Scope and Flat Apertures

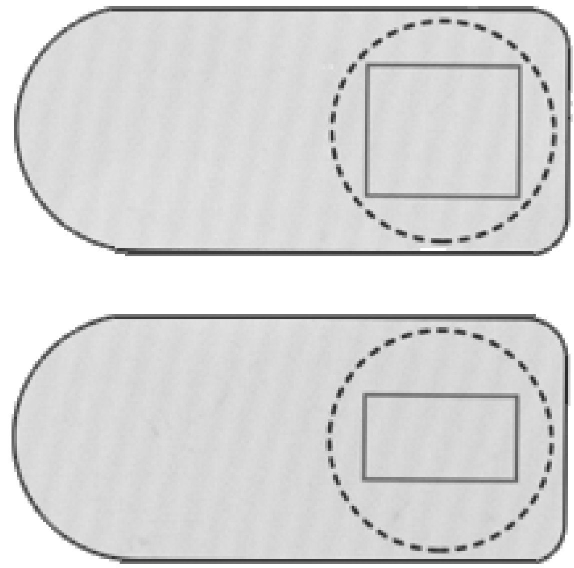
In the previous issue of this publication, we discussed the advantages of the "scope" format. Compared to the nonanamorphic 1.85: 1 aspect ratio "flat" format, the "scope" format is usually brighter, sharper, and less grainy.

The aperture plate comparison and table following show the reasons for these advantages. The film image area of the "scope" format (.825 inches wide by .690 inches high) is over I .5 times larger than the 1.85:1 "flat" format (.825 inches wide by .446 inches high). The nearly square "scope" aperture is more efficient in using the circular cone of light from the lamphouse, resulting in higher screen luminance. The elongated rectangle of the "flat" aperture uses only about 39 percent of the available light at the aperture plate, compared to about 60 percent efficiency for "scope." Typically, a projector set up to produce the SMPTE standard 16 footlamberts screen luminance for the 2.39:1 aspect ratio "scope" format will have only about 13 footlamberts for the 1.85:1 "flat" format, even though the "scope" screen image is wider. The smaller image area of the "flat" format requires significantly more magnification than "scope" to fill the same .screen height, so grain and dirt look larger onscreen and any fuzziness or vertical unsteadiness is more visible.

The introduction of CinemaScope by 20th Century Fox in 1953 remains one of the most significant engineering achievements in motion picture technology. The technical triumph of the "scope" format is its elegant simplicity. The anamorphic lens allows the use of the maximum image area on the film, and puts it on the screen. A larger image area gives pictures that are brighter, sharper, steadier, and less grainy. In contrast, the current 1.85:1 "flat" format evolved simply by cropping the available film image area and projecting it at greater magnification to produce a widescreen picture, at the expense of both light and image, and a waste of available film area on the print.

Perhaps a New Format?

Imagine using the current "scope" image area, but with an anamorphic lens having less "squeeze" than the 2X factor used for the 2.39:1 aspect ratio. For instance, a l.5X anamorphic lens would produce a 1.79:1 aspect ratio onscreen, almost an exact match to the 16:9 (1.78:1) proposed format for high-definition television. To retain the current 1.85:1 aspect ratio, a l.55X "squeeze" would work. If the industry adopted a new "universal" aspect ratio of 2:1, a 1.67X anamorphic lens would be the choice.

Comparison of "Scope" and "Flat" Apertures	
"Scope" Aperture: Height = 0.690 inches Width = 0.825 inches Area = 0.569 square inches Light Efficiency = 59.9%	
Flat Aperture (1.85:1): Height = inches Width = 0.825 inches Area = 0.368 square inches Light Efficiency = 38.7%M	
Apertures shown with a 0.110 inch diameter circle of light from lamphouse superimposed.	

Considering using a l.5X anamorphic lens that produces a 1.79:1 aspect ratio, the only modification to the projector would be the new l.5X anamorphic lens. The current "scope" aperture would be used for both 2.39: 1 and this new format. The standard 4-perforation pulldown would be retained, with no mechanical modifications necessary to the projector. For a 1.79:1 aspect ratio, the screen masking would be pulled in slightly from the current 1.85:1 width. No change in a existing analog or digital sound formats should be nessary.

This proposed format would be much more efficient in putting light on the screen. Today, a projector set to produce 16 footlamberts luminance for the "scope" format has only about 13 footlamberts in "flat" because of light wasted by the shorter aperture height. With a l.5X anamorphic lens, the same projector and lamp will give about 21 footlamberts because the larger aperture area more efficiently uses the circular cone of light from the lamphouse. The larger film image area of the new "scope" format requires much less magnification then 1.85:1 "flat," greatly improving sharpness, grain, and vertical steadiness. Because the energy of the light source is spread over a larger area of film, more light can be put onscreen with less heat on the film. This improves focus stability and reduces the possibility of heat damage. This is advantageous today because the desire to have larger screens in auditoriums is often accompanied by higher wattage xenon bulbs.

The general dimensions of this suggested format were demonstrated in 1984 by Glenn Berggren under the auspices of the MPAA and the Intersociety. At the time, most viewers agreed that the format offered significantly sharper images, less grain, greater depth of focus, and improved light efficiency. Factoring in the numerous technological advances that have taken place in the last thirteen years (i.e.: finer-grain, higher resolution, "faster" Kodak film stock; larger screens; more even light distribution; and better contrast ratios), the improvement onscreen today would be even more dramatic.

To optimize quality, this new format would require designing and building a new family of anamorphic camera lenses, including zoom and "prime" lenses of various focal lengths. The design is fairly straightforward (actually somewhat simpler than the 2X "squeeze" anamorphics). Possibly, the "squeeze" could be done digitally (as many special effects are today), but at additional cost.

The new format would necessitate theatres to be equipped with new anamorphic lenses, each costing approximately $3000. Although the major lens manufacturers support the concept, they need a commitment from production, distribution,and exhibition before investing in lens development. A "wait-and-see" attitude has prevailed at all levels. But the trend toward screens exceeding 30 feet in height and 60 feet in width mandates the exploration of new equipment. Adequately illuminating huge screens with aggravating focus flutter or causing heat damage to the film presents real challenges.

Kodak's "Operation Bigscreen" is poised to analyze a new format. Other groups are exploring format options as well. The National Association of Theatre Owners (NATO) has established a Blue Ribbon Technical Committee to "monitor where the industry is headed...and determine what is best so that no one gets blind-sided." Because exhibitors and audience alike want a high-quality film image, it is incumbent upon all of us to work together to achieve this.

I am most interested in commencing a dialogue about adoption of a new format. We have the need, we have the technology, and the opportunity to increase screen brightness by a minimum of 30 percent should be of great interest to all of us. Let me know your opinion.

Comparison of Current and Possible Future 35mm Projection Formats

FORMAT	Current Formats		Possible Future Formats		
	1.85:1 sph	**2.39:1 ana**	**2.00:1 ana**	**1.85:1 ana**	**1.79:1 ana**
Comments	"Flat"	"Scope"	ASC 2:1	Match "flat"	Nominal 1.5X
Film Image Height (in.)	0.446	0.69	0.69	0.69	0.69
Film Image Width (in.)	0.825	0.825	0.825	0.825	0.825
Film Image Area (sq.in.)	0.368	0.569	0.569	0.569	0.569
Lens Horizontal Squeeze	**1.00X**	**2.00X**	**1.67X**	**1.55X**	**1.50X**
Lens Focal Length (mm)	48.5	75	75	75	75
Screen Height (ft.)	20	20	20	20	20
Screen Width (ft.)	37	47.8	40	37	35.9
Screen Area (sq.ft.)	740	956	800	740	717
Magnification (height)	538	348	348	348	348
Magnification (width)	538	695	582	538	522
Magnification (area)	**289444**	**241860**	**202536**	**187224**	**181656**
Light Efficiency (%)	38.7	59.9	59.9	59.9	59.9
Screen Luminance (ft)	**13.4**	**16**	**19.1**	**20.7**	**21.3**

Assumptions:

- Format is aspect ratio, sph=Spherical Lens, ana=Anamorphic Lens
- Screen height of 20 feet is assumed for all formats in this comparison
- Lens focal length example assumes projection distance (lens to screen) of

85 feet

- Magnification (area) correlates most closley with image structure (sharpness and graininess)
- Light efficiency is percentage of light used from a uniformly illuminated 1.10 inch diameter circle of light
- Screen luminance base case is 16ft for 2.39:1 anamorphic format

For more information, contact me at john.pytlak@kodak.com