THE ULTIMATE EYE.

Leica® lenses close up.

The fundamental question.

Basically, a lens is an optical device that directs light to expose an image on photographic film.

But to the serious photographer, amateur or professional, a lens is as important as color is to a painter.

The fundamental question is: how well is the light directed?

The Leitz® tradition.

At Leitz, there is a legacy in optical excellence that is unparalleled. No other company in the world has worked so long and so assiduously to perfect the transmission of light through glass.

Since 1849, Leitz has manufactured superior microscopes. It is presently one of the world's two top companies in the field. For over half a century, Leitz has been making lenses for its Leica® cameras. In fact, Oskar Barnack, who joined the E. Leitz company in 1911 as a master machinist and design engineer, developed the first 35mm camera, the "original Leica" in 1913.

Leica lenses are made in Wetzlar, West Germany and in Midland, Canada. Reflecting the practices employed at both locations, this brochure describes the many extraordinary procedures that go into making Leica lenses capable of performing like no others.

Oskar Barnack in his laboratory at Wetzlar, circa 1930.

Optical design.

Lens design is an integral part of the Leitz commitment to quality.

A Leica lens begins its existence hypothetically, as a solution to a particular set of problems involving speed, focal length, resolution, sharpness, size, weight, and cost. To determine initial feasibility, a Leitz optical designer sits down before a terminal and begins a kind of dialogue with a computer.

The computer is programmed by Leitz to help the lens designer calculate the way light will pass through the lens from different image points. It allows him to determine the appropriate glass, the shapes of the elements and their spacing. The computer makes it possible to do all this very rapidly and exactly.

This automatic design phase can generate as much as a 6 inch high pile of printouts on a single lens. However, it permits a lens to be fully analyzed before fabrication, which saves considerable time and money.

To meet specific performance characteristics, often a totally new glass is required. For this reason, the optical design department works closely with the Glass Research Laboratory of Ernst Leitz, Wetzlar, GmbH. Much of the glass produced by the laboratory is unique and available only to Leitz.

If computer analysis suggests the lens can be manufactured and the necessary optical glass can be secured, the mechanical design phase begins.

The computer generates drawings which show configuration and spacing of lens elements.

Optics honed to perfection.

Optical glass is the essence of a lens. How a lens performs depends almost entirely on the properties and design of its optical glass.

To ensure that Leica lenses only contain glass of the highest quality, Leitz operates the Glass Research Laboratory in Wetzlar. This unit of the company is of strategic importance, as it is responsible for the creation and production of special glasses to meet the special needs not only of our camera lenses but also of our binoculars, microscopes and other optical equipment.

Leica lenses use optical glass of a high 1.75 to 1.90 refractive index, much of which is produced by the Leitz Glass Research Laboratory. It costs significantly more than less refractive material, but it permits a better control of aberrations, particularly in the high speed lenses.

This rare-earth glass also makes a single layer of antireflection coating effective for most Leica lenses, which allows more light to be transmitted. Of course, multi-coating is applied in certain special cases for the suppression of ghost images and for the improvement of image contrast.

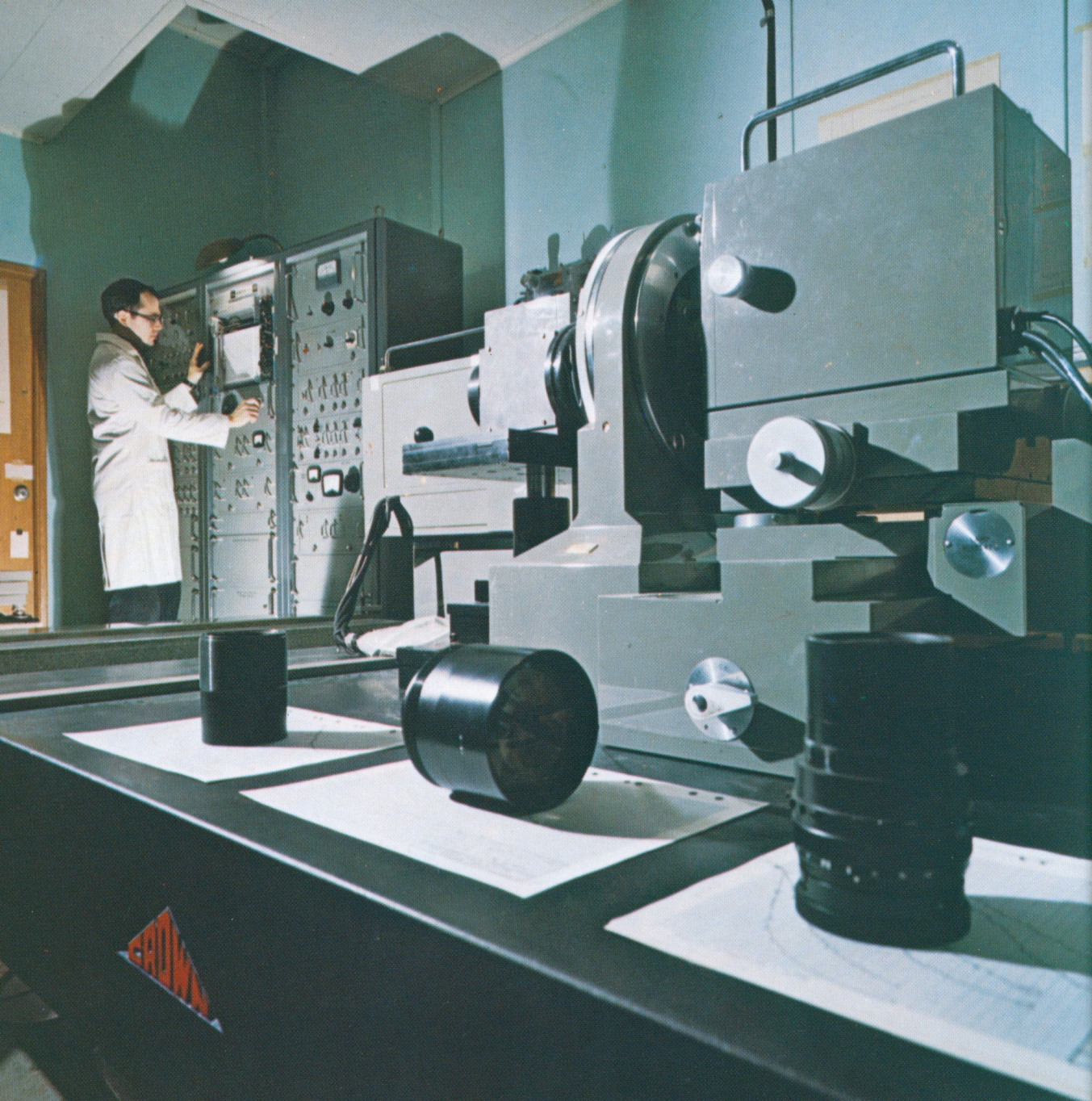
Many of these antireflection coatings are developed in Leitz research laboratories. They help our lenses realize almost 100% transmission in the central part of the visible spectrum. Combined with Leitz "Absorban,™" an adhesive used to cement lens elements together, the coatings effectively screen out any undesirable ultra-violet light.

Absorban as well as the special Leitz coatings for uncemented optical systems ensure that Leica lenses provide the same transmission of neutral colors, irrespective of focal length. This is an invaluable asset for color photography. All lenses are also matched so that the colors reproduced are as close as possible to those in nature.

The thickness of Leica lenses is polished to tolerances of ten microns (.00039 inch). Sphericity is controlled to three hundredths of a micron; centering to four microns. Every lens element is custom fitted to its mounting with a minimum clearance, dictated by thermal expansion, of three to seven microns.

In some high speed lenses, loss of resolution in the corners of a photograph noticeably occurs at full aperture. Leica lenses offer edge-to-edge sharpness at every aperture. Full aperture is always a working aperture in every Leica lens. Whenever necessary, it can be used without hesitation.

Special glasses are developed at the Leitz Wetzlar Glass Research Laboratory.



Mechanical design.

What is optically possible may not be mechanically possible.

The problem: how to fit the various parts of a lens into an "envelope" which is constrained at the rear by the bayonet and diaphragm and at the front by filter and lens hood requirements. The difficulty of the task can be measured by the fact that a typical lens can easily contain over 100 parts.

The mechanical designer must also maintain very precise air spaces and center all lens elements perfectly. It is his additional responsibility to make sure that the optical glass is thick enough in the center to realize the desired performance and thick enough at the edges to be supported. Finally, it is up to him to try to keep the lens as small and lightweight as possible.

The mechanical department may prepare hundreds of drawings before giving the go-ahead to build prototypes.

Five prototype lenses are constructed. They are then tested on an Ealing-Beck Eros IV, one of the finest lens-testing instruments commercially available. This device, used both in lens development and quality control, measures the optical transfer function of a lens. It defines a lens's modulation or loss of contrast (light intensity) to an accuracy of one percent and its recording of fine details or resolving power (light frequency) to within five degrees of arc. Eliminating the human judgement factors present in both the optical and mechanical design stages, it enables Leitz lens designers to predict precisely how a lens will transfer light from source to film.

At this point, only one question remains to be answered and that is the most decisive one: what is the quality of the images produced by the experimental lens? The answer is found by using the five prototypes extensively to take black and white as well as color photographs under different lighting conditions. The results are carefully studied with respect to contrast, resolution, and color. If its performance is consistent with the high standards of Leica quality, the lens is then deemed worthy of manufacture.

The Ealing-Beck Eros IV measures the optical transfer function of Leitz lenses.

Built-in precision.

Mechanics largely determine how long a lens functions at optimal performance. That's why every mechanical detail is exactingly designed and engineered for accuracy.

Male and female helicals for the focusing mount are made in unique pairs. Each pair is then individually lapped in together. Smooth, uniform movement with a maximum play of 1/100mm (.00039 inch) results, plus the assurance that the focus won't change over decades of use.

All helical focusing mounts and aperture rings rotate in the same direction and are identically positioned. So your hands know exactly where and how to change aperture and to focus on the different lenses. Further, all operating rings are adjusted to turn easily and accurately, even under the strain of extreme temperatures.

The diaphragms in Leica lenses have been endurance tested up to 50,000 cycles without any sign of wear. They are mounted on moly-coated ball bearings and have a minimum of eight leaves which makes for a rounder opening and reduced starring in intense light. In the R (reflex) lenses the automatic diaphragms are adjusted to within a very fine 1/8th of an f-stop.

Precision also effects lens changing by making it easier and faster. To fit a Leica lens into its camera mount, the raised red dot on the lens merely has to be aligned with the raised red dot on the camera body. Then an 1/8th of a turn, followed by a very audible click, insures that the lens is locked correctly and securely in place.

Made to be tough.

Leica lens housings are hard black anodized, which makes them far more durable than if lacquer or chrome were used. Special alloys must be employed in fabricating the lens housings, if this process of anodization is to attain the desired color, surface finish, and hardness. These alloys are more difficult and costly to machine, but machinability is sacrificed for quality.

All metal components are corrosion-protected so that they function reliably even under the most adverse climatic and atmospheric conditions. Leica lenses can be used without restriction over a temperature range of -13° to 140° F. (-25° to 60° C).

Leica lenses are also built to withstand very high levels of vibration through the extensive use of brass and other alloys. The bayonet, for example, combines a special brass alloy with three layers of different coatings to achieve a hard chromium finish.

One of many measurements is the accuracy of diaphragm settings.

Tests and more tests.

Leica lenses are essentially handmade with every aspect of manufacture carefully supervised. There are many quality controls. Most apply to all lenses at all phases of production, and are not merely limited to testing of samples.

For example, the parfocalization of each lens is tested at least twice on a collimator. Before it goes into the focusing mount, every Leica lens is mounted on a projection bench to check image quality and centering. Its performance is measured against a negative of a theoretically perfect test pattern. If any lens should fail, it is returned to production until it is corrected.

The automatic stop down mechanism in every R lens must be able to close and stabilize within 40 milliseconds. The amount of torque required to adjust the f-stops and to focus is exactly uniform from lens to lens.

The ultimate test.

As the last step in building Leica lenses, every lens is tested by taking a series of at least three photographs with it. The subject is this intricately designed test pattern of type, resolution targets and a grey scale.

The negatives are scrutinized under a 25 power microscope (equivalent to a three by two foot enlargement). Only if our standards of sharpness and resolution are met, is the lens accepted.

The serial number of every lens is recorded and the negatives filed. So if the lens should ever need to be returned for repair, it can be compared against its original performance.

The photo test is the final stage in what is probably the most painstakingly precise manufacturing process in the world today.

This test chart is used to verify sharpness and resolution of lenses.

People make a difference.

Tests are not the only guarantee of Leica quality. Leitz people are too. Each person involved in production is required to maintain the company's high standards. For this reason, any lens that fails to measure up can be rejected at any stage of manufacture.

Craftsmen form more than half of the Leitz work force. These highly skilled individuals undergo a long and rigorous apprenticeship to earn their positions. Nearly every supervisor and inspector has been employed by the company for at least 25 years.

Leica means performance.

All Leica lenses can be used at full aperture without degradation of the optical performance. Spectral transmission is uniform from lens to lens, so you get consistent color when you interchange lenses. The lenses will stay tight, operate smoothly and fit snugly for years.

The price of quality.

Leica lenses are unavoidably expensive. It's simply not feasible to make so fine a lens for less.

Perhaps Leica lenses offer you more capability than you want, or can use, or are willing to pay for. Yet, if you perceive photography as the opportunity to seize the elusively memorable with a great image, you owe it to yourself to use the lenses, and the cameras that maximize this opportunity.

The Leica lens is, indeed, the ultimate photographic eye. It is incomparable in design and manufacture, and unmatched in performance.

E. Leitz, Inc., Rockleigh, N.J. 07647.

Optical elements are inspected and re-inspected at every step of manufacture.

Leitz® means precision. Worldwide.

30M - 12/77MG

Printed in U.S.A

LEICA M LENSES

21mm f/3.4	SUPER-ANGULON	11 103
28mm f/2.8	ELMARIT	11 801
35mm f/2	SUMMICRON	11 309
35mm f/1.4	SUMMILUX	11 870
50mm f/2	SUMMICRON	11 817
50mm f/1.4	SUMMILUX	11 114
50mm f/1	NOCTILUX	11 821
90mm f/2.8	TELE-ELMARIT	11 800
90mm f/2	SUMMICRON	11 123
135mm f/4	TELE-ELMAR	11 851
135mm f/2.8	ELMARIT	11 829

LEICA VISOFLEX LENSES

65mm f/3.5	ELMAR	11 162
90mm f/2.8	ELMARIT	11 026
90mm f/2	SUMMICRON	11 133
135mm f/4	TELE-ELMAR	11 852
135mm f/2.8	ELMARIT	11 828
200mm f/4	TELYT	11 063
280mm f/4.8	TELYT	11 914
400mm f/6.8	TELYT	11 966
560mm f/6.8	TELYT	11 864

LEICA R LENSES

16mm f/2.8	FISHEYE-ELMARIT-R	11 222
19mm f/2.8	ELMARIT-R	11 225
21mm f/4	SUPER-ANGULON-R	11 813
24mm f/2.8	ELMARIT-R	11 221
28mm f/2.8	ELMARIT-R	11 204
35mm f/2	SUMMICRON-R	11 115
35mm f/2.8	ELMARIT-R	11 201
35mm f/4	PA-CURTAGON-R	11 202
50mm f/2	SUMMICRON-R	11 215
50mm f/1.4	SUMMILUX-R	11 875
60mm f/2.8	MACRO-ELMARIT-R	11 203
90mm f/2.8	ELMARIT-R	11 239
90mm f/2	SUMMICRON-R	11 219
135mm f/2.8	ELMARIT-R	11 211
180mm f/2.8	ELMARIT-R	11 919
180mm f/4	ELMAR-R	11 922
180mm f/3.4	APO-TELYT-R	11 240
80-200mm f/4.5	VARIO-ELMAR-R	11 224
250mm f/4	TELYT-R	11 920
400mm f/6.8	TELYT-R	11 960
560mm f/6.8	TELYT-R	11 865