Introducing Vivitar Series 1 Lenses

Several years ago, due to the extraordinary requirements of the U.S. Space program and the U.S. Defense Department, extremely advanced optical design techniques were developed employing very large computers, arranged in series. These techniques helped solve optical design problems that had previously been too complicated for the earlier, less sophisticated computers. Vivitar learned of these techniques and launched a program to develop a series of lenses suitable for general photographic work, capable of performance unheard of at the time, and yet, rationally priced so many photographers could afford them. This article will describe how the Vivitar Design Group was formed, what its objectives were and what it has accomplished so far. In deference to those readers who do not have a scientific background in optics, we have attempted to keep the account as non-technical as possible.

The first step was to assemble an international team of American and Japanese optical designers, mechanical designers and production engineers. Because costs in optical goods manufacturing are closely related to manufacturing techniques and tolerances, it required considerable innovative production engineering on the part of the Japanese, in particular, to make the idealized computer program a manufacturing success. Unlike the space program, in this

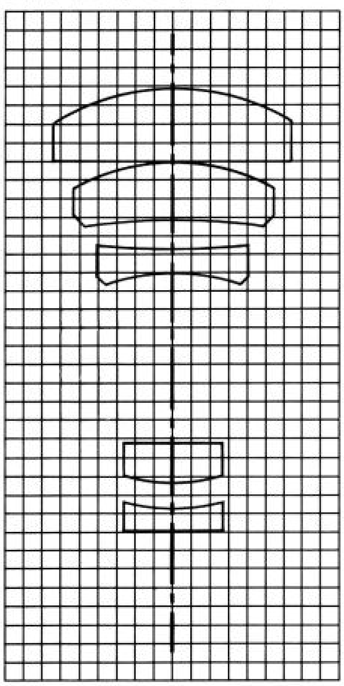


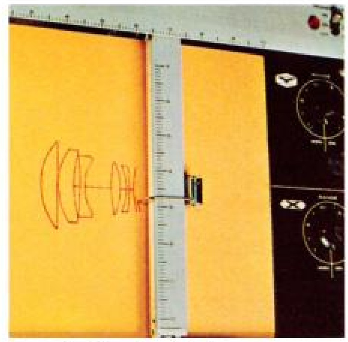
Figure 1. 200mm f3.0 compact telephoto.

project manufacturing costs were critical as they would relate to the ultimate consumer prices. Of course, this was not the first effort on the part of Vivitar to use computer techniques to improve photographic optics. There had been a great improvement in 35mm SLR camera lens quality since the 1960's due to the advent of the automatic lens design optimization computer programs. Lenses designed with computer aid were becoming smaller, with larger apertures and producing an image quality superior to that of the finest lenses of the past. Some manufacturers, in fact, were assuming that their lenses provided performance more than adequate to the needs of most photographers. Vivitar designers did not agree because they recognized a serious shortcoming in the basic design of most photographic lenses.

Traditionally 35mm camera lenses have been designed to produce optimal results when photographing objects which are, relatively speaking, at a great distance from the camera. Since it is known that the degree of aberration introduced is greater as the lens approaches close focusing, the very improvements in optical design made possible by the computers have dramatized the poor image quality at close focus distances. In the past this problem was overcome by designing general lenses that functioned optimally at infinity and separate special purpose lenses for close-up and macro photography. But somewhere in between the very close-up distances and moderate close-up distances, performance suffered. Moreover, photographers today have wider interests and there has been a demand for general purpose lenses that would minimize aberrations in close-up work. And as photographers became more knowledgeable and more critical in terms of resolution and contrast, they asked, "why can't a lens perform equally well at all points from minimum focal distance to infinity?"

The search for a solution to this question took three years of study by the Vivitar design group, using one of the world's largest computer banks. First, before we can show the difference between the performance of typical photographic lenses and the new Series 1 lenses, we should explain a new method of evaluating lens performance. For years, scientists have been dissatisfied with the conventional method of resolution testing to determine lens performance. The results were too dependent on subjective evaluation in addition to other drawbacks. In recent years scientists have been using an additional method of evaluating lens performance, called Modulation Transfer Function (MTF).

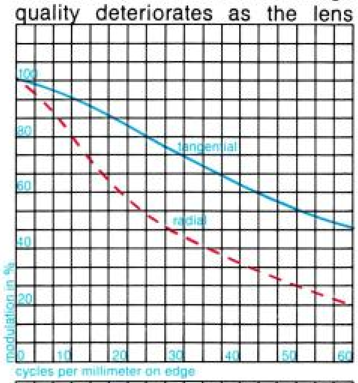
The MTF chart shows the ability of a lens to reproduce an image like the object; if the lens has any



imperfection in design or manufacture, it will not be able to reproduce the object data within defraction limitations. The deviation as shown on the MTF curve provides the optical designer with a complete picture of the lens' capabilities in terms of a predictable combination of resolution and contrast.

Now, let's look at a typical good quality 200mm compact telephoto lens. Fig. 1 shows the optical construction of this lens. Fig. 2 then shows the MTF curve when the lens is focused at infinity, and Fig. 3 shows the MTF curve when the lens is focused at a magnification of —.1. This is a close-up focus setting. The image quality at the edge of the format would be considered very poor.

There have been available several methods of designing a lens that would theoretically provide superior performance at all focus settings. One method was to mechanically change the air space between one element or lens group from the rest of the lens as the focus distance was changed. A few existing lenses use this principle, usually referred to as a "floating element" lens. However, this slight mechanical change of a lens element position has been practical only in wide angle lenses since the mechanical configuration of longer focal length lenses is not readily adaptable to this type of modification. A better design solution to this problem, applicable to telephoto lenses, has been developed by Vivitar and subsequently patents were applied for covering this area. Since image quality deteriorates as the lens



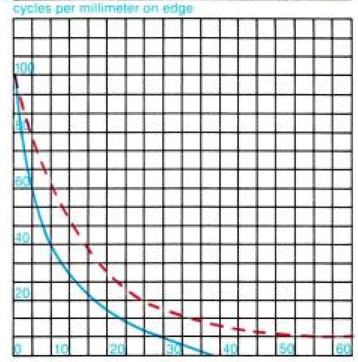


Figure 2. MTF for a 200mm f3.0 objective optimized at M = 0.

Figure 3. MTF for a 200mm f3.0 objective optimized at M = 0, focussed at M' = −1.

changes its position relative to the film, the Vivitar designers offset this by introducing a stationary rear compensating lens that would correct the aberrations introduced as the lens moves away from the film. At the same time this design reduces the length of travel required for a specific focus distance and permits closer focusing with greater mechanical reliability. Thousands of computer runs were required to develop the exact shape of the compensating lens.

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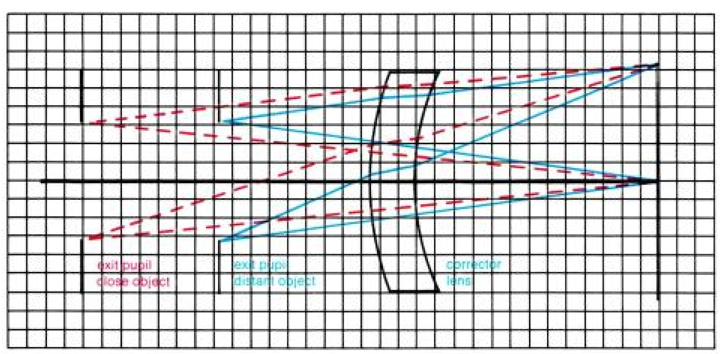


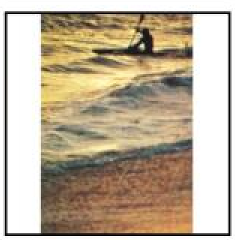
Figure 4. Concentric corrector element showing no change in axial correction for focusing movement of objective lens but showing a change for the corner of the format.

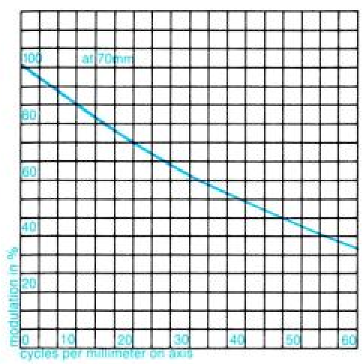
Summary

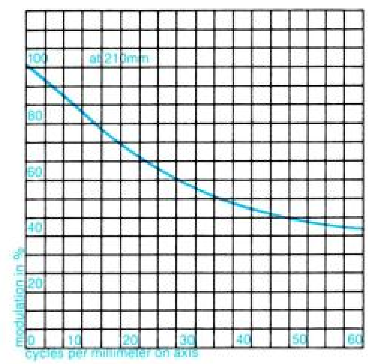
70-210mm f3.5 Automatic Zoom lens with Macro Focusing

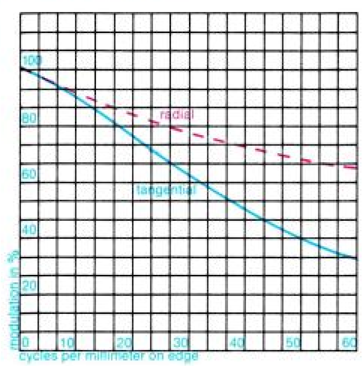
Automatic lens design optimization computer programs in the last few years have produced lenses for 35mm SLR cameras that are smaller, faster and superior in image quality to the finest lenses of the past.
However, these lenses were designed (according to tradition) to function most efficiently at a great distance from the cameras, usually at infinity. Consequently, their performance at close distances was not as efficient, as many aberrations were introduced at close focusing ranges.
In these same years, there has been an increased use of zoom lenses by advanced and professional photographers, and in many cases the image quality produced by these lenses did not compare favorably to those obtained with single focal length lenses.
American optical designers had been developing more sophisticated uses of computer banks in the design of photographic lenses for scientific purposes. Vivitar commissioned a team of American and Japanese optical designers to develop a new generation of photographic lenses, using one of the world's largest computer banks, that would be superior in performance to anything available today, yet rationally priced.
After three years of development work in both the U.S.A. and Japan, Vivitar introduced at PHOTOKINA in Cologne, Germany the new Series 1 lenses. The problem of image quality at close focus distances, in fact at all distances from infinity to the minimum focal distance has been solved with new designs. Simultaneously, new concepts were employed in the design of a remarkable new type of zoom lens that, for the first time, introduces a macro capability in a zoom lens, and optical performance that compares to the finest single focal length lenses.
The new Vivitar Series 1 will be a complete line of photographic lenses for 35mm SLR cameras; all the product of Vivitar's extremely sophisticated auto-optimizing computer programs, and designed to be demonstrably superior to other lenses currently available.

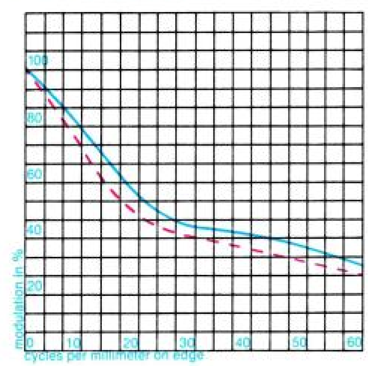
This is the first automatic zoom lens for 35mm SLR cameras that also provides macro capability. A unique mechanical design permits both zooming and focusing with the same control. Although the lens has a larger maximum aperture than other zoom lenses, it is surprisingly short and light. Most significant is the high performance, accomplished by a novel approach to zoom optical design as explained in the introductory article on another page. The MTF chart illustrates exceptionally high performance at the plane of best focus.* This caliber of performance was unavailable before in zoom lenses and compares favorably to the finest original equipment telephoto lenses. The unique combination of a macro capability with a three to one telephoto zoom make this lens a remarkable all-purpose lens; particularly for the photographer who wants versatility without compromise in performance. The finish on the lens mount is specially anodized and vinyl non-slip grips make focusing more positive.

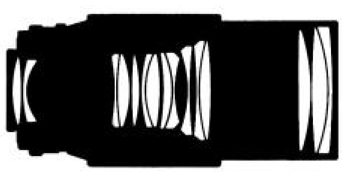












Optical Specifications

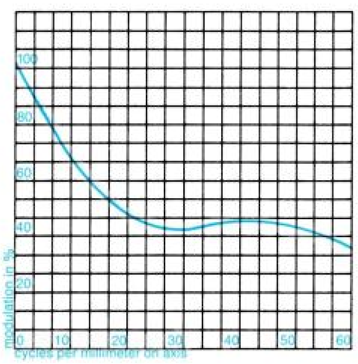
Construction:	15 elements 10 groups
Angle of view:	11-32 degrees
Minimum focus distance:	Normal: From focal plane—6′ 6½″ Macro: From focal plane—11½″
Maximum magnification in Macro:	1:2.2

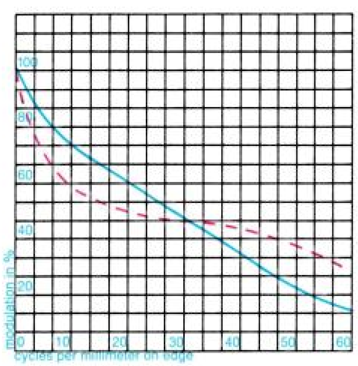
Mechanical Specifications

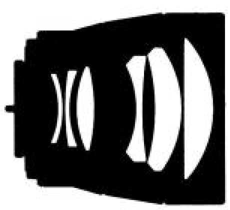
Filter size:	67 millimeters
Weight:	31 ounces
Length:	6⅛ inches
Max. diameter:	3$^{1}/_{16}$ inches
F/number range:	f3.5-22 (EE coupled lenses to f16 only)

135mm f2.3 Automatic Telephoto lens

One of the fastest automatic telephoto lenses available today. But the truly remarkable feature of this lens is its optical performance at all focusing points. Practically all conventional lenses are designed to provide optimum performance at a particular magnification, usually infinity. This lens employs a uniquely positioned rear compensating element that automatically corrects aberrations at all points from the closest focusing distance to infinity. Consistently excellent results are therefore evident all through its unusually wide focusing range. The 135mm lens is one of the most versatile telephoto lenses. It offers perspective compression, bringing in distant scenes yet suitable for portraits, providing the ideal combination of high speed and 2.5 magnification over the normal lens. And an additional bonus is the ability of this lens to focus as close as 3 feet. The lens barrel is tapered to fit the hand better; and special vinyl grips have been designed to make the focusing more positive. A window isolates the f stop in use.







Optical Specifications

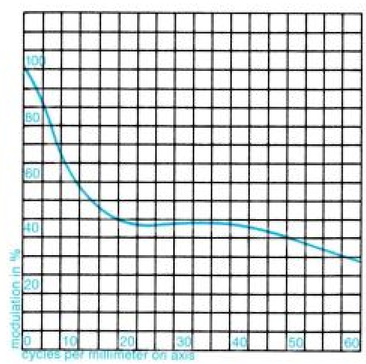
Construction:	6 elements 6 groups
Angle of view:	18 degrees
Minimum focus distance:	From focal plane—3′

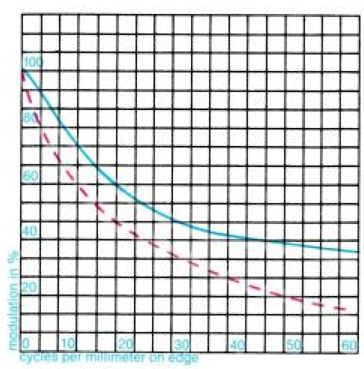
Mechanical Specifications

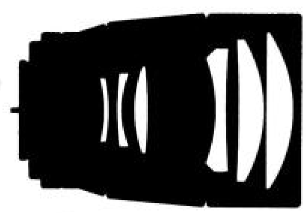
Filter size:	72 millimeters
Weight:	22 ounces
Length:	3.6 inches
Max. diameter:	3⅛ inches
F/number range:	f2.3-22 (EE coupled lenses to f16 only)
Lens hood:	Built-in, retractable

200mm f3. Automatic Telephoto lens

This lens shares with the Series 1, 135mm f2.3, the use of a uniquely positioned rear compensating element to automatically correct aberrations at all points from the closest focusing distance to infinity. It focuses as close as 4 feet and consequently will provide magnifications unusually large for this size focal length lens. It is also one of the fastest automatic 200mm telephoto lenses. The 4 x magnification over a normal lens combined with the large aperture make it an unusually desirable lens for true telephotography. It can be easily hand-held for sports and wildlife photography where a 200mm lens is considered a "normal" lens. The lens performs consistently in the areas of resolution and contrast regardless of the size of the magnification of the image from 4 feet to infinity. The MTF chart illustrates this exceptional performance for a 200mm telephoto lens. The lens barrel is tapered to fit the hand better, special vinyl grips make focusing more positive, and there is a window to isolate the f stop in use.







Optical Specifications

Construction:	6 elements 6 groups
Angle of view:	12 degrees
Minimum focus distance:	From focal plane—4′

Mechanical Specifications

Filter size:	72 millimeters
Weight:	27 ounces
Length:	4.7 inches
Max. diameter:	3⅛ inches
F/number range:	f3.0-22 (EE coupled lenses to f16 only)
Lens hood:	Built-in, retractable

*MTF performance at the plane of best focus provides a meaningful method during the design process for assessing image quality and making comparative evaluations of various lenses. A complete MTF analysis plots several planes of focus for various spectral characteristics and target distances. For reasons of space, MTF curves illustrated are single measurements at maximum apertures.

For more complete information:
Write for a technical paper, "Improvements in Close Focusing With Lenses For 35mm Cameras," by Ellis I. Betensky.

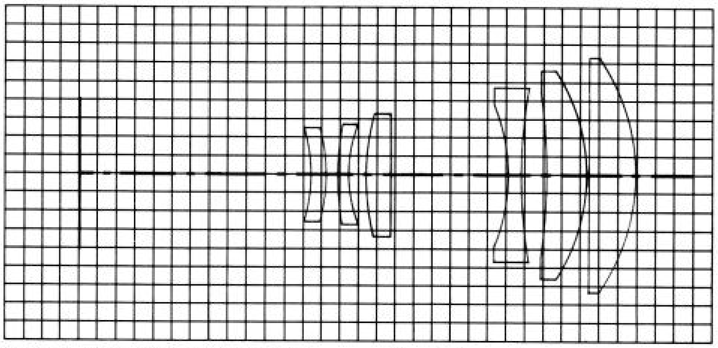


Figure 5. 200mm with corrector lens.

Fig. 4 shows how this unique rear compensating lens functions. It corrects for aberrations at the film plane which result from changes in focus. Naturally these aberrations are most pronounced in the corners of the format, as we noticed in Fig. 2. Light transmission through the center is relatively unaffected by focusing changes, and is also relatively unaffected by the rear compensating lens. Image sharpness is optimized throughout the format from center to edge, and at all focus distances. This would be impossible without the unique compensating lens. The resultant lens design is shown in Fig. 5. Both the Vivitar Series 1, 135mm f 2.3 and the 200mm f 3 use this new principle to automatically correct aberrations as focusing varies.

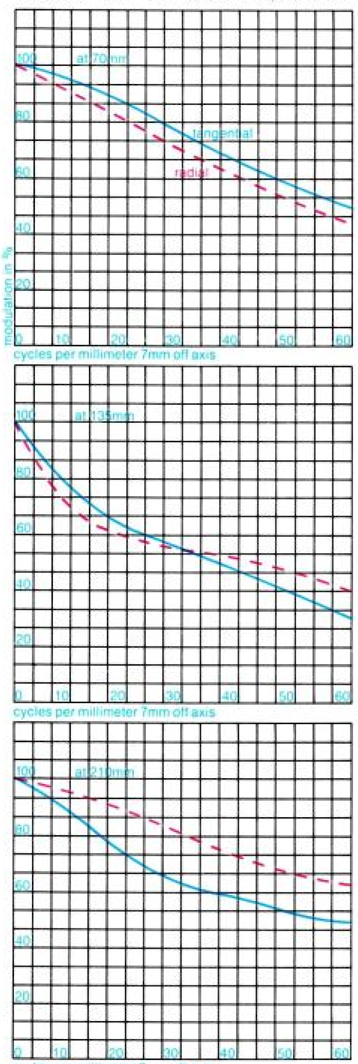


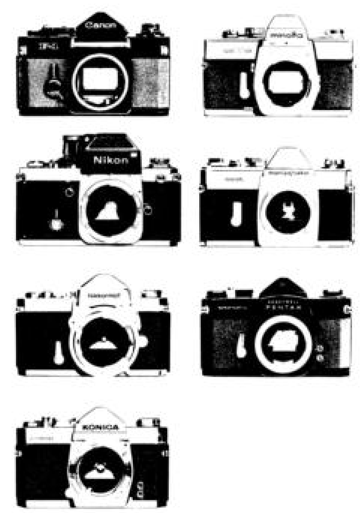
Figure 6. MTF for focal lengths of 70, 135, and 210mm of 70-210 f3.5 zoom.

Similar problems of imaging at close distances occur with zoom lenses. Recent developments have made possible zoom lenses with high enough image quality to be considered an acceptable alternative to fixed focal length lenses. But present zoom lenses can still be improved. The aberration changes resulting from close focusing with a zoom lens are even more complicated than with a fixed focal length lens. In the design of the Vivitar Series 1, 70-210mm Macro Focusing Zoom lens, an extraordinary amount of computer time was required to produce a zoom lens with many features. Normally a zoom lens is focused by moving the front group of elements only. However this movement is, of course, limited by the mechanical capabilities of the lens barrel plus the image degrades markedly as the object to lens distance decreases—a direct result of focusing only the front elements. Focusing the entire lens reduces the aberration changes to a greater extent than focusing only the front group of elements. However, the aberration change is different for each focal length of the zoom lens. A simple corrector lens could be used to compensate for close focusing, but this would only work at one focal length. A complex corrector lens group theoretically could be designed to reduce aberrations at all focal lengths, but this has been too complicated and has not been attempted to date.

A novel solution was devised by the Vivitar designers for the Series 1 zoom lens to provide excellent image quality at close-up focusing. Since the zooming elements in the lens readily move, a computer simulation established that these same moving elements could be used for close focusing as well. In this way a general purpose zoom lens was designed that would correct aberrations at close focus, optimize performance in the normal zoom range, and could also be focused and zoomed with one simple control. Patents have been applied for, to cover these new design formulations. The MTF curves in Fig. 6 show the high performance quality of the zoom lens at different zooming positions; consistent image quality unattainable through previous design efforts.

The Vivitar Series 1 program is just beginning and is a synergistic relationship between American and Japanese optical designers and the highly innovative Japanese production engineers. The lenses described in this folder are examples of what can be done utilizing the extraordinary advances that have been made in both of the fields of optical design and computer technology in the last few years. As the Vivitar designers work on different ratio zoom lenses, on new wide angle lenses, and on telephoto lenses of other focal lengths, the challenge is always there: to produce lenses for the advanced and professional 35mm photographer that duplicate or exceed the performance of scientific lenses costing thousands of dollars, and to offer these lenses to the photographer at rational prices.

Vivitar Series 1 lenses are available in mounts to fit Canon, Nikon, Nikkormat, Konica, Minolta, Mamiya/Sekor and Pentax cameras. Each lens automatically couples to the light metering system of the camera.



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