldstraat 7
1831 Diegem (Mechelen)
Tel. 02 722 04 11

Sweden
Canon Svenska AB
127 88 Skårholmen,
Tel. 08 744 85 00

Finland
Oy Canon Ab
Komettvägen 3
00 380 Helsingfors
Tel. 90 56 061

Norway
Cannor A. S.
Postboks 4, 1476 Rasta,
Tel. 67 90 87 90

Denmark
Princo A/S
Produktonsvej 23, 2600 Glostrup,
Tlf. 44 53 40 40Tel. 0222 66 146

English version
ZC6 – 2505 Eng

Printed in The Netherlands