Super-Speed Lenses

How much extra speed do you really get, and what (besides cash) is the price you pay to get it?

by Bennett Sherman and Jason Schneider

With current ASA 400 color films pushable to E.I. 800 and fine quality 50mm f/1.4 lenses available from numerous camera manufacturers, who needs "super-speed" lenses? Haven't the f/1s and f/1.2s of the world been relegated to the role of extravagant, expensive, and bulky luxuries appealing mainly to snobbish gadgeteers and the handful of remaining "low light" photojournalists? Perhaps, to some extent, but like all great half truths, these rhetorical questions hint at only part of the story. After all, super-speed lenses have always been considered specialized tools and, surprisingly, their popularity has actually increased slightly as film speeds have gotten higher.

Does this seem paradoxical? Well, there's more to using super-speed lenses than just getting the last possible photon of light on the film. Today's color negative materials (such as Kodacolor 400) produce acceptable results under a wide range of available light, including daylight, fluorescent, incandescent, and mixed illumination. Even Ektachrome 400, a nominally daylight-balanced color slide film, can produce amazingly good results under mixed illumination. The unmistakable trend to emerge from all of this is a substantial increase in available-light color shooting among all classes of photographers and, with it, a renewed interest in super-speed lenses. After all, even if you're attempting nothing more exotic than capturing a youngster's birthday party sans flash, you'll probably get sharper pictures if you can open that half a stop or so and shoot at a higher shutter speed.

O.K., let's presume that you do lots of available-light shooting or that you specialize in sports photography, both cases where a super-speed lens should let you stop action at 1/500 or 1/1000 sec. even under fairly dismal conditions. But what sort of image quality can you expect from today's best super-speed lenses? And what about their "true" speed—are you getting all the extra speed you're paying for?

Well, it's considerably easier to provide a definitive answer to the second question: you'll find the true f/stop (calculated optical transmission) listed next to the respective marked f/stop for each lens listed in the table on page 168. The first question is much stickier, and is, in fact, the main subject of this article.

The major problem with super-speed lens tests (ours included) and with the

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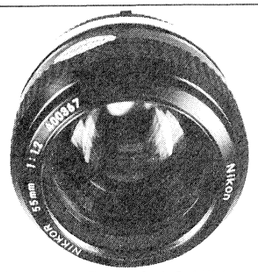
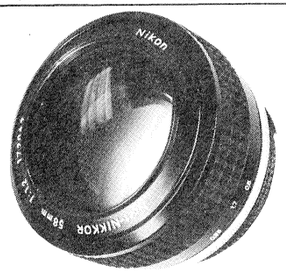
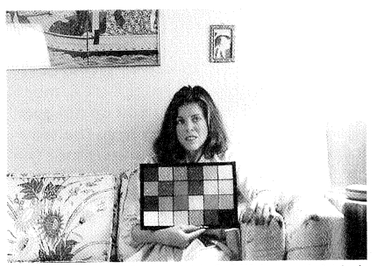


Current 55mm f/1.2 Nikkor

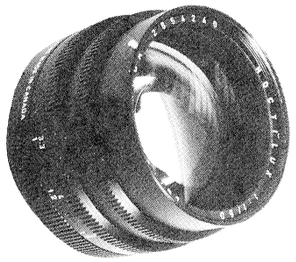
Full scene, 55mm f/1.2 Nikkor at f/1.2



Earlier 58mm f/1.2 Noct-Nikkor



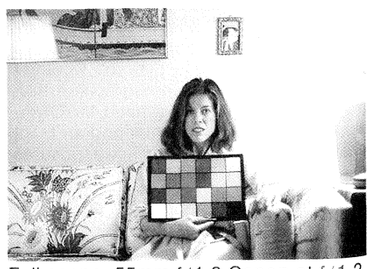
Full scene, 50mm f/1.2 Nikkor at f/1.4



Leitz 50mm f/1.0 Noctilux non-aspheric

Full scene, 50mm f/1.0 Noctilux at f/1.0

Canon 55mm f/1.2 AL with aspheric



Full scene, 55mm f/1.2 Canon at f/1.2

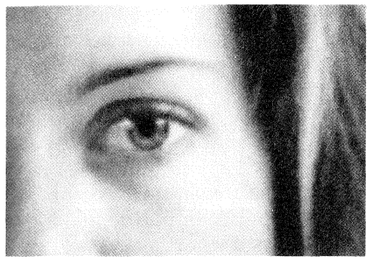
Zeiss Planar 85mm f/1.4

Full scene, 85mm f/1.4 at f/1.4

15X image of model's eye at f/1.2

15X image of model's eye at f/2

Overall Evaluation: The loss in sharpness and contrast when going from an f/2 aperture to the widest opening (f/1.2) is not objectionable. Off-axis details at maximum aperture are also well resolved and exhibit good contrast. Slight falloff in exposure (darkening) toward the corners of the image is due to deliberate design, which limits the size of the lens elements in order to keep lens' weight and size within practical bounds.



15X image of model's eye at f/1.2

15X image of model's eye at f/2

Overall Evaluation: The loss in sharpness and contrast that occurs when this lens is opened up from f/2 to f/1.2 is comparable with the newer lens above. The slightly longer focal length makes the off-axis image quality a bit easier to maintain. Falloff in exposure toward the corners appears less in this lens, but its larger elements make it bigger and heavier than the newer version. Overall image quality at maximum aperture is at about the same level as the 55mm f/1.2 above.

15X image of model's eye at f/1.0

15X image of model's eye at f/2

Overall Evaluation: This Leitz-Canada lens is the fastest nominal aperture lens in these tests. However, the heavy, high-index glass used and restricted diameters of the elements result in some exposure falloff toward the corners, exceeding a full stop loss. Contrast and sharpness are comparable to other f/1.2 lenses, and when stopped to f/2, overall image quality is very high. Off-axis image quality is very good, in spite of the exposure falloff.

15X image of model's eye at f/1.2

15X image of model's eye at f/2

Overall Evaluation: The Canon 55mm f/1.2 features a machine-generated aspheric element which results in image quality at full aperture that is almost as good as that achieved at f/2. Off-axis, the image quality does not suffer at maximum aperture. Falloff in exposure is kept within reasonable limits by the compact optical design and selected optical glasses. Metered exposures were accurate, indicating a close correlation between this lens' marked and effective apertures.

15X image of model's eye at f/1.4

15X image of model's eye at f/2

Overall Evaluation: The 85mm f/1.4 Zeiss Planar is the largest and heaviest lens tested. The sharpness and contrast are very good, as a result of quality design and manufacturing. The shutter speed used for these exposures was the same (1/125 sec.) as that used with the f/1.2s wide open, resulting in the darker image shown. Still, off-axis image quality is excellent and falloff at corners is minimal.

SUPER-SPEED LENSES

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gorgeous prints and transparencies we've seen shot at maximum aperture with these lenses (and displayed by various manufacturers) is really quite simple. The target (in the case of MODERN's tests) or the subject (in the case of the lens makers' pictures) is characterized by high contrast. For example, when Leitz projected Kodachrome transparencies shot with its (recently discontinued) 50mm f/1.2 Noctilux at maximum aperture, the overall quality was fantastic. Now, as it happens, the lens used to make the transparencies was an extremely expensive piece of glass and was handpicked by the factory for this demonstration project. No matter. Almost any super-speed lens of reasonable quality can produce outstanding results when shooting a brightly lit carnival at dusk. A critical question is how well will it do with a subject of average or low contrast, the kind you might encounter in your living room?

Furthermore, since so much praise and awe have been generated by the use of aspheric lens surfaces (the kind that are much trickier to grind because they're not sections of a sphere), we wondered how great and what kind of performance difference could be detected when we compared pictures shot with expensive "all spherical" lenses and those with one or more aspherics at maximum aperture and at f/2, a common shooting aperture with these optics. You can see the results of our tests (within the limits imposed by magazine reproduction) on pages 104 and 105.

Now let's back up and give you bit of background. Twenty-five years ago, when 35mm SLRs were first beginning to become popular, the "normal" lens was usually a 50mm f/2.8 or a 58mm f/2. Soon afterward, the six element f/2s were opened up a bit to f/1.9 and even up to f/1.7. Lenses faster than these were considered to be "super-speed." It didn't take long for optical engineers to discover that the six-element designs they had been using for the f/2s were simply not good enough to produce satisfactory f/1.4s. Even with the newest high-index, exotic rare-earth optical glasses which were being developed by glass manufacturers around the world, optical engineers recognized that a radical change had to be made in the design of these early super-speed lenses.

Seven-element design

Among the original super-speeds was the famous 50mm f/0.95 Canon lens which featured seven glass elements, and pieces ground out of the rearmost elements so that the lens could fit into the Canon rangefinder cameras.

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But the seven-element design method was not the only approach to getting sharp-imaging super-speed lenses. Leitz engineers decided to try their hand at a six-element, four-group 50mm f/1.2 lens for the Leica with a special non-spherical surface ground and polished into two of the elements.

Two types in use today

The situation today remains pretty much at this level: The two approaches are still being used. Most f/1.4 and faster lenses today are seven-element designs. A few are made with aspheric surfaces. Most interesting is the position of Leitz. The f/1.2 Noctilux with aspheric surfaces has recently been discontinued. So Leitz-Canada, under the engineering direction of Dr. Walther Mandler, developed a satisfactory f/1.0 using the latest rare-earth glasses and no aspherics. We have included this latest all-spherical version of the Noctilux in our experiments. Canon offers their f/1.2 with aspheric surfaces. Of course, this lens has also been included in the experimental photographic test on pages 104 and 105.

What exactly are we looking for when we field-test these super-speed lenses? As we mentioned, we want to show you what these lenses do with subjects of low or medium contrast. We chose a typical at-home scene as our test subject. Often, we try to get candid pictures of our family at home, with nothing more than the room lights on. This is easy to accomplish with high-speed film and a super-speed lens. With, for example, Kodak's Ektachrome 400 and an f/1.2 lens, we can take snapshots at home with an illumination level no greater than around 10 or 15 candelas (footcandles). This is just the kind of lighting we would probably find in a living room with a floor lamp or a couple of table lamps turned on. Shutter speeds of 1/60 or 1/125 sec. would be entirely satisfactory.

However, for our tests, we chose a slower color-transparency film with excellent color rendition when used with ordinary 2900 K household lamps, Kodak Professional Ektachrome 50T. Our model was seated near a table lamp, and another placed so that a cross-illumination of 3:1 was obtained for the test photographs. An intricate pattern in the fabric of the sofa near the model's right shoulder gave us good detail for close examination of edge (actually zonal) image quality, while the model herself was positioned at the center of the format.

We examined all the processed transparencies with an 8X magnifier, and with the laboratory microscope at 50X. We also looked at these test shots with a pair of matched Kodak Carousel slide projectors, making comparison judgments

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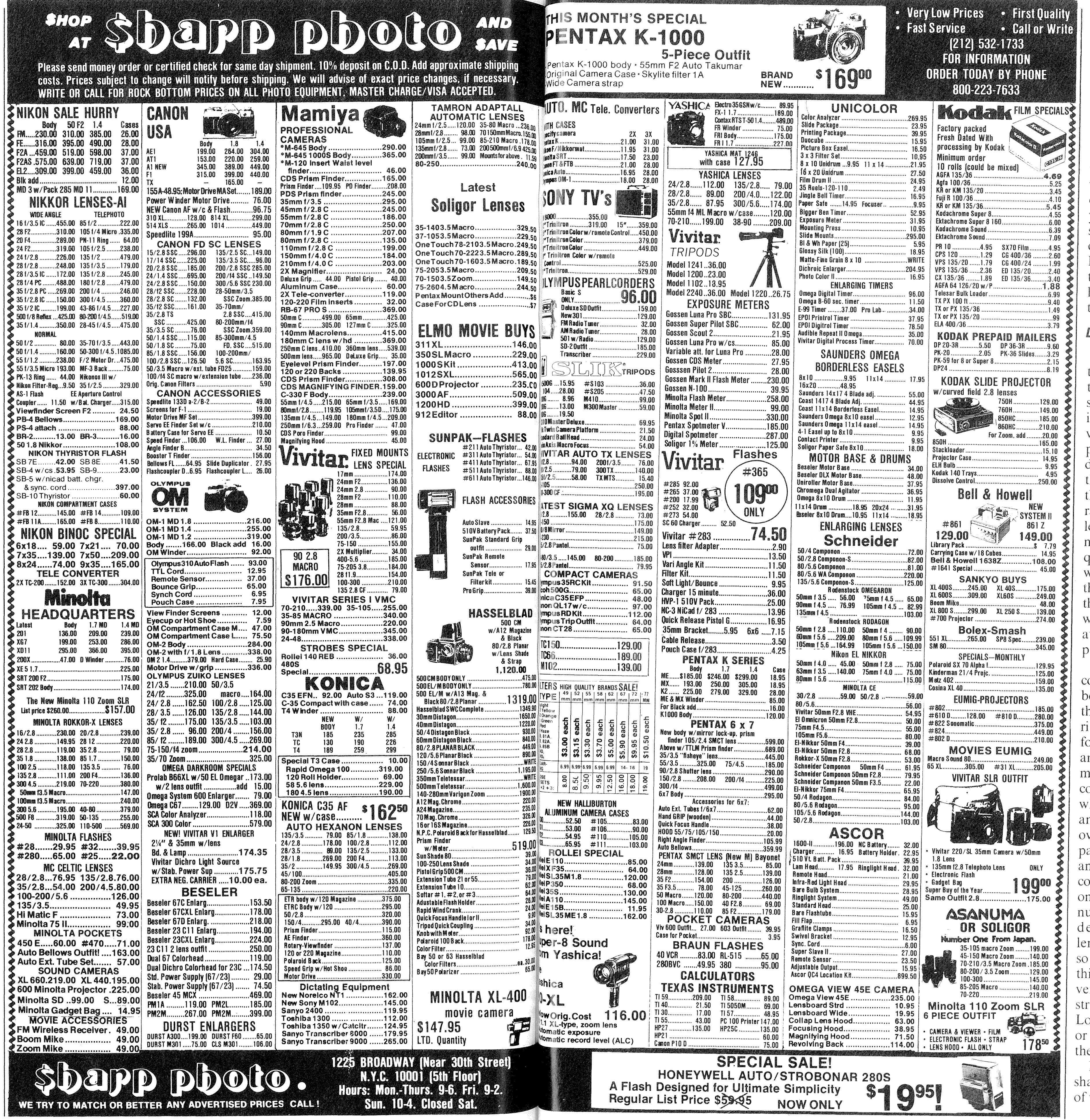
of image characteristics with all of the slides. We hunted for traces of contrast loss in the fine detail—the eyelashes in particular. We also compared shadow and highlight detail in the model's hair. We were able to detect significant image quality changes between lenses and between the pictures at maximum aperture and at one or two stops down (see results on pages 104 and 105).

In the case of the all-spherical surface lenses (all but the Canon 55mm f/1.2), an improvement in sharpness was observed whenever the lens was stopped down. However, in each case, the wide-open transparencies were judged to be acceptably sharp, and little loss of detail or contrast was noticed. In the case of the Canon aspheric lens, the difference between the f/1.2 and the f/2 images was, as expected, not as great. However, the overall image quality at f/1.2 did not seem to be noticeably better than that achieved by the all-spherical lenses. Part of the problem may be that, in spite of efforts to the contrary, there is enough scattering and ghost light coming from element edges, light reflections from coated surfaces and from residual aberrations, to cause a noticeable loss of contrast in some of the finer detail, and in darker areas of the image.

When we looked closely at the off-axis images, the quality differences between lenses became more apparent. For example, in the Leitz-Canada 50mm f/1.0 Noctilux, there is considerable vignetting toward the corners. This is not an accident; it's deliberately built in to try to reduce the horrendous off-axis flare which appears in the image, and reduces contrast and resolution. The skew rays which pass through the outer parts of the elements on their way to the off-axis image often go badly off course. So, to avoid the resulting image quality loss, the designers purposely allow some aperture falloff for the extreme off-axis (edge) image points. All of the super-speed lenses we tested for this article showed this designed-in vignetting. We conclude that it's almost unavoidable when trying to engineer a super-speed lens with a reasonable number of glass elements.

Since the aspheric surface in the Canon 55mm f/1.2 lens is close to the diaphragm, off-axis rays pass through the lens more normally than they would for an aspheric surface at the back or in the front element. As a result, the beneficial effect of the aspheric surface applies to the off-axis light rays as well. We found that the off-axis image quality for the Canon lens at maximum aperture was not noticeably poorer than it was when the lens was stopped down to f/2. In other words whatever help the aspheric surface was designed to give could be seen over the entire image format.



What aberrations seemed to be the most important in the images formed by these lenses? First of all is the spherical aberration—both rim-ray (at the extreme edges of the lens at maximum aperture) and zonal, which occurs when the lens is closed down about one stop. A very careful balance must be made between the remaining rim-ray spherical and the residual zonal spherical aberrations so that the image quality will improve, not get worse, as the lens is stopped down. Nevertheless, with these super-speed lenses you do sacrifice a small amount of image sharpness and contrast when shooting at common apertures such as f/4 or f/5.6. However, by the time you reach apertures such as f/8 and f/11 superspeed lenses generally perform on par with their slower (f/1.7 or f/1.4) counterparts.

Lenses polished individually

But too much zonal spherical aberration can be a serious problem, too. If there is too much of it, a definite focus shift may be encountered when the lens is focused by observing the groundglass view with the lens wide open, and the picture is taken when the lens is stopped down, say, two full stops. Canon's use of the aspheric surface helps to get rid of this sticky problem in one complete (but radical) design change. The only problem which remains is that of the smoothness and accurate polishing which is required for the aspheric surface, and which has to be done one lens at a time in the optical shop. It is to Canon's credit that the 55mm f/1.2 does perform very well, and there are few if any aberrations attributable to irregularities in the aspheric surface.

Another problem is that of visible color due to spherical aberration. It may be that the optical engineer has designed the lens with a nice balance between the rim-ray and zonal spherical aberrations for green light. But, when we put blue and red light through the same lens, we might find that the blue rim-ray is overcorrected and results in a blue flare, while the red beam is undercorrected and there is red flare visible also. The overall result is a loss of color fidelity, particularly toward edges of the format and in the finer details of the image. This color variation of spherical aberration is one of the main reasons for the large number of lens elements required in the design of fast normal-focal-length lenses. This is also the main reason why so many lenses incorporate the familiar thick pairs of elements with a strong convex surface on one end and a similar strongly concave surface at the other. Look at the diagrams of some of the f/2 or faster normal lenses and you'll find these thick meniscus pairs easily.

Because a camera lens must produce a sharp image over a relatively wide angle of view, the off-axis (edge) image quality

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becomes a very important and limiting factor. It turns out to be easier to design a fast lens of longer than normal focal length because it does not have to cover as wide an angle of view. But the lens elements must be larger and the aberrations even more closely corrected or balanced. Balancing these factors, we did not expect the 85mm f/1.4 Zeiss Planar to show any better or worse image quality than we found in the shorter focal length f/1.2s. Our tests showed that the design and manufacturing quality built into the Planar is of the highest level. In short, you don't have to sacrifice anything in terms of image quality if you choose the longer focal length Planar for its more pleasing characteristics as a portrait lens.

Wide open: Canon is best

In conclusion, if the extra speed is essential, today's super-speed lenses do not force us to accept noticeably poorer image quality either at wide, intermediate or stopped down apertures. If the lens is used primarily wide open, the aspheric Canon may be the best choice. But, all of the lenses we tested in our indoor picture-taking experiments yielded good to excellent color transparencies at maximum aperture. In short, while super-speed lenses remain considerably more expensive and somewhat bulkier than their slower counterparts, their overall performance is now good enough to allow them to be purchased as replacements for, rather than additions to slower lenses of similar focal length.

SUPER SPEED LENSES—EFFECTIVE APERTURE*

Lens		f/no.	t/no.
Noct-Nikkor	58mm	1.2	1.29
Nikkor	55mm	1.2	1.27
Canon Aspheric	55mm	1.2	1.27
Leitz Noctilux	50mm	1.0	1.09
Zeiss Planar	85mm	1.4	1.46

*The effective aperture, or t/number was calculated by combining the measured lens aperture and its light transmission.

SUPER SPEED LENSES—IMAGE QUALITY*

Lens		Center	Edge
Noct-Nikkor	58mm	Good	Accept.
Nikkor	55mm	V. Good	Good
Canon Aspher	55mm	V. Good	V. Good
Leitz	50mm	V. Good	Accept.
Zeiss Planar	85mm	Good	Good

*Image quality as expressed here is the combination of the resolving power and contrast as obtained in MODERN TESTS.

—THE END